# **Experiment: Measurements**

# I. INTRODUCTION

Measurements are essential to experimental sciences such as chemistry, physics, biology, and geology. The measurements are usually made using the metric system units. This experiment is intended to give practice in making measurements to the greatest precision possible using metric units. The precision of a measurement is limited by the calibration of the measurement tool. A balance that gives readings to only the nearest 0.001 gram cannot be used to give masses to 0.00001 gram.

#### Materials and Equipment

Balance, metric rulers, meter stick, thermometer, thermometer clamp, sodium chloride (table salt), ice, 150 mL beaker, 400 mL beaker, 125 mL Erlenmeyer flask, 250 mL beaker, 10 mL, 50 mL, 100 mL graduated cylinders, solid unknown.

### **II PROCEDURE**

#### <u>Mass</u>

- Your instructor will give directions on how to use the balance. Some general rules to follow when using the balances are:
- The "tare" button will zero the balance.

• Always use a container or weighing paper for weighing chemicals. Do not place chemicals directly on the balance pan.

• Clean up any materials on or near the balance.

• If a balance seems to be out of order, please tell your instructor. DO NOT attempt to make adjustments on the balance.

1. In order to gain practice with the balance measure the mass of one of the weights in the weight sets. (Choose any size weight you like)

2. Weigh a coin to the nearest 0.01 gram. Record your answer on the data page.

3. Weigh an empty 150 mL beaker to the nearest 0.01 grams. Record your measurement.

#### Volume measurements

There are 10 mL, 25 mL, and 100 mL graduated cylinders available. Use the size most appropriate for the measurements.



- 1. Fill a test tube to the **brim** with water. Measure the volume of water.
- 2. Fill a 125 mL Erlenmeyer flask to the **brim** with water. Measure the volume of water to the nearest 1 mL.

#### Temperature

- Temperature measurements are made using mercury thermometers, thermocouples, gas filled thermometers, alcohol thermometers, etc. We will a digital thermometer.
- Measurement errors can result from the way the thermometer is located in a liquid. We can minimize some sources of error if we observe the following practices:
- Position the thermometer probe away from the walls of the container. Be sure the liquid is thoroughly mixed.
- Allow the thermometer to be in contact with the liquid for enough time so that the thermometer reaches equilibrium with the liquid.
- Temperatures should be measured to the precision allowed by the thermometer. If the thermometer scale reads to ±1.0 °C, only readings to the nearest degree are possible.

#### Cold tap water

- 1. Half fill a 400 mL beaker with cold tap water.
- 2. Place the thermometer bulb in the water.
- 3. Allow the thermometer to reach thermal equilibrium
- 4. Keep the thermometer in the middle of the liquid away from the glass.
- 5. Read and record the temperature of the tap water.

#### **Boiling water**

- 1. Half fill a 250 mL beaker with tap water.
- 2. Add one or two boiling chips to the water, using the
- arrangement shown in the figure.
- 3. Heat the water to boiling.

4. Read and record the temperature being sure to keep the thermometer bulb away from the bottom of the beaker.

#### Ice water

1. Place a hand-full of crushed ice in a 250 mL beaker.

2. Add approximately 50 to 60 mL of cold tap water.

3. Add more ice if necessary so that there is ice mixed with the water.

4. Without stirring place the thermometer in the water. Wait for thermal equilibrium, then read and record the temperature. Repeat this measurement with stirring.

#### Ice water plus salt

- 1. Weigh out approximately 4 to 6 grams of sodium chloride, NaCl.
- 2. Add the salt to the ice-water mixture.
- 3. Stir for few minutes and add more ice if necessary.
- 4. Read and record the temperature of the mixture.

#### **Distance/length Measurements**

- 1. Measure the external height of a 400 mL beaker in both centimeters and inches.
- 2. Measure the length of a test tube in both centimeters and inches.



**Boiling Water** 

### **Density Determination**

The density of a substance is an intensive physical property. It can be used to help identify a material. The formula for calculating density is:

D = <u>Mass in grams</u> Volume in milliliters

#### **Density of water**

1. Weigh a clean dry 10 mL graduated cylinder to the nearest 0.01 gram. Record the weight.

2. Add tap water to the graduated cylinder bringing the water level to the 10 mL mark.

Record the volume of water.

- 3. Weigh the graduated cylinder and water.
- 4. Calculate the density from the mass of water (obtained from the difference in mass

of the empty and full graduated cylinder) and the measured volume.

## Density of a solid object

1. Obtain a solid object. Record the vial number. (The unknown vial and the inside of the vial must be dry before you begin the experiment. If it is not, pour the metal onto a paper towel and allow it to dry. Use a paper towel to dry the inside of the vial.)

2. Weigh the solid object and the vial on the balance. Record mass.

3. Add enough tap water to a 100 mL graduated cylinder to bring the water level to the 50 mL mark. Record the volume of water.

4. Carefully place the unknown solid object (all of it!) into the graduated cylinder. The water level will rise.

5. Read and record the new position of the water level.

6. Weigh the empty vial and subtract to find the mass of the unknown solid.

7. Calculate the density of the solid object.

8. Dry the unknown solid and the vial as described in step one.



# **Experiment - Measurements**

Report Sheet

Name \_\_\_\_\_

Lab Partner \_\_\_\_\_

#### Mass measurement

1.	Mass of the gram weight from the weight sets	grams
2.	Mass of the coin(identify)	grams
3.	Mass of a 150 mL beaker	grams
Vo	lume measurements	
1.	Test tube	mL
2.	125 mL flask	mL
Те	mperature	
1.	Cold tap water	oC
2.	Boiling water	oC
3.	Ice water without stirring with stirring	oC
4.	Ice water and salt	oC
Di	stance/Length Measurements	
1.	Height of 400 mL beakercm	in
2.	Length of test tubecm	in

Density determination for water

1.	Weight of empty 10 mL graduated cylinder	grams
2.	Weight of 10 mL graduated cylinder plus water	grams
3.	Weight of water	grams
4.	Volume of water	mL
5.	Density calculation	g/mL

Show your calculations:

# Density determination of solid object

Vial number				
1. Mass of unknown solid and vial	g	Irams		
2. Mass of empty vial	g	Irams		
3. Mass of solid object	g	Irams		
4. Initial volume of water in 100 mL cylinder	n	nL		
5. Volume of water and solid object	n	nL		
6. Volume of solid object	n	nL		
7. Density of solid object	g	ı/mL		

Show your calculations:

Prelab	Name	Section
Measurements		

Complete the following questions **BEFORE** class. Refer to your textbook.

- 1. Write the full names of each of the following units:
  - a. mL\_\_\_\_\_
  - b. mg\_\_\_\_\_
  - c. km \_\_\_\_\_
  - d. °C \_\_\_\_\_

2. Write abbreviation for each of the following units:

- a. Liter \_\_\_\_\_
- b. micrometer \_\_\_\_\_
- c. kilogram \_\_\_\_\_
- d. milligram \_\_\_\_\_
- 3. Complete the following blanks:
  - a.  $1L = \____ dL$  b.  $1m = \____ cm$  

     c.  $1km = \____ m$  d.  $1mL = \___ L$  

     e.  $1mg = \___ g$  f.  $1cm^3 = \___ mL$
- 4. If an unknown metal weighs 12.35 g and occupies a volume of 4.57 mL, what is the density of this metal?