Experiment 3 CLASSIFICATION OF MATTER & MEASUREMENT OF DENSITY

Chem 110 Lab

I. INTRODUCTION

A. CLASSIFICATION OF MATTER

Matter may be divided into separate categories on the basis of a number of different classification schemes. For example, matter can be classified on the basis of state of matter at room temperature—whether it is solid, liquid, or gas. In this experiment you will be determining whether a sample of matter is an example of an element, a compound, a hom ogeneous mixture, or a heterogeneous mixture on the basis of its appearance.

B. MEASUREMENT OF DENSITY – EXPERIMENTAL DENSITY

Density is the ratio of the mass of a substance to its volume. $\text{Density} = \frac{\text{mass}}{\text{volume}}$

The unit of density may vary depending on the state of matter of the substance. Usually densities of liquids and solids are given in g/mL or g/cm^3, whereas densities of gases are often reported in g/L. To interpret the density unit, consider the density of aluminum which is 2.7 g/cm^3 or 2.7 grams per cubic centimeter. This means that 1 cm^3 of aluminum has a mass of 2.7 g or stating it another way—2.7 g of aluminum occupies a volume of 1 cm^3

In this experiment you will make mass and volume measurements and calculate densi ties of a variety of materials. When you make accurate measurements using the following measuring devices, you must report the values to the correct number of significant figures and include units. Remember:

- 100 mL graduated cylinder all values reported to 1 decimal place
- 10 mL graduated cylinder: all values reported to 2 decimal places
- top-loading balance digital display – all values reported to 2 decimal places

When you calculate density, your answer must be reported to the correct number of significan t figures.

C. ACCURACY OF A MEASUREMENT

You can determine the accuracy of your experimental density by comparing it to the theoretical density. The theoretical density is the most correct or well established value. Accuracy may be reported as <u>Error</u>, which is the difference between the experimental and the theoretical value, with theoretical always subtracted from experimental. (Therefore, error will be either positive or negative.)

$$\text{Error} = \text{experimental value} - \text{theoretical value}$$

<u>Absolute Error</u> is calculated in the same manner, however, the absolute value is taken, so absolute error will always have a positive value.

$$\text{Absolute Error} = |\text{experimental value} - \text{theoretical value}|$$

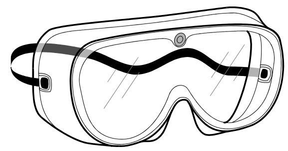
<u>Percent Absolute Error</u> (or Percent Error) indicates the significance of an error and is calculated:

$$\text{Percent Absolute Error} = \left(\frac{\text{absolute error}}{\text{theoretical value}}\right)100$$

Let's say we've measured a distance of 50 feet and are off by 3 feet (the error is 3 feet). And then we measure a distance of 5,000 ft and are again off by 3 feet (the error is again 3 feet). The 3 foot error is much more significant in the 50 foot measurement (6% error) than is the 3 foot error in measuring 5000 feet (0.06% error).

II. EXPERIMENT

PUT ON YOUR GOGGLES
AND LAB APRON!



A. CLASSIFYING MATTER

On the reagent bench are samples of various materials. In the first column of Table 3.1, write the name of the material. In the second column give a brief description of the material, including the state of matter (solid, liquid, gas), color, and any other observation. In the third column state whether the material looks homogeneous or heterogeneous. Finally, in the fourth column, write the class of matter to which the material belongs: compound, element, homogeneous mixture , or heterogeneous mixture. (Note: a solution is a type of homogeneous mixture.)

Table 3.1 Classification of Matter

MATERIAL	DESCRIPTION	APPEARANCE • HOMOGENEOUS • HETEROGENEOUS	CLASS • COMPOUND • ELEMENT • HOMOGENEOUS MIXTURE • HETEROGENEOUS MIXTURE

B. DENSITY OF AN IRREGULARLY SHAPED OBJECT.

1. Get two rubber stoppers, size #2, and a 100 mL graduated cylinder from the reagent bench.

2. Weigh the rubber stoppers together and record their mass in Table 3.2.

3. Pour about 40 mL (somewhere between 35 & 50 mL) of water into the 100 mL graduated cylinder. Record the measured volume in Table 3.2.

4. Tilt (slightly) the graduated cylinder and carefully slide in the two rubber stoppers (Don't splash!). Record the volume of the water plus stoppers.

TABLE 3.2 Measurements of Mass and Volume

Mass of rubber stoppers	
Volume of water	
Volume of water plus rubber stoppers	

5. Calculate the volume and density of the rubber stoppers. Show the complete set-up of each calculation in Table 3.3.

TABLE 3.3 Calculation of Volume and Density of Rubber Stoppers

	SET-UP OF CALCULATION, INCLUDING ALL UNITS
Volume of rubber stoppers	
Density of rubber stoppers	

C. DENSITY OF AN UNKNOWN LIQUID

1. Get a 50 mL beaker and 10 mL graduated cylinder from the reagent bench. (The term reagent is the general name for any substance or mixture used in the lab.) Clean and dry them (dry the graduated cylinder as well as you can).

2. Take the beaker and this paper to your instructor, who will pour an unknown into the beaker. Write your unknown number in Table 3.4.

3. Weigh the empty 10 mL graduated cylinder and record its mass in Table 3.4.

4. Pre-rinse the 10 mL graduated cylinder by adding 1-2 mL of your unknown, rolling it around the inside walls of the cylinder, and pouring it down the sink. (Pre -rinsing will remove any water remaining in the graduated cylinder).

5. Pour about 7 mL (anywhere from 6 to 8 mL) of your unknown liquid into the 10 mL graduated cylinder. Record the measured volume under "Run 1" in Table 3.4.

6. Weigh the graduated cylinder plus unknown liquid and record the mass under "Run 1" in Table 3.4.

7. Pour more unknown into the graduated cylinder until you have about 9 mL (anywhere from 8.5 to 10 mL) of unknown. Weigh the graduated cylinder plus unknown. Record the measured volume and mass of the graduated cylinder plus unknown under "Run 2" in Table 3.4.

BE SURE TO USE THE SAME BALANCE FOR ALL WEIGHINGS.

DO NOT DISPOSE OF YOUR UNKOWN LIQUID UNTIL <u>AFTER</u> YOUR INSTRUCTOR HAS APPROVED YOUR MEASUREMENTS AND CALCULATIONS

TABLE 3.4 Mass and Volume Measurements

Unknown Number:_____________	Run 1	Run 2
Mass of empty 10 mL graduated cylinder		
Volume of unknown sample		
Mass of graduated cylinder plus unknown		

CALCULATIONS ARE ON NEXT PAGE

8. CALCLULATIONS:

a. For each run, calculate the mass of unknown and the density of the unknown. Then calculate the average density. Give complete setups with all units in Table 3.5. Be sure your si gnificant figures are correct

TABLE 3.5 Calculations of Mass and Experimental Density of Unknown Liquid

Unknown # ______	SET-UP OF CALCULATIONS, INCLUDING ALL UNITS	
	Run 1	Run 2
Mass of sample		
Density		
Average Experimental Density		

b. Ask your instructor for the theoretical density of your unknown ________________________

c. Calculate the Percent Absolute Error in your experimental density (using your average experimental density) of the unknown liquid, which is calculated as follo ws:

$$\text{Percent Absolute Error} = \frac{|\text{experimental value} - \text{theoretical value}|}{\text{theoretical value}} \quad 100$$

Give the complete setup of your calculation below. Be sure to include all units and that the significant figures in your answer are correct.

Report Experiment 3 <u>CLASSIFICATION OF MATTER & MEASUREMENT OF DENSITY</u>
Chemistry 110 Lab

Name ______________________________ ______________________________ Date ______________
(last) (first)

Instructor's Initials______________

A. CLASSIFYING MATTER

Table 3.1 Classification of Matter

MATERIAL	DESCRIPTION	APPEARANCE	**CLASS**

B. DENSITY OF AN IRREGULARLY SHAPED OBJECT.

TABLE 3.2 Measurements of Mass and Volume

Mass of rubber stoppers	
Volume of water	
Volume of water plus rubber stoppers	

TABLE 3.3 Calculation of Volume and Density of Rubber Stoppers

	SET-UP OF CALCULATION, INCLUDING ALL UNITS
Volume of rubber stoppers	
Density of rubber stoppers	

C. DENSITY OF AN UNKNOWN LIQUID

TABLE 3.4 Mass and Volume Measurements

Unknown Number:_____________	Run 1	Run 2
Mass of empty 10 mL graduated cylinder		
Volume of unknown sample		
Mass of graduated cylinder plus unknown		

TABLE 3.5 Calculations of Mass and Experimental Density of Unknown Liquid

	SET-UP OF CALCULATIONS, INCLUDING ALL UNITS	
	Run 1	Run 2
Mass of sample		
Density		
Average Experimental Density		

Average Experimental Density of Unknown: ______________________________

Theoretical Density of Unknown: ______________________________

Calculation of Percent Absolute Error:

III. QUESTIONS

1. A solid object that has a mass of 7.72×10^{-2} g is added to a graduated cylinder containing 20.0 mL of water. The new volume reading is 23.9 mL. Calculate the density of the object.

2. Lead has a density of 11.34 g/cm^3. What is the volume, in mL, of 25.1 grams of lead?

3. How many significant figures are in each of the following measured numbers?

a. 0.74 _____ b. 720 _____ c. 0.0409 _____ d. 0.0010700 _____

4. To how many significant figures should the answers to each of the following be reported? (Assume numbers without decimals are exact numbers)

a. (0.74)(31.5)(22.4) a. _________

b. 16.3 + 9.27 + 4.025 b. _________

c. $\frac{61.5 - 57.3}{57.3}(100)$ c. _________

d. 25.65 - 18.47 d. _________

e. $1125 \text{ cm} \left(\frac{1 \text{ inch}}{2.54 \text{ cm}}\right)\left(\frac{1 \text{ ft}}{12 \text{ in}}\right)\left(\frac{1 \text{ yd}}{3 \text{ ft}}\right)$ e. _________

5. Consider the measurements and calculations involved in determining the density of the unknown liquid in today's experiment. Tell what effect each of the following would have on your experimental density—would the calculated density be higher than it should be or lower, or will there be no effect on the density. Circle the correct answer.

a. Using 15 mL of unknown liquid instead of 7 mL. high low no effect

b. Including the mass of the graduated cylinder in the weight of unknown liquid

high low no effect