

## DENSITY AND CLASSIFICATION

### I. INTRODUCTION

**Classification** is an important skill in science. Biologists classify organisms to better understand their characteristics. A pathologist classifies diseases to see if they have similar causes. Chemists classify different materials in order to understand and predict their properties. In this lab you will classify several materials as compounds elements or mixtures.

**Density** is the ratio of the mass of a substance to the volume occupied by the object:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

The units of density varies, depending upon the material measured. Density is grams per cubic centimeter ( $\text{g/cm}^3$ ) for solids, grams per milliliter ( $\text{g/mL}$ ) for liquids, and grams per liter ( $\text{g/L}$ ) for gases. The density of aluminum is given as  $2.7 \text{ g/cm}^3$  ( $\frac{2.7 \text{ g Al}}{1.0 \text{ cm}^3 \text{ Al}}$ ). This means that a  $1 \text{ cm} \times 1 \text{ cm} \times 1 \text{ cm}$  cube of aluminum would weigh 2.7 g.

The number of **Significant Figures** in measured numbers shows the uncertainty of the measuring device. Significant figures are the digits in any measurement that are known with certainty plus one more digit which is estimated.

#### A. Significant Figures in Calculations

##### 1. Addition and Subtraction

The answer may not have any more **decimal places** than the least accurate number

For example:  $91.$  *This is the least accurate number (least number of decimal places)*

$$\begin{array}{r} 91. \\ + 4.00 \\ \hline \end{array}$$

$95.$  *The answer has 2 significant figures*

##### 2. Multiplication and division

The answer contains the same number of sig. fig. as the measurement with the **least number** of sig. fig.

For example:  $23 \times 2.00 = 46$  *The answer has 2 sig figs.*

Accuracy (how close you are to the correct value) may be improved by carrying out several determinations and then computing an average value. The significance of the error in any given measurement depends on the magnitude of the error compared to that of the measurement. An error of one foot in measuring the height of a person is a relatively large error, whereas an error of one foot in determining the distance to Mars is a relatively small error. This relative error is usually expressed as a percentage of the measurement and is called percent error.

$$\% \text{ Error} = \frac{|\text{measured value} - \text{accurate (theoretical) value}|}{\text{accurate (theoretical) value}} \times 100$$

Chemistry is an experimental science, observations and making accurate measurements are very important. In this experiment you will measure mass, volume, length and temperature. From these measurements you will perform calculations to obtain other values.

## **II. PROCEDURE**

### **A. Classifying compounds elements, heterogeneous and homogeneous mixtures by appearance**

On the reagent bench are several samples of various materials. Write the name of the material, a brief description of its state, color and any other pertinent observation, state if the material appears homogeneous or heterogeneous and finally classify it as a compound element or mixture.

**Table 1: Classifying Types of Matter**

Material	Description	Homogeneous or heterogeneous	Classification : Compound, element, homogeneous mixture, or heterogeneous mixture

B. Density of an irregular shaped object.

1. Obtain two size # 2 rubber stoppers and a 100 ml graduated cylinder from the side bench.
2. Weigh the rubber stoppers together and record to  $\pm 0.01$  g.
3. Pour approximately 40 ml (somewhere between 35-50 ml) of water into the cylinder. Record the exact volume (measured to the nearest 0.1 ml).
4. Tilt (slightly) the graduated cylinder and carefully slide in the two rubber stoppers (Don't splash!) Record the new volume.

DATA:

Table 2

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

*Did you record the correct units and number of sig figs in your measurements?*

CALCULATIONS:

1. Calculate the volume of the stoppers. The volume of the water displaced is equal to the volume of the stoppers.

*NOTE:*  $1\text{ml} = 1\text{ cm}^3 = 1\text{ cc}$

2. Calculate the density of the rubber stoppers:

Table 3

	Set-up	Answer
Volume of Rubber Stoppers		
Density of rubber stoppers		

*Do you have the correct units and number of sig figs in your answers?*

Instructor's Initials \_\_\_\_\_

### C Density of an unknown liquid

1. Obtain a 50 ml beaker and 10 ml graduated cylinder from the side bench. Clean and dry it.
  2. Take the beaker and report sheet to your instructor, who will pour an unknown into the beaker. Write down your unknown number.
  3. Find the mass of the empty 10 ml graduated cylinder to .01g and record in table 4.
  4. Pre-rinse the 10 ml graduated cylinder, with approximately 1-2 ml of your unknown. The unknown is safe to be poured down the sink. (Pre-rinsing will remove any residue water left in the cylinder).
  5. Pour approximately 7 ml (between 6-8 ml) of your unknown into the 10 ml graduated cylinder. Record the exact volume to 0.01ml under "Run 1".
  5. Weigh the graduated cylinder plus unknown liquid to  $\pm 0.01g$ . Record the weight under "Run 1".
  6. Add more unknown to the graduated cylinder until you have approximately 9 ml (between 9-10 ml) of unknown. Weigh. Record the exact volume and weight under "Run 2".
- \* **DISPOSAL:** Dispose (after your calculations have been instructor approved on your report sheet) the unknown liquid in the sink.

#### DATA:

Unknown Number \_\_\_\_\_

Table 4

	Run 1	Run 2
Mass of empty 10 ml graduated cylinder		
Volume of unknown		
Mass of graduate cylinder plus unknown		

*Did you record the correct units and number of sig figs in your measurements?*

#### CALCULATIONS:

1. Calculate the mass of the unknown for both runs, using the weight of the empty graduated cylinder from part A and record in table 5. Set-up:
2. Calculate the density for both runs. and record in table 5. Set-up:
3. Calculate an average of the two runs on the next page.

Table 5

	Run 1	Run 2
Mass of unknown		
Density of unknown		

AVERAGE Density

Set-up:

$$\text{Average density} = \underline{\hspace{2cm}}$$

4. Write your unknown number and average density **on the report sheet**. Then, take your report sheet to your instructor and obtain the correct value. Calculate the % error.

$$\% \text{ Error} = \frac{|\text{measured value} - \text{accurate (theoretical) value}|}{\text{accurate (theoretical) value}} \times 100$$

PERCENT ERROR

Set-up:

$$\text{Percent error} = \underline{\hspace{2cm}}$$

*Do you have the correct units and number of sig figs in your answers?*

**Before you leave the lab you must have your lab instructor initial your report sheet.**

**NO CREDIT will be given for lab reports without the instructor's initials!**

**D. Practice Problems Complete the following problems before leaving the lab**

Show all work and significant figures.

1. What is the mass, in g, of a sample of 2.00 liters gold if the density of gold is 19.3 g/cc?

Answer \_\_\_\_\_

2. Water has a density of .998 g/ml. What is the volume, in ml, of .35 kg of water?

Answer \_\_\_\_\_

# Chem. 110 Lab Report

Name \_\_\_\_\_

Date \_\_\_\_\_

Lab Section \_\_\_\_\_

Initials \_\_\_\_\_

## EXPERIMENT 3

### DENSITY AND CLASSIFICATION

#### A. Classifying compounds elements, heterogeneous and homogeneous mixtures by appearance

**Table 1: Classifying Types of Matter**

Substance	Description	Homogeneous or heterogeneous	Classification : Compound, Element, Homogeneous mixture, or heterogeneous mixture

#### B. Density of an irregular shaped object.

DATA:

Table 2

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

CALCULATIONS:

Table 3

	Set-up	Answer
Volume of Rubber Stoppers		
Density of rubber stoppers		

#### C. Density of an unknown liquid

DATA:

Table 4

	RUN 1	RUN 2
Volume of unknown		
Mass of graduate cylinder plus unknown		

## CALCULATIONS:

Table 5

	Run 1	Run 2
Mass of empty graduated cylinder		
Mass of unknown		
Density of unknown		

AVERAGE DENSITY

Set-up:

Unknown number \_\_\_\_\_

Density = \_\_\_\_\_

Correct density = \_\_\_\_\_  
(From instructor)PERCENT ERROR

Set-up:

Percent error = \_\_\_\_\_

