# Mass and Volume Lab

## Purpose

The purpose of this experiment is to determine **<u>the identity</u>** and **<u>the density</u>** of two unknown metals. The precision and accuracy of the results will also be determined.

## Background and Introduction

The ratio of mass to volume of a substance is defined as density. ***A substance of uniform composition can be identified by because <u>density is a characteristic physical property matter because each substance has a unique density.</u>*** **If the mass increases then the volume will increase and density can be calculated.** The mass and volume of metal samples will be measured and the density will be calculated. Mass is measured directly using a balance. The volume of an irregularly shaped solid, however, cannot be measured directly. Instead, its volume is measured by an indirect method called water displacement. The initial volume of a given amount of water is measured using a graduated cylinder. The solid is then carefully added to the water in the graduated cylinder and the new (final) volume is recorded. The volume occupied by the solid must be the same as the volume of water that has been displaced and is therefore equal to the difference between the final and initial volumes. Density is calculated according to the following formula:

$$D = \frac{m}{V}$$

D= density, $m$ = *mass, and V = volume*

## Methods (Procedure)

1. Obtain samples of red metal shot and silver metal shot.

2. Obtain a clean, 25-mL and 10 mL graduated cylinder and add exactly 5 mL of water to the 10mL cylinder and exactly 14 mL of water to the 25 mL cylinder. Record these values as the initial volumes in the data table (column b).

3. Label the three weighing dishes: 1, 2, and 3. Pre-weigh three different masses of each metal using the weighing dishes.

4. Re-weight sample #1 again in the weighing dish. Record the mass of sample #1 in column 'a' of the data table.

5. **<u>Silver metal volume</u>**: Use the 25 mL graduated cylinder. Add 14 mL of water to the cylinder. Record 14 mL as the initial volume. Transfer sample #1 of the silver metal into the 25 mL cylinder that contains the 14 mL of water.

6. **<u>Red Metal volume:</u>** Use a 10 mL graduated cylinder. Add the 5 mL of water in the cylinder. Record 5mL as the initial volume. Transfer sample #1 of the red metal into the 10 mL cylinder that contains the 5 mL of water.

7. The best way to transfer the metal is to bend the weighing dish and tip the cylinder at a slight angle and gently pour the metal pieces into the water so that the water does not splash or splatter. If the water splashes out or splatters or if you spill the cylinder you must start over.

8. Record the final volume (volume of water plus the sample) in column 'c' of the data table.

9. Subtract the initial volume (value ***b***) from the final volume (value c) to calculate the volume of sample #1. Record this value in the column d in the data table. (volume of sample = value c – value b)

10. ***<u>Do not pour out the metal or water from the cylinder.</u>*** Record the volume of water in the cylinder as the new initial volume for sample two. Weight sample 2 again, record the mass and transfer sample two into the cylinder. Record the final volume as shown by the cylinder in column c for sample 2. Calculate the volume of the sample per step 7.

11. Repeat steps 4 - 8 for each of the remaining samples. The initial volume for sample 2 was the final volume from sample 1. The initial volume for sample 3 was the final volume from sample 2. Follow this procedure to obtain the initial volume measurements for the remaining sample(s). Record initial and final volume measurements and the volume of each subsequent sample in the data table.

| | a | b | c | d | e |
|---|---|---|---|---|---|
| Sample | Mass of Sample, (g) | Initial Volume, (mL) | Final Volume, (mL) | Volume of sample, (mL) **(c -b)** | Mass/ volume ratio of the sample (g/ mL) **(a ÷ d)** |
| Red 1 | | | | | |
| Red 2 | | | | | |
| Red 3 | | | | | |
| AVERAGE | XXXXX | XXXXXXX | XXXXXXX | XXXXXXX | |
| Silver 1 | | | | | |
| Silver 2 | | | | | |
| Silver 3 | | | | | |
| AVERAGE | XXXXX | XXXXXXX | XXXXXXX | XXXXXXX | |

The mass to volume ratio can be calculated directly by dividing the measured mass of an object by its measured volume. Using the mass from column 'a' and volume from column d, calculate this ratio for each sample. ***These are your calculated ratio values****.* Now calculate the average (mean) ratio. **<u>This average ratio is your experimentally determined density</u>.**

## Post-Lab Questions

*Answer these questions in your lab book. Do not write the questions. Number you answers.*

1. Use the following **<u>accepted values</u>** of density to determine the probable identity of your metal by comparing these accepted values (shown below) **<u>with your experimentally determined density</u>** values for each metal. Write in your lab book: The red metal is __________. The silver metal is ___________.

| **Metal:** | **Magnesium** | **Aluminum** | **Barium** | **Titanium** | **Zinc** | **Copper** | **Lead** | **Hafnium** |
|---|---|---|---|---|---|---|---|---|
| **Density (g/mL):** | **1.55** | **2.70** | **3.50** | **4.51** | **7.14** | **8.96** | **11.3** | **13.10** |

2. Use the following equation to calculate the percent error in your **<u>experimentally determined</u>** for density from column e of the data table and the accepted value provided this handout. Report your percent error to three significant figures. The percent error measures the accuracy of your results. ***Consider your results accurate if the percent error is equal or less than 10%***. **<u>Show your work for both your red metal & silver metal data.</u>**

$$\text{Percent error} = \frac{|\text{Accepted value - Calculated value}|}{\text{Accepted value}} \times 100$$

3. State if your result accurate is or is not accurate for the red metal and then do the same for the silver metal.

4. Are your ratio calculated ratio values for precise? Use the formula below to calculate the range of your three ratio values for each metal. **<u>Show your work for both the red metal & the silver metal.</u>** Report the % range to3 significant figures. ***Consider your values precise if the range is less than or equal to 20% and answer, red metal: yes - precise, or no - not precise; silver metal: yes-precise, or no - not precise.***

$$\% \text{ Range} = \frac{|\text{Highest value - Lowest value}|}{\text{Lowest value}} \times 100$$

5. The hypothesis stated that as the mass increased, the volume would increase. Look at your data table Was the hypothesis for this experiment always true for each different IV, sometimes true, or never true? If the hypothesis was not always true, why did this happen? Does the graph show the trend was true (as the mass increase, the volume increases)?

6. Why can a substance be identified by its density?