

## **DENSITY OF LIQUIDS & SOLIDS**

### Experiment 2

#### **INTRODUCTION:**

Density is a measure of the quantity of mass of a substance that occupies one unit of volume. In other words, the density of a substance is the ratio of its mass to its volume:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

When measured at the same temperature and pressure, all samples of a particular substance have the same density regardless of the quantity or shape of the sample. Thus density is an *intensive* property of matter and is often used by chemists to identify a substance. The density of a liquid or of a solution is usually reported in units of grams per milliliter (g/ml). The density of a solid is reported in units of grams per cubic centimeter (g/cm<sup>3</sup>). Because 1 ml is equivalent to 1 cm<sup>3</sup>, these units are interchangeable.

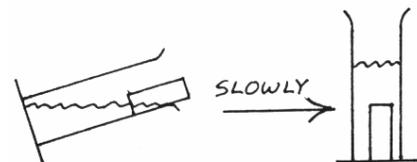
#### **APARATUS & MATERIALS:**

- |                      |                 |
|----------------------|-----------------|
| ? Balance            | ? oil           |
| ? graduated cylinder | ? water         |
| ? 3 test tubes       | ? solid unknown |

## **PROCEDURE:**

### ***Part I: Density of a Solid Unknown***

1. Obtain a solid sample from the instructor.
2. Weigh the solid sample directly on the balance, and record the mass.
3. Add approximately 20 to 30 ml of water to your cylinder. Read the volume of the water to the nearest 0.1 mL, and record the volume.

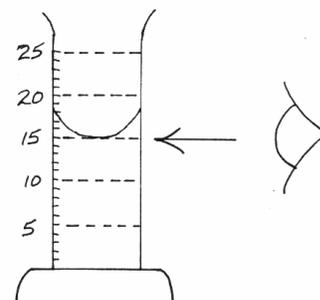


**(Note: the volume of the water used must completely submerge the solid sample)**

4. Tilting the graduated cylinder slightly, slowly slide the solid sample down the inside wall of the cylinder. Avoid splashing any of the water out of the cylinder (see diagram).
5. Read the volume of the liquid in the graduated cylinder, and record the volume.
6. Drain the water from the graduated cylinder. Dry the solid sample, and return to the instructor.

### ***Part II: Density of a Liquid***

1. Weigh a clean, dry, graduated cylinder. Record the mass as “Tare Mass”.
2. Remove the cylinder from the balance, without excessive handling, to avoid transferring dirt and oil from your fingertips.
3. Pour 10 to 15 ml of distilled water to the graduated cylinder. Read the volume of your sample to the nearest 0.1 mL, and record as “Volume of Water”. (Note: Be sure to read the liquid meniscus correctly, as shown in the diagram to the right).
4. Weigh the water and the graduated cylinder, and record the mass as “Mass of Water and Tare”.
5. Dispose of the water in the sink, and clean and dry the graduated cylinder.
6. Repeat steps 3-5 with a sample of oil, and record data as above.



**NOTE: DO NOT DISPOSE OF THE OIL IN SINK. SAVE FOR USE IN PART III**

### ***Part III: Density and Floating***

1. Add 2-3 mL of water into each of two test tubes.
2. Add an equal amount of oil to one of the test tubes with water and shake carefully to mix the contents. Let the contents settle, and observe how many layers form. Identify each layer.
3. Add an equal amount of alcohol to the other test tube with water and shake carefully to mix the contents. Let the contents settle, and observe how many layers form.
4. To the third test tube carefully add 2-3 mL of water, an equal amount of oil and an equal amount of alcohol in the order described. Observe the layers formed. Identify each layer.

### **CALCULATIONS:**

#### ***Part I : Density of Solid***

1. Determine the volume of the solid by subtracting the volume of water from the volume of water and solid.
2. Calculate the density of sample and record on Report Form.
3. Identify your solid sample from the list in Table on page 4, and determine percent error.

$$\text{Percent error ? } \frac{(\text{observed value}-\text{true value})}{\text{true value}} \times 100$$

#### ***Part II: Density of a Liquid***

1. Determine the mass of water by subtracting the mass of the empty cylinder (tare mass) from the mass of the cylinder and water.
2. Calculate the density of water, and record on Report Form.
3. Similarly calculate the density of oil, and record on Report Form.

## DENSITIES OF SOME SOLIDS

<i>Substance</i>	<i>Density at 20°C (g/cm<sup>3</sup>)</i>
aluminum	2.70
steel	7.86
brass	8.50
copper	8.96

**REPORT FORM**  
Experiment 2

*Part I. Density of a solid*

	<b>Record Data and Show calculations here</b>
Mass of metal	
Volume of water in graduated cylinder	
Volume of water + solid unknown	
Volume of solid unknown*	
Density of solid unknown*	
Identity of solid unknown	
Percent error*	

**\* Note: These quantities must be calculated**

**Part II. Density of a liquid**

	<b>Record Data or Show calculations here</b>
Volume of water	
Tare mass	
Mass of water + Tare	
Mass of water*	
Density of water*	
Volume of oil	
Mass of oil + Tare	
Mass of oil*	
Density of oil*	

**\* Note: These quantities must be calculated**

**Part III. Density and Floating**

Arrange, oil, alcohol and water in the order of decreasing density:

\_\_\_\_\_ > \_\_\_\_\_ > \_\_\_\_\_  
highest lowest

