

**Basic Skills for Chemistry**  
**CHEM-1020**  
**Experiment No. 4**

**Density of a Solid**

**INTRODUCTION:** The density of a metal, in the form of irregularly shaped pieces, will be determined by measuring the masses and volumes of several metal samples and applying the formula  $d = m/v$ . Three determinations will be made using different amounts of metal each time. The metal masses will be determined by weighing a full container of metal and then reweighing every time a sample of metal is removed. The volumes of the different amounts of metal will be determined using Archimedes' principle, which states that an object displaces a volume of liquid equal to its own volume. You will calculate an average metal density from the three trials and compare your experimental result with an accepted literature value.

**PROCEDURE:** Obtain a numbered vial containing a metal sample. Record all subsequent data on the data table on the next page using black, nonerasable ink. **Vial Number and Metal Name** \_\_\_\_\_

**Trial 1:** Weigh the full vial of metal and record its mass. Put about 25 mL of distilled water into a 50 mL graduated cylinder. Record the volume of water to the correct number of decimal places. Gently pour about one-third of the metal into the graduated cylinder. (This is referred to as sample 1.) Tap the bottom of the cylinder gently on the bench top to dislodge any air bubbles between the pieces of metal. Record the new volume of water plus metal the graduated cylinder. Weigh the vial with the remaining two-thirds of metal in it. The mass of metal you placed in the graduate cylinder is the difference between the mass of the full vial and the mass of the two-thirds full vial. The volume of the metal is the difference between the volume of water alone and the volume of water plus metal. From now on, do not remove any water or metal from the graduated cylinder. Proceed to the next trial.

**Trial 2:** Pour one-half of the metal remaining in the vial into the graduated cylinder. (The metal now in the graduate cylinder constitutes sample 2.) Record the new volume of the water plus metal. Weigh the vial with the remaining metal in it (1/3 full vial).

**Trial 3:** Pour the metal remaining in the vial into the graduate cylinder. Record the new volume of the water plus metal (sample 3). Record the mass of the empty vial.

**Cleanup:** Use a metal screen to separate the metal and water and return the wet metal to the original vial. Return the vial, *uncapped*, to the laboratory supply cart. Shake excess water out of your graduate cylinder wipe down all wet bench surfaces with a sponge

On page 3, clearly show the setups and calculations you used to answer the questions.

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**Data Page**

**Trial #1**

**Trial #2**

Mass of full vial \_\_\_\_\_

Mass of full vial (same as Trial 1) \_\_\_\_\_

Mass of 2/3 full vial \_\_\_\_\_

Mass of 1/3 full vial \_\_\_\_\_

Mass of sample 1  
\*\*\*\*\*

Mass of sample 2  
\*\*\*\*\*

Volume of water and first sample \_\_\_\_\_

Volume of water and second sample \_\_\_\_\_

Volume of water alone \_\_\_\_\_

Volume of water alone (same as Trial 1) \_\_\_\_\_

Volume of sample 1  
\_\_\_\_\_

Volume of sample 2  
\_\_\_\_\_

**Trial #3**

Mass of full vial (same as Trial 1) \_\_\_\_\_

Mass of empty vial \_\_\_\_\_

Mass of sample 3 \_\_\_\_\_

Volume of water and sample 3 \_\_\_\_\_

Volume of water alone (same as Trial 1) \_\_\_\_\_

Volume of sample 3  
\_\_\_\_\_

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**Report Page for Density of a Solid**

1. Calculate the density of the metal from each trial using the equation  $d = m/v$ . Show your setups clearly for each density calculation. (12 points)

2. Calculate the average metal density from the three trials. Show your setup. (2 points)

3. Enter the literature value for the metal density: \_\_\_\_\_

Cite the reference used: \_\_\_\_\_

4. Calculate the percent error of your density determination. Show your work clearly. (3 points)

$$\% \text{ error} = \frac{|\text{reference value} - \text{experimental value}|}{\text{reference value}} \times 100 \%$$

4. Does the density of the substance vary significantly with the amount of metal used in the determination? Should the density values for the three different amounts of metal be the same or not? Explain. (3 points)