

PRE-LAB DISCUSSION

Chemistry is the study of matter, which is defined as anything that has mass and volume. In this experiment, you will measure volumes of different materials, using indirect methods. You also will use the relationship between the mass and volume of a substance to find its density.

Volumes of liquids are measured directly in a graduated cylinder. Liquid quantities dealt with in the laboratory usually expressed in milliliters (ml), although larger quantities may be expressed in liters (L). Volumes of regularly shaped geometric solids can be calculated from direct measurements of their dimensions. For example, the volume of a rectangular solid is calculated by multiplying its length, width, and height ($V = l \times w \times h$). Volumes of solids usually are expressed in cubic centimeters (cm^3).

Many solids do not lend themselves to direct measurement of their dimensions. These include irregularly shaped objects, such as rocks, and regular solids that are too small to be measured with accuracy. Volumes of such solids can be measured by water displacement. If a solid immersed in a liquid, such as water, the solid will push aside, or displace, a volume of water equal to its own volume. Thus, each milliliter of water displaced by a solid represents one cubic centimeter of solid volume.

Density is an important property of matter. By itself, or in conjunction with other properties, density can be used to identify substances. Density is defined as the quantity of matter in a given unit of volume. This relationship, expressed mathematically, is

$$\text{density} = \frac{\text{mass}}{\text{volume}} \quad \text{or} \quad d = \frac{m}{v}$$

PURPOSE

Learn and practice techniques and calculations for determining volume and density of a substance.

EQUIPMENT

Laboratory balance
Graduated cylinder, 100-mL

Graduated cylinder, 10-mL
Thread

MATERIALS

Distilled water
Unknown liquids (Liquid A, liquid B...)
Irregularly shaped solids (Rocks, metals, coins...)

PROCEDURE

PART A, LIQUIDS AT ROOM TEMPERATURE

1. Measure and record the mass of a clean, dry 10-mL graduated cylinder. (a)
2. Add some amount of distilled water to the cylinder. Read and record the volume of distilled water. (b)
3. Measure and record the combined mass of the cylinder and water. Dispose of the water. Clean and dry the cylinder. (c)
4. Repeat steps 1 and 2 for two unknown liquids.

OBSERVATION AND DATA

Part A

1. Mass of 10-mL graduated cylinder _____ g (a)
2. Volume of water _____ mL (b)
3. Sample Mass (cylinder + sample)
 - a) Distilled water _____ g (c)
 - b) Unknown liquid _____ g
 - c) Unknown liquid _____ g

PART B, IRREGULARLY SHAPED SOLIDS

1. Measure and record the mass of an irregularly shaped solid by equal arm balance. (d)
2. Round a piece of thread around the solid.
3. Add some water to the empty 100-mL graduated cylinder and record the volume. (e)
4. Immerse the solid into the cylinder holding from the thread. Record the combined volume of solid and liquid. (f)
5. Repeat steps 1 to 4 for another unknown solid.

Part B

1. Mass of irregular solid, _____ g (d)
2. Volume of water _____ mL (e)
3. Combined volume of irregular solid and water_mL (f)
4. Volume of irregular solid _____ g (f - e)
5. Write the same values for the next irregular solid.

CALCULATIONS

- Density of unknown liquid = $m / V = (c - a) / b = \dots\dots\dots$
- Density of unknown liquid = $m / V = (c - a) / b = \dots\dots\dots$

If the true densities of substances are known, experimental error can be calculated by:

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

CONCLUSION AND QUESTIONS

1. The density of distilled water at 20 °C is approximately 1.0 g/mL. Compare your experimental result with this value. What errors might account for differences between your result and accepted value?
2. Why is it necessary to indicate temperature when giving density values of liquids?
3. This table below lists the densities for several substances. (Liquids are at 20 °C) Using this table and your data, try to identify the following:
 - a) Unknown liquid a;
 - b) Unknown liquid b;
 - c) Unknown solid a;
 - d) Unknown solid b;
4. Density is a characteristic property of matter. Do you know other such properties?

<u>Sample</u>	<u>Density</u>
Lead	11.34 g/cm ³
Copper	8.93 g/cm ³
Aluminum	2.70 g/cm ³
Ethanol	0.79 g/mL
Vegetable oil	0.92 g/mL
Glycerin	1.25 g/mL
Ethylene glycol	1.11 g/mL