DENSITY - A PROPERTY OF MATTER
Reminder – Goggles must be worn at all times in the lab!

PRE-LAB DISCUSSION:
Chemistry is the study of matter, which is usually defined as anything that has mass and volume. You already have some experience determining mass and volume in the lab. In this experiment, you will measure volumes of different materials, using direct and indirect methods. You will also 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 are 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 ($V = \ell \cdot w \cdot h$). Volumes of solids are usually 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 any degree of accuracy. Volumes of such solids can be measured by water displacement. If a solid is 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 that is 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:

$$\text{Density} = \frac{\text{mass}}{\text{volume}} \qquad \text{or} \qquad D = \frac{m}{V}$$

You will be expected to use the measuring skills and techniques developed in earlier lab sessions and in the first part of this experiment to find the mass and volume of different substances. You will use these data to calculate the density of these substances.

PURPOSE:
To combine methods of determination of both mass and volume to calculate the density of several solids and liquids.

PROCEDURE:
Part I: SOLIDS.
1. Get a piece of glass rod and some thread from the front table. (Be sure to return the rod at the end of this class period.
2. Weigh the glass rod and record its mass to three places past the decimal.
3. Fill a 10 mL graduated cylinder with enough water to cover the glass rod, but not so much as to over-run the 10 mL mark. Record the initial volume.
4. Tie a piece of thread around the section of glass rod. Lower the glass into the water in the cylinder until it is completely submerged. Read and record the NEW water level.
5. Repeat this process with pieces of copper and zinc, being certain to record all volumes and masses on your lab paper.

Part II. Densities of Liquids at Room Temperature.
1. Clean and dry your 10 mL graduated cylinder.
2. Weigh the cylinder carefully and record its mass to the nearest thousandth.
3. Take the cylinder to the back table and measure out EXACTLY 1.00 ml of ethanol. Record this volume on your data sheet.
4. Go back to your lab station and reweigh the cylinder and contents and record the mass to the nearest thousandth.
5. Repeat steps 1 - 4 using glycerine.
6. Clean and dry your graduated cylinder.
7. Record the mass of your empty cylinder to the nearest thousandth.
8. Fill the cylinder to the 10.00 ml mark with distilled water. Be sure to read the bottom of the meniscus. Record this volume of water on your data sheet.
9. Reweigh your cylinder and water and record this mass on your data sheet to the nearest thousandth.

RESULTS:
Observations and Data

Part I: Solids

Mass and Water Displacement

	Mass	Original H_2O Level	Final H_2O level
1. Glass rod	_____g	_____mL	_____mL
2. Zinc	_____g	_____mL	_____mL
3. Copper	_____g	_____mL	_____mL

Part II: Densities of Liquids at Room Temperature

	Volume of sample	Mass of empty graduate	Mass of grad + contents
1. Ethanol	_____ml	_____g	_____g
2. Glycerine	_____ml	_____g	_____g
3. Water	_____ml	_____g	_____g

Calculations

1. Complete the calculation of the density of each substance. Remember, D = m/V. List the masses of these substances arrived at from your data or calculations. List the volumes from your data or calculations. Calculate the densities from the mass and volume data. The "accepted values" for various substances are listed below. Finally, calculate the difference between YOUR lab value and the accepted value.

Solids	**Mass (g)**	**Volume (ml)**	**Density g/ml or g/cm^3**	**Accepted Density**	**Difference in Density**
Glass rod				2.4 g/cm^3	
Zinc				7.10 g/cm^3	
Copper				8.94 g/cm^3	

Liquids	**Mass (g)**	**Volume (ml)**	**Density g/ml or g/cm^3**	**Accepted Density**	**Difference in Density**
Ethanol				0.79 g/ml	
Glycerine				1.25 g/ml	
Water				1.00 g/ml	