Name _____

Lab: It's All About Density

Background:

Density is defined as the amount of matter that occupies a given unit of space: it can also be thought of as the "compactness" of a substance. Dense materials (such as lead or gold) are very heavy for their size whereas less dense substances (such as a big bag of feathers or a filled balloon) are light for their size.

Density is equal to a substance's mass per unit volume, where *mass* is the amount of matter in an abject *measured in grams) and *volume* is the amount of space that an object occupies (measured in milliliters or cubic centimeters). The equation to calculate density is as follows:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \quad \text{OR} \quad D = \frac{M}{V} \text{ (in g/mL or g/cm}^3\text{)}$$

Density if an intrinsic physical property of matter – that is, it is a property unique to a specific substance (at a specified temperature) no matter what size the sample. A substance's density varies with temperature and pressure changes. The benchmark for comparing density is water which, at 4°C, has a density of 1.00 g/mL. Substances that float in water are less dense than water, while substances that sink are more dense that water.

Table 1:

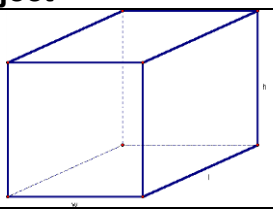
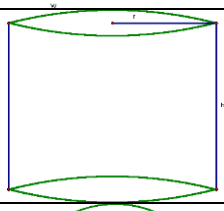
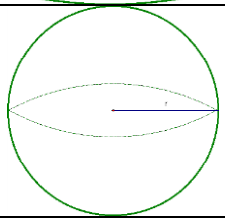
Shape of Solid Object		Volume (in cm^3)
Cube or Rectangle		V = L x W x H
Cylinder		$V = \pi \times r^2 \times h$
Sphere		$V = 4/3 \times \pi \times r^3$

Table 2:

Densities of Common Substances			
Substance	**Density (g/cm^3)**	**Substance**	**Density (g/cm^3)**
Helium	0.0002	Sulfur	2.07
Air	0.001	Silicon	2.33
Balsa Wood	0.11-0.14	Glass	2.4-2.8
Cork	0.22-0.26	Aluminum	2.70
Maple Wood	0.65-0.75	Calcium carbonate	2.93
Ethanol	0.789	Rubber	1.34
Mineral oil	0.86-0.93	Iron	7.86
Polyethylene plastic	0.92	Copper	8.92
Water	1.000	Lead	11.3
Polystyrene plastic	1.06	Mercury	13.6
Fool's Gold (FeS_2)	5.0	Gold	19.3

Procedures:

1. Determine the mass and volume of each of the following seven materials using the appropriate method as outlined in the background section.
   - Station 1 – Clear Liquid I
   - Station 2 – Clear Liquid II
   - Station 3 – White block
   - Station 4 – Foam block
   - Station 5 – Rubber stopper
   - Station 6 – Glass sphere
   - Station 7 – Metal cylinder
2. Record the mass and volume of each substance in the Density Data Table. Be sure to include the appropriate units.
3. Calculate the density of each material
4. Determine the identity of the unknown metal cylinder by comparison with the actual values for density.

Pre-lab Questions:

Type of Material	M or V Data	Mass (grams)	Volume (mL or cm^3)	Density (g/mL or g/cm^3)	Identity of Solid
Rectangular Solid	L = 1.23 cm W = 2.34 cm H = 3.45 cm	10.6 g			
Cylindrical Solid	h = 3.45 cm d = 1.12 cm	26.72 g			
Irregular Solid	Vol water = 25.2 mL Vol water + solid = 37.4 mL	61.1 g			
Liquid	Mass empty cylinder = 40.1 g Mass cylinder + liquid = 93.2 g		67.2 mL		

Lab Data:

Station	Name of Object	Mass (g)	Volume (mL of cm^3)	Density (g/mL or g/cm^3)
1	**Clear Liquid I**	Cylinder + liquid = Cylinder = Liquid =		
2	**Clear Liquid II**	Cylinder + liquid = Cylinder = Liquid =		
3	**White Block**		V = L x W x H L = W = H = V =	
4	**Foam Block**		V = L x W x H L = W = H = V =	
5	**Rubber Stopper**		Water = Water + stopper = Glass =	
6	**Glass Sphere (Water displacement method)**		Water = Water + glass = Glass =	
	Glass Sphere (Measurement method)		V = 4/3 πr^3 d = r = V =	
7	**Metal Cylinder (Water displacement method)**		Water = Water + metal = Metal =	
	Metal Cylinder (Measurement method)		V = $\pi r^2 h$ d = r = h = V =	

Post-Lab Questions:

1. Rank the materials tested in this lab in order from most dense to least dense.

2. If the foam block was cut in half, would the density change? Explain.

3. List the items in this lab that would float on water. How was this determined?

4. Consider the following six materials – water, mercury, mineral oil, cork stopper, rubber stopper, and a piece of lead. If these materials were added to a graduated cylinder, in water order would they be found from top to bottom?

5. Why is density an important factor to know about a material?

6. Use the "Table of Densities of Common Substances" to identify Clear Liquids I & II.

7. Observe the metal cylinder tested at Lab Station 7. Using the density you obtained and observations, identify the metal.

8. From you answer to question 7, which method for determining density did you find to be more accurate? Explain.

9. Explain how you would find the density of your own body.