

Density & Physical-Chemical Properties

Name: _____

Part I: 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.

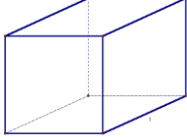
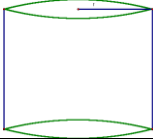
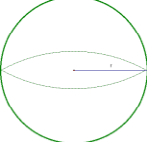
Density is equal to a substance's mass per unit volume, where **mass** is the amount of matter in an object (measured in grams) and **volume** is the amount of space that an object occupies (measured in milliliters or cubic centimeters). The equation to calculate density is as follows:

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

Density is 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. Density can therefore be used to distinguish one substance from another.

Determining the density of an object involves measuring the object's mass and volume and then calculating the density. The technique for measuring the volume of a solid, however, depends on the shape of the sample. For a regularly shaped solid – such as a cube, cylinder, or sphere – the volume can be calculated using the appropriate equation from Table 1.

Table #1

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

NOTE: $\pi = 3.14$ and $r = \text{radius} = \frac{1}{2} d = \frac{1}{2} \text{diameter of cylinder or sphere}$

The volume of an irregularly shaped solid, however, cannot be measured using a ruler; it must be found indirectly using a method called **displacement**. Water displacement involves submerging the object into a known volume of water and measuring the volume rise after adding the object. The volume of water displaced by the solid is equal to the object's volume (in mL or cm³).

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	Fool's Gold (FeS ₂)	5.01
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
Ebony Wood	1.11-1.33	Gold	19.3

Directions:

1. Use the sample data provided, as well as the background information to calculate for density of each substance.
2. Determine the identity of each substance by comparison with the actual values for density from Table #2.
3. Fill in the data Table #3 showing your work and calculations within each box. Be sure to include your units.

Table #3

Type of Substance	M or V Data	Mass (grams)	Volume (mL or cm ³)	Density (g/mL or g/cm ³)	Identity of Substance
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 H ₂ O + solid = 37.4 mL Vol H ₂ O = 25.2 mL	61.1 g			
Liquid	Mass cylinder + liquid = 93.2 g Mass cylinder = 40.1 g		67.2 mL		

Part II: Physical-Chemical Properties & Changes:

Identify each of the following as a Physical or Chemical change; Put a **PC** next to physical changes and a **CC** next to chemical changes.

1. Piece of wood burns to form ash → _____
2. Diamonds are the hardest minerals → _____
3. Bicycle chain rusts → _____
4. Food is digested in the stomach → _____
5. Aluminum is flattened into a foil form → _____
6. Piece of apple rots on the ground → _____
7. Plant turns sunlight, CO₂, and water into sugar and oxygen → _____
8. Sugar dissolves in water → _____
9. Popsicle melts → _____
10. Autumn leaves changing color → _____
11. Hot glass cracks in cold water → _____
12. Fogging a mirror with your breath → _____
13. Heat and radiation are produced during a nuclear blast → _____
14. Dry ice is a very volatile solid → _____

15. Choose two (2) of the above examples and explain why you chose chemical or physical. Choose one of each type of change and provide an explanation.

Physical change explanation:

Chemical change explanation: