
Density

Questions

- How does a change in mass and/or volume affect density?
 - What determines if an object will sink, float or remain suspended in a liquid substance?
 - How can density be used to identify a substance?
-

Vocabulary

Define the following vocabulary words:

- Matter
 - Mass
 - Volume
 - Density
-

Matter

Matter - A substance that has mass and volume

- Mass = "stuff"
- Volume = "space"



Matter
Solid, Liquid and Gas

Mass

Mass - The measure of matter in an object.

- Units: grams (g)
- Apparatus: Balance

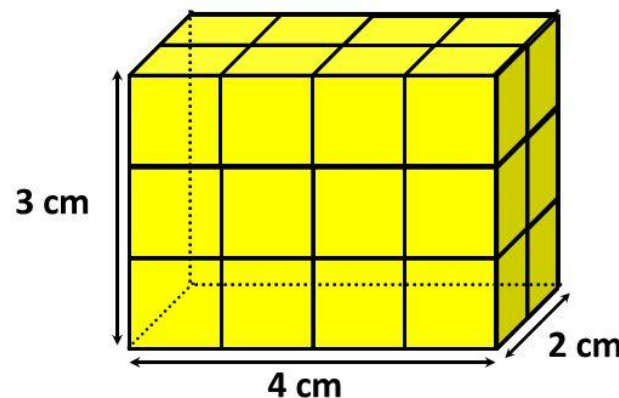
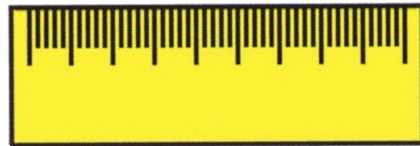


PRESSURE & TEMPERATURE affect volume!

Volume

Volume - How much “space” an object occupies

- Units: Milliliter (mL) **or** Cubic centimeter (cm³)
- Apparatus: Graduated cylinder, ruler, overflow can



$$\text{Volume} = 4 \times 2 \times 3$$

$$\text{Volume} = 24 \text{ cm}^3$$

$$\text{Volume} = \text{length} \times \text{width} \times \text{height}$$

Density

Density - describes the relationship between a material's mass and volume.

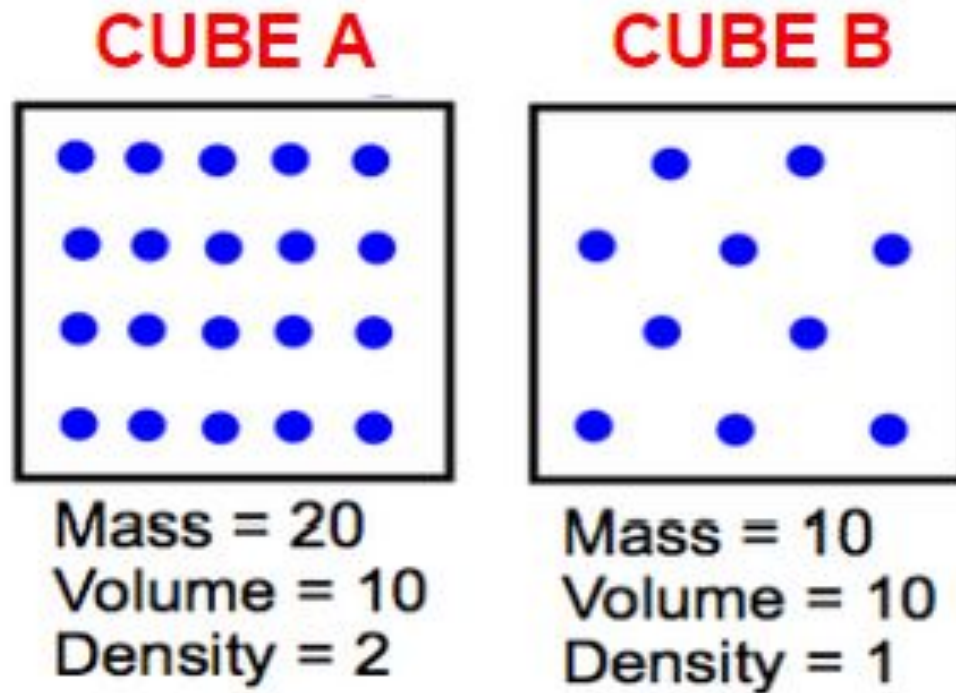
$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \quad D = \frac{M}{V}$$

Units:

- **Mass** = grams (g)
 - **Volume** = milliliters (mL) or cubic centimeters (cm³)
 - **Density** = g/mL or g/cm³
-

Density

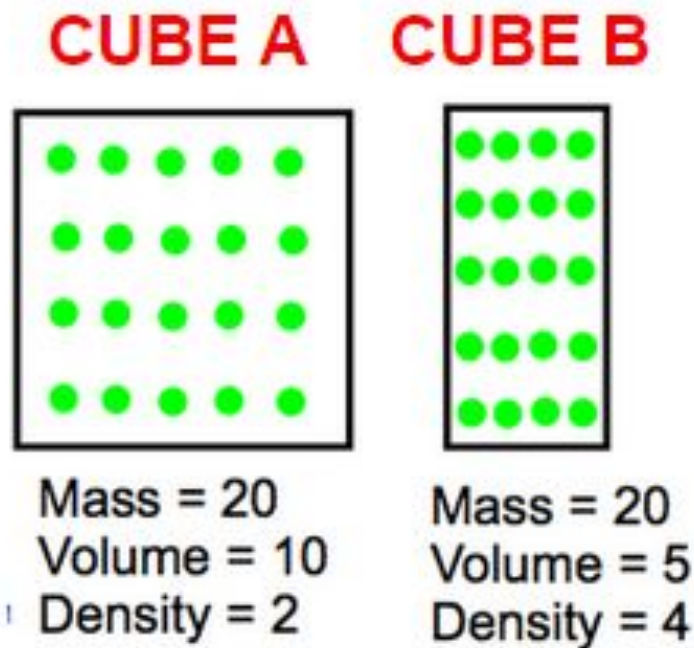
Density = "Compactness"



CUBE A is more compact than CUBE B.

Density

Density = "Compactness"

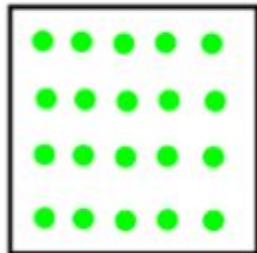


CUBE B is more compact than CUBE A.

Density

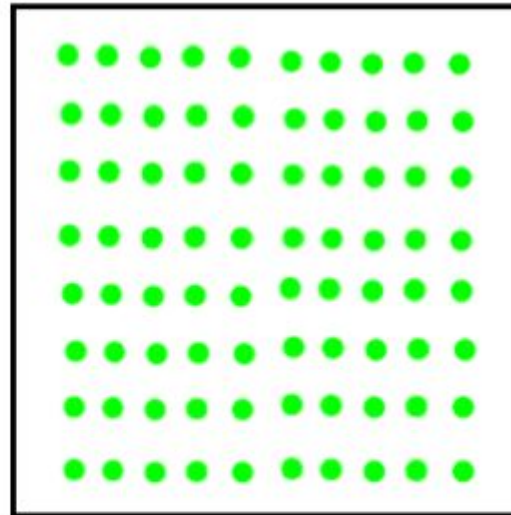
Density = "Compactness"

CUBE A



Mass = 20
Volume = 10
Density = 2

CUBE B

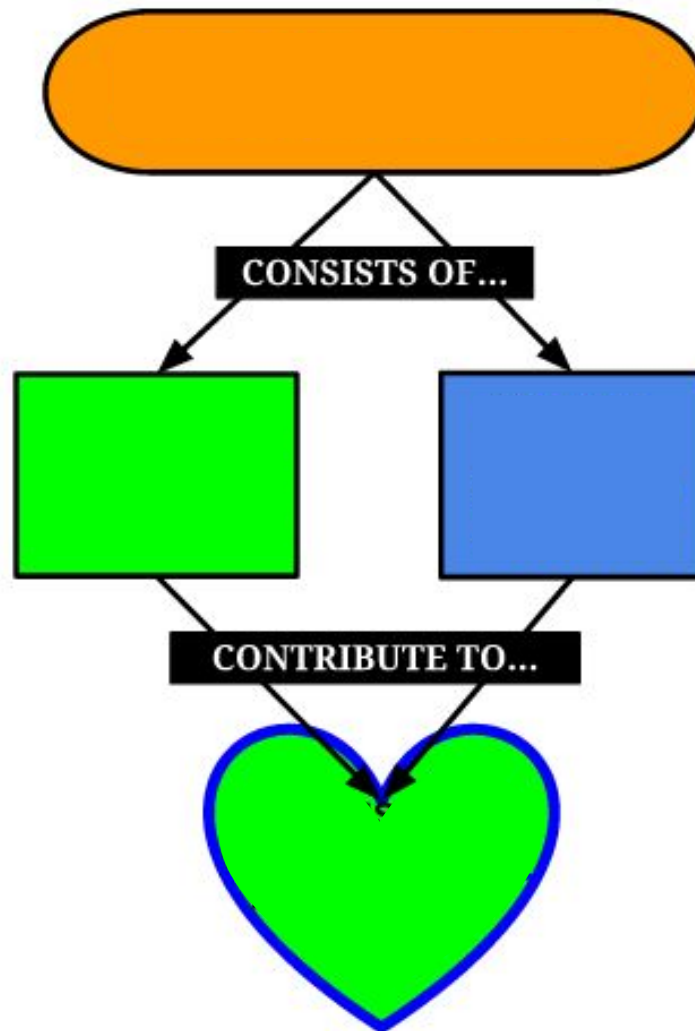


Mass = 80
Volume = 40
Density = 2

CUBE A and **CUBE B** have the same compactness.

Matter Graphic Organizer

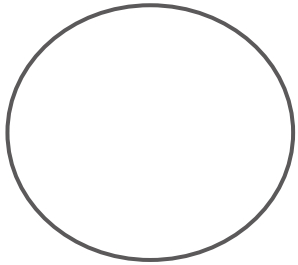
Draw in your notebook



Place these terms in the diagram:

- Density
- Volume
- Matter
- Mass

Density



Water has a density of 1.0 g/mL

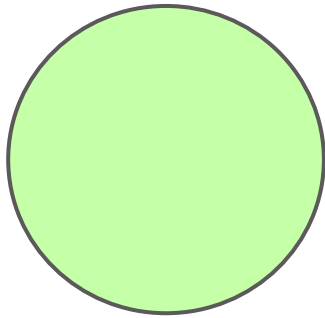
Ping Pong Ball:

- Density = 0.0840 g/cm^3 .
- Less than the density of water (1 g/cm^3)
- Floats



- Objects with a density greater than 1.0g/mL will **sink**
 - Objects with a density less than 1.0g/mL will **float**
-

Density



Water has a density of 1.0 g/mL

Glass Marble:

- Density = 2.5 g/cm^3 .
- Greater than the density of water (1 g/cm^3)
- Sinks



- Objects with a density greater than 1.0g/mL will **sink**
 - Objects with a density less than 1.0g/mL will **float**
-

Video: Invisible Water



- $D_{\text{helium}} = 0.00018 \text{ g/ml}$
- $D_{\text{air}} = 0.0012 \text{ g/ml}$
- $D_{\text{sulfur hexafluoride}} = 0.00617 \text{ g/ml}$

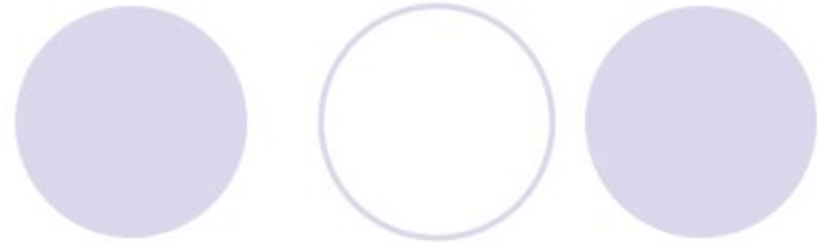
Liquid Layers



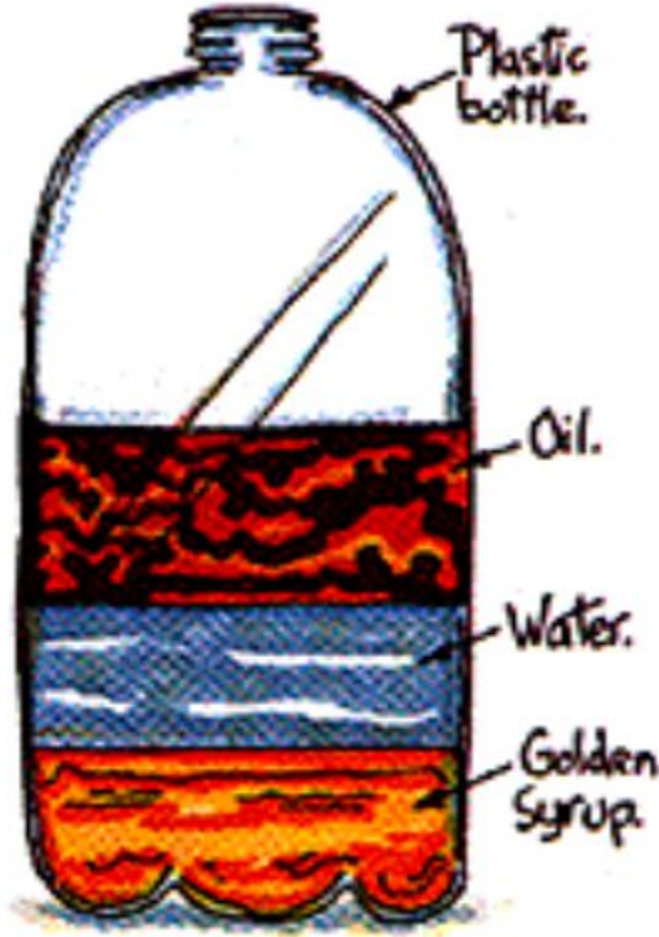
- If you pour together liquids that don't mix and have different densities, they will form liquid layers.
- The liquid with the **highest density** will be on the bottom.
- The liquid with the **lowest density** will be on the top.

Liquid Layers

- Draw this in your notebook
Which layer has the highest density?
- Which layer has the lowest density?
- Imagine that the liquids have the following densities:
 - 10g/cm^3 . 3g/cm^3 .
 - 6g/cm^3 . 5g/cm^3 .
- Which number would go with which layer?



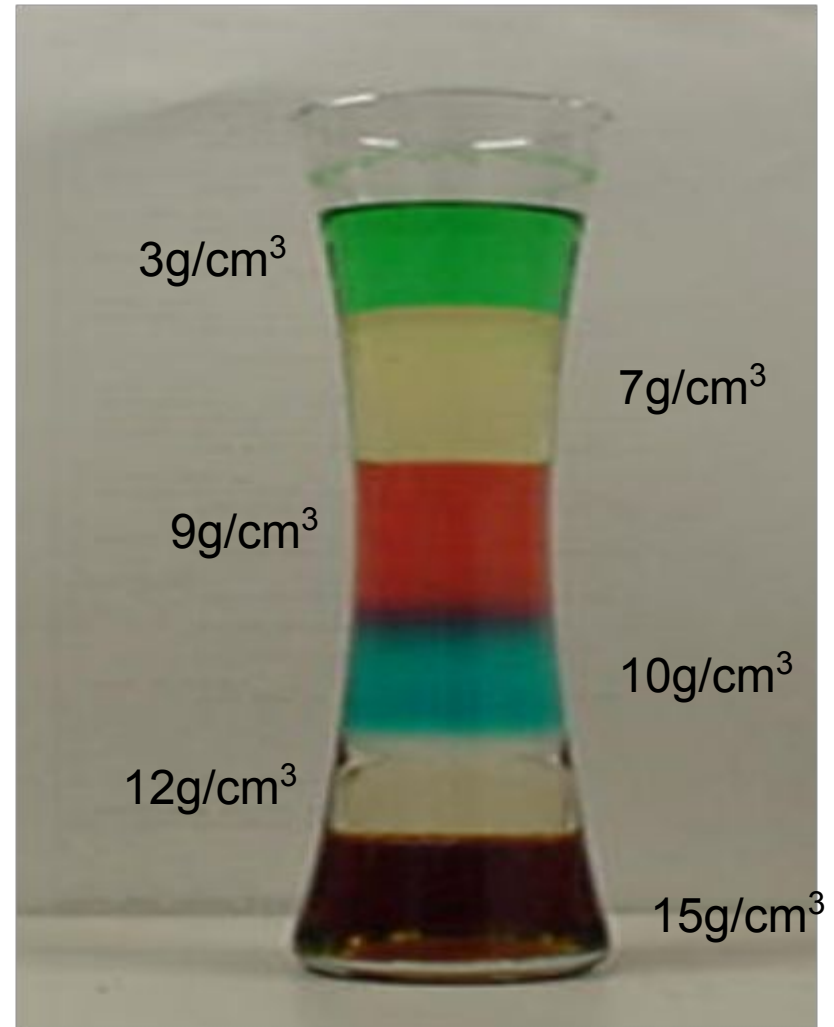
Liquid Layers – Try with your neighbor



- Which liquid has the highest density?
- Which liquid has the lowest density?
- Which liquid has the middle density?

Liquid Layers – Try on your own!

- Imagine that the liquids on the right have the following densities:
 - 15g/cm^3 10g/cm^3
 - 3g/cm^3 9g/cm^3
 - 7g/cm^3 12g/cm^3
- Match the colors to the correct densities.



Density - Example 1

Calculate: the density of carbon dioxide gas if 5g occupies a volume of 100mL?

$$D = ?$$

$$M = 5g$$

$$V = 100\text{mL}$$

$$D = \frac{M}{V} \quad D = \frac{5g}{100\text{mL}} = 0.05g/\text{mL}$$

Density - Example 2

Calculate: A block of aluminum occupies a volume of 15.0mL and has a mass of 40.5g. What is its density? Will it sink or float in water?

$$D = ?$$

$$M = 40.5\text{g}$$

$$V = 15.0\text{mL}$$

$$D = \frac{M}{V} \quad D = \frac{40.5\text{g}}{15.0\text{mL}} = 2.7\text{g/mL}$$

SINK in water

Density - Example 3

Calculate: A 10.0 cm^3 sample of copper has a mass of 89.6g . What is the density of copper? Will it sink or float in water?

$$D = ?$$

$$M = 89.6\text{g}$$

$$V = 10.0\text{cm}^3$$

$$D = \frac{M}{V} \quad D = \frac{89.6\text{g}}{10.0\text{cm}^3} = 8.96\text{g/cm}^3$$

SINK in water

Density - Example 4

Calculate: A sample of iron has the same dimensions of 2cm x 3cm x 2cm. If the mass of this object is 94 g, what is the density of iron? Will it sink or float in water?

$$D = ? \quad V = L \times W \times H$$

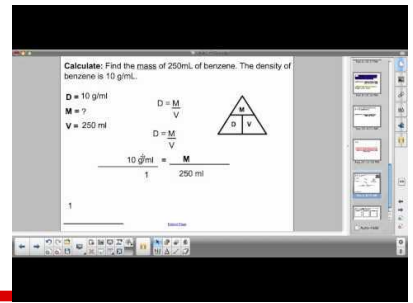
$$M = 94\text{g} \quad V = 2 \text{ cm} \times 3 \text{ cm} \times 2 \text{ cm}$$

$$V = 12\text{cm}^3$$

$$D = \frac{M}{V} \quad D = \frac{94\text{g}}{12\text{cm}^3} = 7.8\text{g/cm}^3$$

SINK in water

Density - Example 5



Calculate: Find the mass of 250mL of benzene. The density of benzene is 10 g/mL.

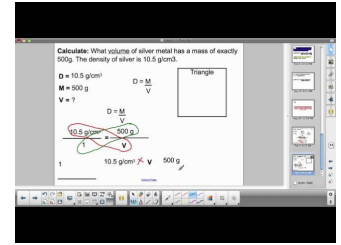
$$D = 10\text{g/mL}$$

$$M = ?$$

$$V = 250\text{mL}$$

$$M = D \bullet V \quad M = (10\text{g/mL}) \bullet (250\text{mL}) = 2,500\text{g}$$

Density - Example 6



Calculate: What volume of silver metal has a mass of exactly 500g. The density of silver is 10.5 g/cm^3 .

$$D = 10.5 \text{ g/mL}$$

$$M = 500 \text{ g}$$

$$V = ?$$

$$V = \frac{M}{D} \quad V = \frac{500 \text{ g}}{10.5 \text{ cm}^3} = 47.6 \text{ cm}^3$$