Matter, Mass, Volume and Density

Matter is anything that has mass and takes up space.

\[ \text{density} = \frac{\text{mass}}{\text{volume}} \]

Mass, volume, density are all properties of matter.
Physical or Chemical?

Which of the following is a physical property of matter?

A. mass
B. volume
C. density
D. A and B only
E. A, B and C
Mass

- The amount of matter in an object.
- How much stuff is in an object.

Units for mass:

Metric — $g$, $kg$

English — $slug$ ($1$ $slug$ $\approx 14.6$ $kg$)

Pound (lb) is NOT a unit for mass
Which of the following is a unit for mass ______.

A. g
B. kg
C. Pound
D. A and B only
E. All of the above
Unit

- Any measurement should have both a **value** and a **unit**.

- A measurement without unit is meaningless and can cause confusion.

  - “He weighs 150”.  lbs?  kg?  g?  ton?

  - “The YouTube video is 50 long”.  seconds?  minutes?  hours?

**Recognize common units for different measurements.**

**Always include unit when reporting a measurement.**
Dr. Chen has a mass of ______.

A. 65 g
B. 65 kg
C. 65 slugs
D. 65 tons
Volume

- How much space an object occupies.
- How big an object is.
- The size of an object.
A Rubik’s cube measures 6 cm on each side. What is its volume?

A) 6 cm$^3$
B) 36 cm$^3$
C) 216 cm$^3$
D) 18 cm$^3$
E) 216 cm$^3$
\[ V = a \times a \times a = a^3 \]

\[ V = l \times w \times h \]

— m³, cm³ (cc)

— Liter (L), milliliter (mL)

1 cm³ (1 cc) = 1 mL

— ft³, inch³
From the two pictures above, it can be determined that the volume of block B is ___.

A) 100.00 L
B) 100.64 L
C) 0.64 L
D) None of the above
From the two pictures above, it can be determined that the volume of block B is ___.

A) 100.00 L  
B) 101.00 L  
C) 1.00 L  
D) None of the above
Another way to find the volume of an object

 Completely submerge it in a liquid, find the difference in the volumes of the liquid before and after.
True of False:

Rock is heavier than paper.

A. True
B. False
C. It depends.
Which is heavier, feathers or gold?

A) Gold
B) Feathers
C) They weigh the same
D) Not enough information
Rock has a higher density than paper.

Gold has a higher density than feather.
Density

- The amount of stuff \textit{per} unit volume.
- Density is a \textit{ratio}.

\[
density = \frac{mass}{volume}
\]

Unit for density: \[\frac{mass \text{ unit}}{volume \text{ unit}}\]
Unit for Density

Which of the following is NOT a valid unit for density?

A. kg/mL
B. g/cm³
C. lbs/L
D. slug/ft³
E. All of the above are valid units for density.
Density

- The amount of stuff \textit{per} unit volume.

\[ \text{density} = \frac{\text{mass}}{\text{volume}} \]

Unit for density: \( \frac{\text{mass unit}}{\text{volume unit}} \)

- g/mL,
- kg/L,
- g/cm\(^3\),
- kg/m\(^3\),
- slug/ft\(^3\),
- slug/in\(^3\)
Based on the information in the picture above, which block has the lowest density?

A) A  
B) B  
C) C  
D) D  
E) Can’t determine without doing calculations.
How would you rank the densities of blocks A ~ D, from the highest to the lowest?

A) A > D > C > B
B) A > B > D > C
C) B > D > C > A
D) D > C > B > A
Based on the information in the picture above, compare the densities of Block A and Block E.

A) Block A has a higher density.
B) Block E has a higher density.
C) They have the same density.
D) Not enough information.
With the information in the two pictures above, it can be determined that the density of block B is ___.

A) 0.64 kg/L  
B) 1.0 kg/L  
C) 1.2 kg/L  
D) More information is needed.
With the information in the two pictures above, it can be determined that the density of block B is ____.

A) 0.64 kg/L  
B) 1.0 kg/L  
C) 1.2 kg/L  
D) More information is needed.
How is it possible?

A. It is impossible; the picture must has been Photoshopped.
B. It is some kind of magic trick. They must be sitting on something or have a hidden floatation device.
C. Any petite person like Dr. Chen can do it.
D. It can happen as long as you are less dense than the water.
E. It can happen as long as you are denser than the water.
If an object floats in a liquid, we can conclude with certainty that _____.

A. The object must be light.
B. The object must have a smaller density than the liquid.
C. The object must have a larger density than the liquid.
D. Not enough information to draw any conclusion.
E. Both A and B
Will it Float?

Brass has a density of 8.5 kg/L. Will a brass block float in a tank of water?

A. Yes
B. No
Will it Float?

Brass has a density of 8.5 kg/L; mercury has a density of 13.6 kg/L.

Will the brass block float in the mercury in the beaker?

A. Yes
B. No
Take-away

- If an object is less dense (have a lower density) than a liquid, it will float in it.

- If an object is denser (have a higher density) than a liquid, it will sink in it.
This could be your hypothesis

But if you did your investigation, your hypothesis will be proven wrong.
Take-away

**Mass:**

How much stuff. \( kg, \) or \( g \) (NOT pounds!!)

**Volume:**

How big. \( m^3, \) \( cm^3, \) \( mL, \) or \( L \)

**Density:**

mass/volume. \( kg/L, \) \( g/cm^3, \) \( kg/m^3, \) etc.