Grade 8 Science

Unit 3: Fluids

Please come join me at the back counter.

When we placed the two cans into the containers of water the Pepsi sunk to the bottom and the Diet Pepsi floated on top.

Why did the two cans react differently?

Density

Density is a property of matter that relates the amount of mass to the volume taken up by the matter. Density can be described with a mathematical equation:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

As you can see in the equation, density is the amount of mass per unit of volume.

What would be the units for density?

Solids - g/cm^3 Fluids - g/ml

Density

Having seen that the Pepsi cans reacted differently in water, and knowing the reason is related to density, what can we determine about the differences between Pepsi and Diet Pepsi?

- We know that the amount of fluid in both cans is the same
- We can assume that the cans are the same material, same size, and therefore the same mass
- Pepsi sank, Diet Pepsi floated, that must mean that the can of Pepsi is heavier
- Because the cans are the same, that would mean that the fluid inside has a different mass - The Pepsi is heavier than the Diet Pepsi
- Being that the volume of fluid is the same, that would mean that the density of Pepsi is higher than the density of Diet Pepsi (there is more mass in the same amount of the fluid)

Can you think of why Pepsi is more dense? Sugar

Density

Consider the following:

If I have two identically sized objects and object A has twice the mass of object B, what can you tell me about their densities?

$V_A = V_B$

$m_A = 2m_B$

$D_A = \frac{m_A}{V_A} = 2\left(\frac{m_B}{V_B}\right) = 2D_B$

$D_B = \frac{m_B}{V_B}$

∴ The density of A is double B.

If I have two identically sized objects of the same material, what can you tell me about their densities?

$V_A = V_B$

$m_A = m_B$

* Same Material Same size

$D_A = \frac{m_A}{V_A} = \frac{m_B}{V_B} = D_B$

∴ The two have the same density.

Density

If I have two objects, both the same material, but object A is two times larger than object B, what can you tell me about their densities?

$V_A = 2V_B$

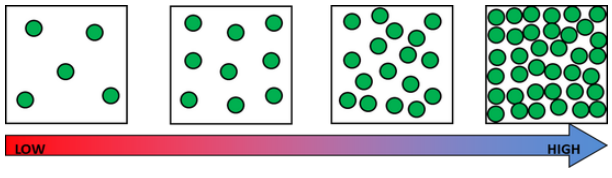
$m_A = 2m_B$

* Same material twice the size

$D_A = \frac{m_A}{V_A} = \frac{2\left(m_B\right)}{2\left(V_B\right)} = D_B$

∴ The two have the same density

We need to remember that density is a per unit value, meaning that any sized objects can be directly compared. The density of water in a pool is the same as the density of water in a cup.

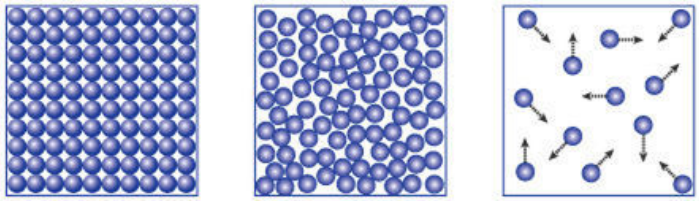


Density - States of Matter

Without knowing it, we have referenced density when talking about the differences amongst the states of matter. What point, relating to density, have we used to differentiate solids, liquids, and gasses?

Spacing of particles

How does this relate to density?



Solid Liquid Gas

In any one type of matter a single particle maintains a constant mass. As the particle changes state, those particles spread out, meaning fewer of them are found in any specific volume. If there are fewer particles, that means there is less mass in that area, and therefore the density is lower.

Although it may appear so, **density and viscosity are not directly related**.

Density

Together we will answer the following density math problems.

If an object has a volume of 32 ml and has a mass of 146 g, what is the density?

$m = 146g$
$V = 32ml$
$D = ?$ ✓

$D = \frac{m}{V}$ ✓
$D = \frac{146}{32}$
$D = 4.56g/ml$

∴ The density is 4.56g/ml. ✓

The density of iron is 7.87 g/cm³. If an iron cannonball has a volume of 105 cm³, what is the mass of the ball?

$m = ?$
$V = 105cm^3$
$D = 7.87g/cm^3$ ✓

$D = \frac{m}{V}$ ✓
$7.87 = \frac{m}{105}$
$m = 7.87 \times 105$
$m = 826.35g$

∴ The mass of the cannonball is 826.35g. ✓

A container holds mercury, a substance with a density of 13.5 g/ml. If the container has a mass of 350 g, how much mercury is in it?

$m = 350g$
$V = ?$
$D = 13.5g/ml$ ✓

$D = \frac{m}{V}$ ✓
$13.5 = \frac{350}{V}$
$V = \frac{350}{13.5}$
$V = 25.93ml$

∴ There is 25.93ml of mercury. ✓

Archimedes' Principle

In all of the questions we have known or were calculating the volume of the object. What if the volume is unknown. For standard shapes, we simply calculate the volume (i.e., length x width x height). What if the object is not a standard size? For the answer, we need to go back 2300 years to Italy... and talk about an old guy taking a bath.

YouTube Link