Unit 2

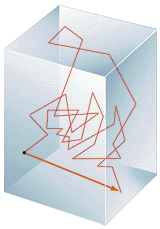
Physical Properties of Matter

Physical Science Fall 2016

Kinetic Molecular Theory

- Kinetic = Movement (Energy)
- Molecule = Particles
- ALL particles in a substance are constantly in motion.

Kinetic Molecular Theory



Kinetic Behavior

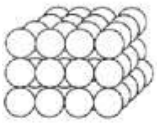
- Particles are always moving, but not always at the same speed
  - FAST movement = higher temperature = gases
  - SLOW movement = lower temperature = solids

Matter

- Any substance that has mass and occupies space.
- 3 States…or *phases*

Phases of Matter

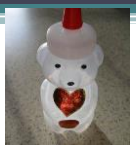
- Solids
  - The particles are packed tightly together and stay in one position.
    - The particles vibrate slightly between each other… so they're not completely motionless.



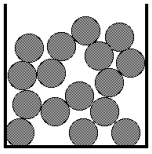
Phases of Matter (cont.)

- Solids
  - Solids are the least energetic phase of matter
  - Solids have a ***definite*** volume and a ***definite*** shape.

Phases of Matter

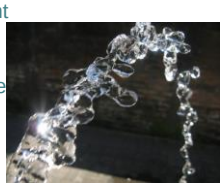


- Liquids
  - The particles are somewhat packed together and move freely around one another.



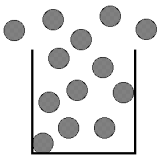
Phases of Matter

- Liquids
  - Liquids have a medium amount of energy (more than solids, less than gases)
  - Liquids have a ***definite*** volume but ***not a definite*** shape.
    - They take on the shape of the container



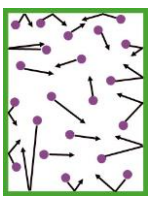
Phases of Matter

- Gases
  - Gas particles spread apart, filling all the space available.

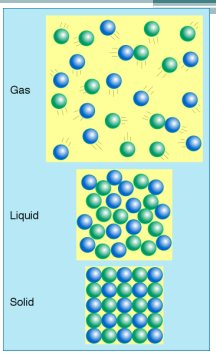


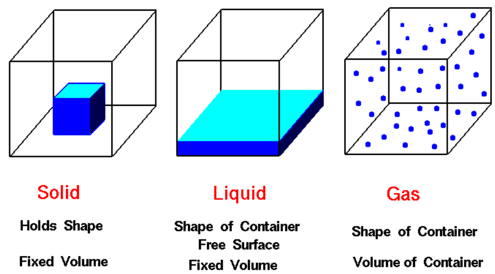
Phases of matter

- Gases
  - Gases are the most energetic phase of matter
  - Gases have ***no definite*** volume and ***no definite*** shape.



Recap





Physical Properties

- <u>All types of matter will have certain characteristics that never change.</u>
- Some examples are: density, boiling point, freezing point, etc.
- We call these **<u>Physical Properties</u>**.

Types of Physical Properties

- <u>Intensive</u>
  - <u>Do not depend on the size or shape of the sample</u>
    - Examples?
      - Color, hardness, BP, etc.
- <u>Extensive</u>
  - <u>Depend on the sizes of the sample</u>
    - Examples
      - Length, mass, volume, etc.

Density

- Why things float while other things sink

What is Density?

- <u>Density is a comparison of how much matter there is in a certain amount of space.</u>

- <u>Or how heavy something is for its size</u>
  - <u>Thing of a rock vs. a cotton ball the same size.</u>

http://upload.wikimedia.org/wikipedia/commons/f/f2/Mossagate.pebble.750pix.jpg

vs.

http://www.rd.ca/cms/images/image/cottonballs_291_20080523-171920.jpg

What is Density

- <u>Density is Mass divided by Volume</u>

  D=m/v
- <u>D=Density</u>
- <u>m=mass(g)</u>
- <u>v=volume(mL)</u>

- <u>So the unit for Density is:</u>

  <u>mass (g)</u>

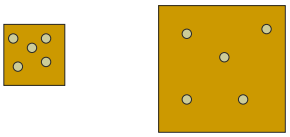
  volume (mL)

Which one is more dense?

- Demonstration: People in a square

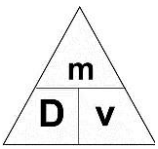
Which one is more dense?

- Now which one is more dense?

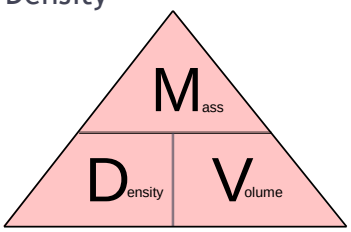


How to Calculate Density

- Density = $\frac{\text{mass(g)}}{\text{volume(mL)}}$



Density

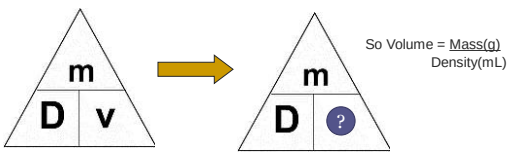


$D = \frac{M}{V}$

$M = D \times V$

$V = \frac{M}{D}$

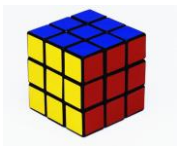
- Use triangle to figure out which equation to use
- If you are given mass and density, you can figure out the volume by covering up the volume triangle



So Volume = $\frac{\text{Mass(g)}}{\text{Density(mL)}}$

Measuring Density for square objects

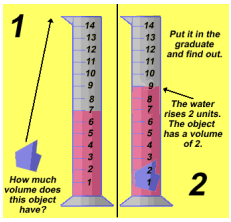
- Find the mass using a balance
- Length x width x height



- But what if it's weird looking?

Density of odd-shaped Objects

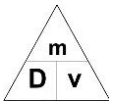
- Find the mass using a balance
- Use Graduated cylinder, beaker to find volume.



Lets try some problems

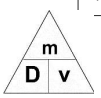
An irregular object with a mass of 18 kg displaces 2.5 L of water when placed in a large overflow container. Calculate the density of the object.

Givens: m=18 kg v=2.5L D=? kg/L		
Equation: D=m/v	Substitution: ? Kg/L = 18 kg/2.5 L	Answer with unit 7.2 kg/L



- *A brick with a mass of 14 g measures 12 cm x 4 cm x 3 cm. Calculate the density of the object.*

Givens:		
Equation:	Substitution:	Answer with unit



- *A bar of gold with a density of 5 g/ml has a volume of 500 mL. Calculate the mass.*

Givens:		
Equation:	Substitution:	Answer with unit

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

- Which layer has the highest density?
- Which layer has the lowest density?
- Imagine that the liquids have the following densities:
- * 10g/mL. * 3g/mL.
- * 6g/mL. * 5g/mL.
- Which number would go with which layer?

Gas Laws – Boyle's Law

Robert Boyle was British Royalty that lived in the 17th century.

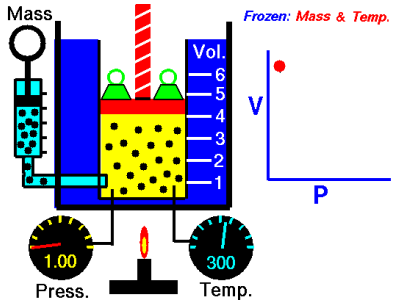
He studied all aspects of science, including *alchemy.*

Do you know what alchemy is?

Gas Laws – Boyle's Law

- When matter turns into a gas, it behaves differently than other matter.
- Boyle's Law is used when the pressure of a gas changes.
- The volume of a fixed amount of gas varies inversely with the pressure of the gas.

Boyle's Law in motion



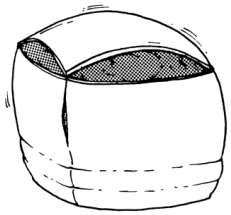
Gas Laws – Pressure

- What is Pressure?

Pressure

- What is Pressure?
  - Gas particles push against the sides of what ever container they are in.
  - Pressure is what keeps balloons inflated.

Gas Laws - Pressure



Factors Affecting Gas Pressure

- Amount of gas
- Volume
- Temperature

Gas Laws - Units

- Pressure can be measured in:
  - Atmospheres (atm)
  - Kilopascals (kPa)
- Temperature is measured in:
  - Kelvin (K)
    - K = Celsius + 273
    - We'll come back to this

Gas Laws – Boyle's Law

- As volume decreases,
  - Pressure increases
- As volume increases,
  - Pressure decreases.
- The equation for Boyle's Law is:
  - $V_1 \times P_1 = V_2 \times P_2$

Gas Laws – Boyle's Law

A sample of hydrogen gas has a volume of 75.0 mL at a pressure of 0.87 atm. What will the volume of the gas be at a pressure of 1.00 atm if the temperature remains the same?

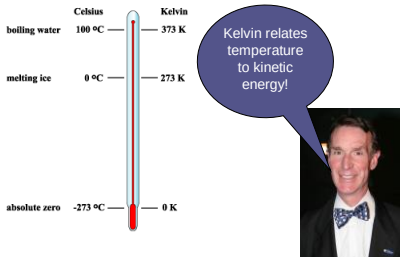
Givens: $V_1 = 75.0$ mL $P_1 = 0.87$ atm $P_2 = 1.00$ atm		
$V_1 * P_1 = V_2 * P_2$ Equation:	75 mL * .87 atm = V_2 * 1.0 atm Substitution:	65.25 mL = V_2 Answer with Units:

The Kelvin Scale

- As T increases, so does kinetic energy
- Theoretically, kinetic energy can be zero, but it hasn't been achieved and probably won't ever be achieved
- Absolute zero- The temperature at which a substance would have zero kinetic energy
- The Kelvin Scale- a temperature scale directly related to kinetic energy
  - Zero on the Kelvin scale corresponds to zero kinetic energy

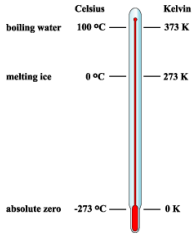
The Kelvin Scale

- Units are Kelvins (K), with no degree (°) sign



Temperature Conversions

- Easy to convert between Celsius and Kelvin
  - How do you think?
    - °C → K? Add 273
    - K → °C? Substract 273
  - 25°C → K?
    - (25+273)= 298 K
  - 310 K → °C?
    - (310-273) = 37°C
- Fahrenheit ↔Celsius?
  - (°F – 32°F) x 5/9 = °C
  - (°C x 9/5) + 32°F = °F

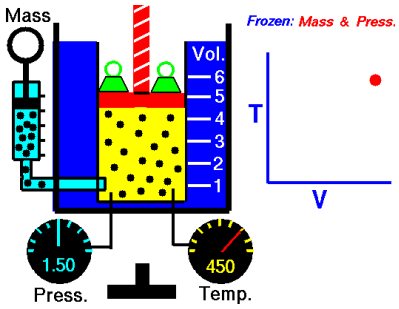


Gas Laws – Charles' Law

Gas Laws – Charles' Law

- Charles' Law is used when the volume of a fixed amount of gas changes with temperature.
- Remember the temp must be in Kelvin!

Charles' Law in Motion



Gas Laws – Charles' Law

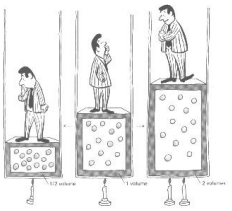
- As temperature increases,
  - volume increases.
- As temperature decrease,
  - volume decreases.
- The equation for Charles' Law is:
  - $T_2 \times V_1 = V_2 \times T_1$

Gas Laws – Charles Law

Nitrogen gas in a balloon takes up a space of 1.5 L at 300 K. The balloon is dipped into liquid nitrogen that is at a temperature of 75 K. What will be the volume of the helium in the balloon at the lower temperature?

Givens: $V_1 = 1.5$ L $T_1 = 300$ K $T_2 = 75$ K		
$V_1 * T_2 = V_2 * T_1$ Equation:	$1.5 \text{ L} * 75 \text{ K} = V_2 * 300 \text{ K}$ Substitution:	$.375 \text{ L} = V_2$ Answer with Units:

Gas Laws – Charles' Law



Gas Laws – The Real World

Gas Laws – The Real World