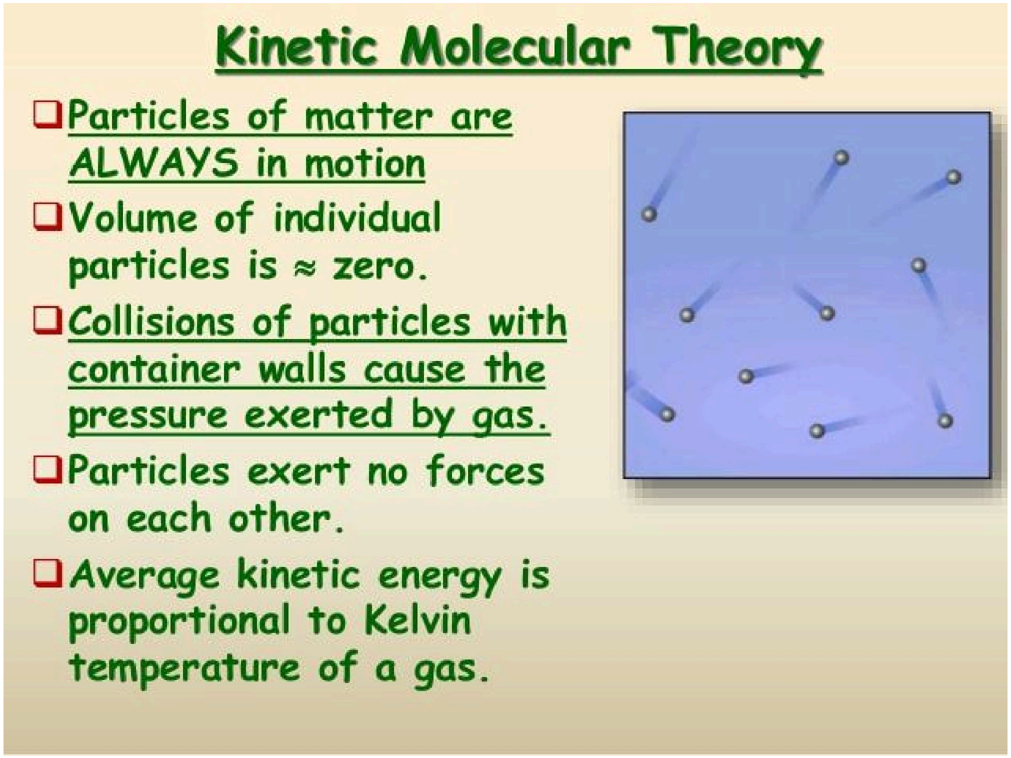
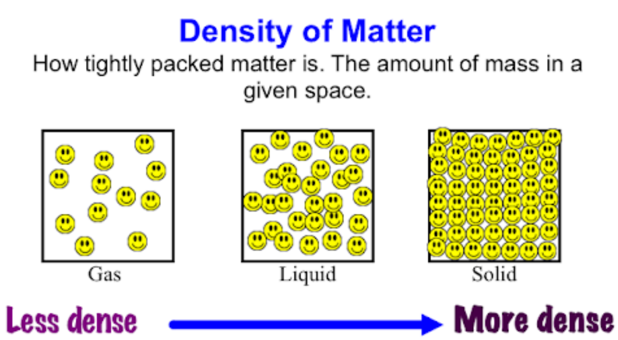
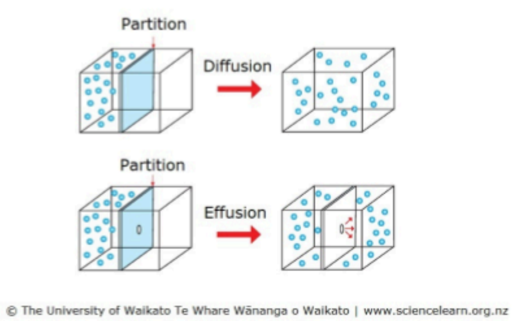
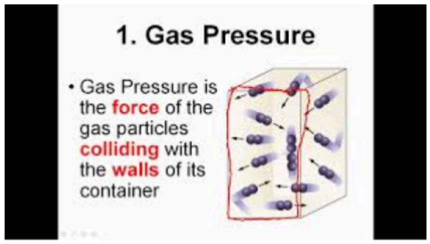
Chemistry Unit 5 Notes

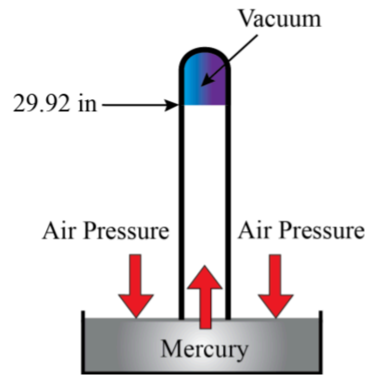


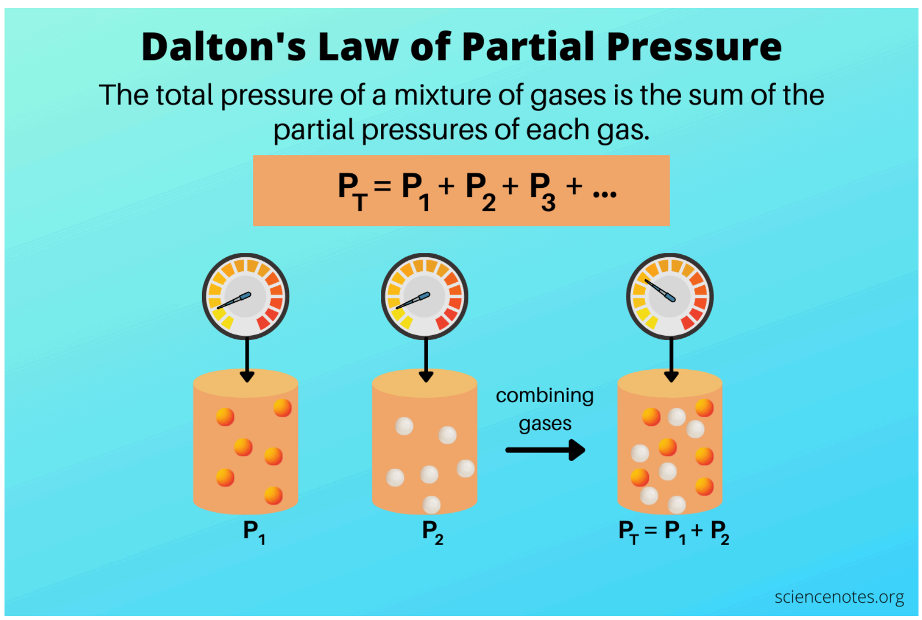




$$\frac{rate_1}{rate_2} = \sqrt{\frac{M_2}{M_1}}$$


1. Gas Pressure
• Gas Pressure is the force of the gas particles colliding with the walls of its container


Vacuum
29.92 in
Air Pressure
Air Pressure
Mercury


Dalton's Law of Partial Pressure
The total pressure of a mixture of gases is the sum of the partial pressures of each gas.
$P_T = P_1 + P_2 + P_3 + ...$
combining gases
P_1
P_2
$P_T = P_1 + P_2$
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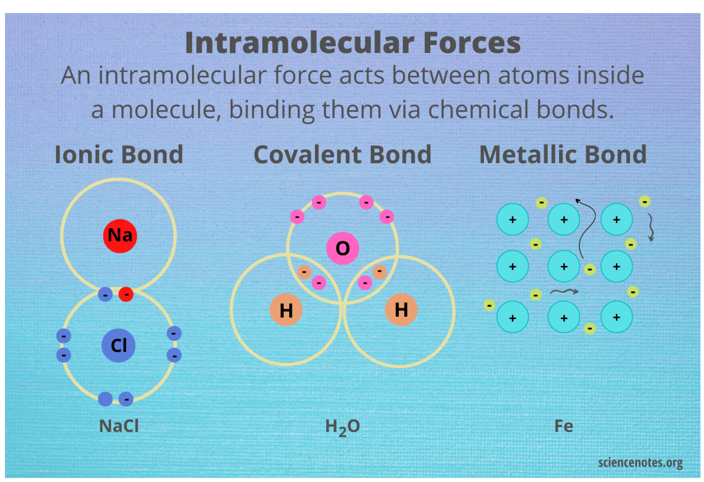
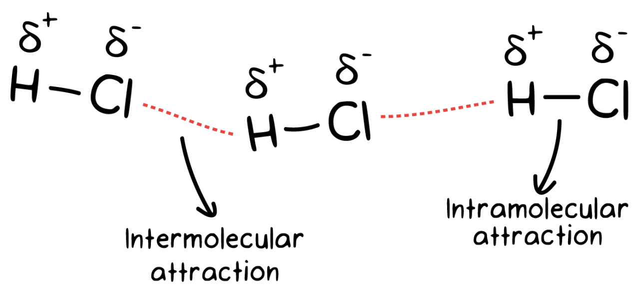
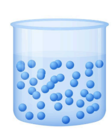

Intramolecular Forces
An intramolecular force acts between atoms inside a molecule, binding them via chemical bonds.
Ionic Bond
Covalent Bond
Metallic Bond
Na
Cl
O
H
H
NaCl
H_2O
Fe
sciencenotes.org

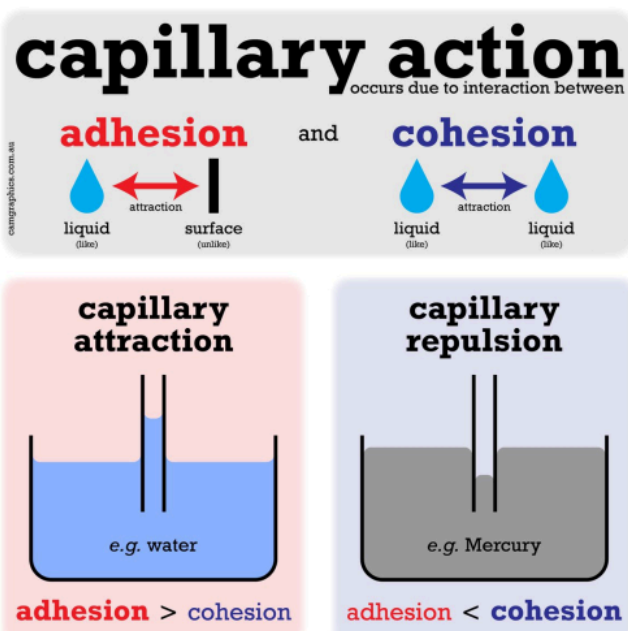
Type of Force	Applied to	Strength
Dispersion Forces	All molecules	0.1 – 5 kJ/mol
Dipolar Forces	Polar molecules	5 – 20 kJ/mol
Hydrogen Bonding	Polar molecules with N – H, O – H or F – H bond	5 – 50 kJ/mol

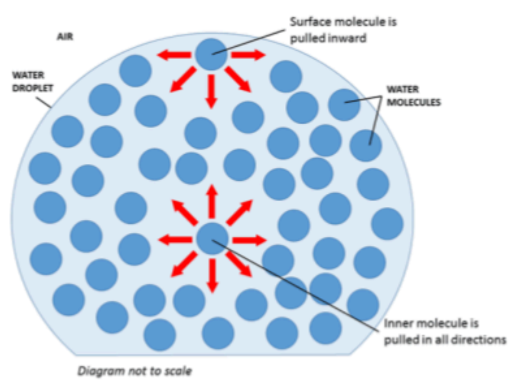
Table 2.6 Summary of the Three Major Intermolecular Forces



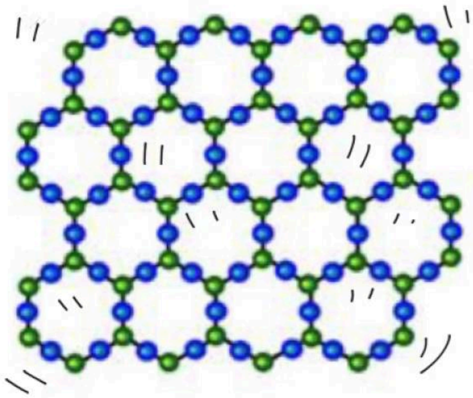
PROPERTIES	SOLID	LIQUID	GAS
Mass	Definite	Definite	Definite
Shape	Definite	Accquires the shape of the conatiner	Accquires the shape of the conatiner
Volume	Definite	Definite	Indefinite
Compressibilty	Not Possible	Almost Negligible	Highly Negligible
Fludity	Not Possible	Can flow	Can flow
Rigidity	Higly Rigid	Less Rigid	Not Rigid
Diffusion	Slow	Fast	Very Fast
Space bewteen particles	Most Closely packed 	Less Closely packed 	Least Closely packed 
Interparticle force	Definite	Slightly weaker than in solid	Negligible


Viscosity
Water
Low viscosity
Olive Oil
Medium viscosity
Honey
High viscosity


capillary action
occurs due to interaction between
adhesion
and
cohesion
attraction
liquid
(like)
surface
(unlike)
attraction
liquid
(like)
liquid
(like)
camgraphics.com.au
capillary attraction
e.g. water
adhesion > cohesion
capillary repulsion
e.g. Mercury
adhesion < cohesion

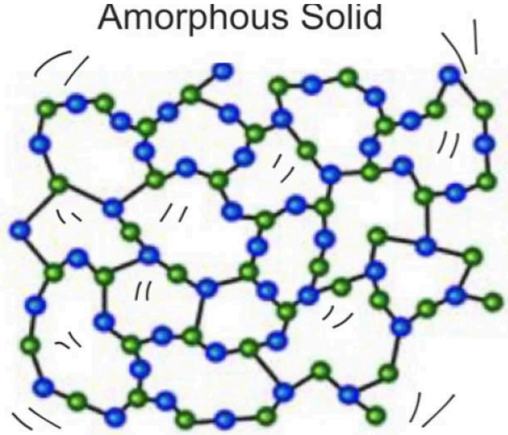

AIR
Surface molecule is pulled inward
WATER DROPLET
WATER MOLECULES
Inner molecule is pulled in all directions
Diagram not to scale

Crystalline Solid

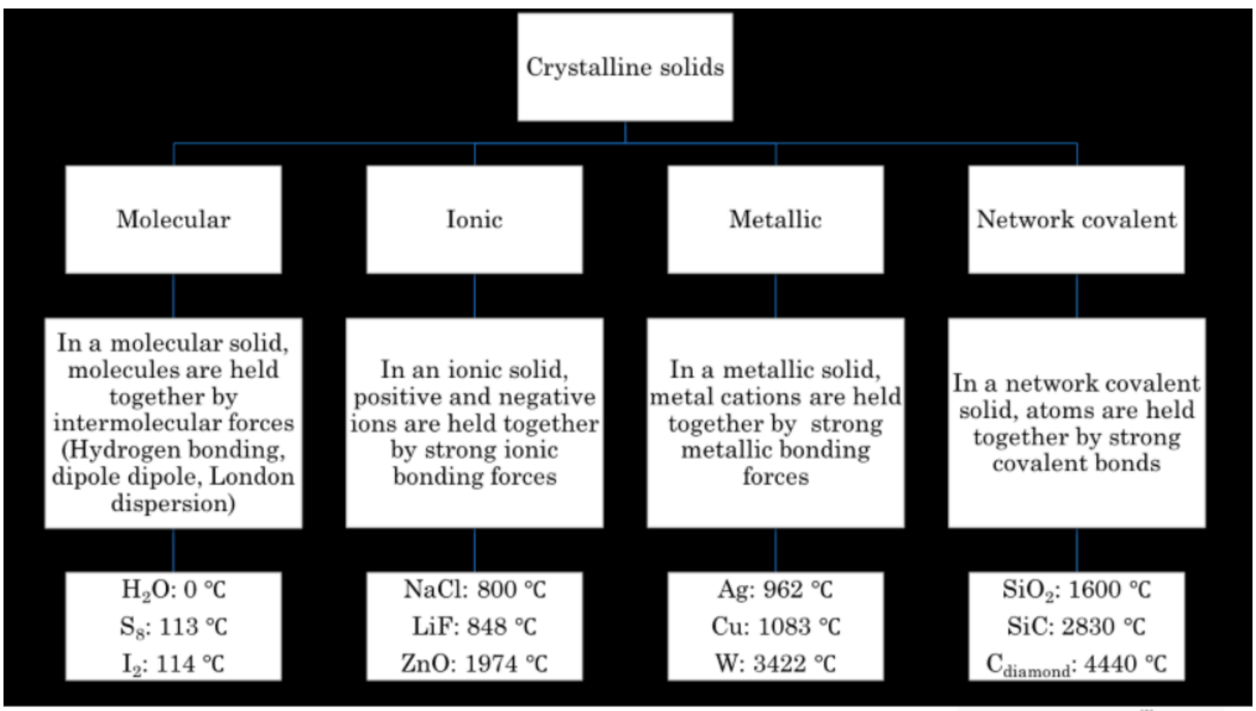


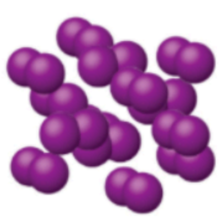
Atoms vibrate in place in a fixed pattern

Amorphous Solid

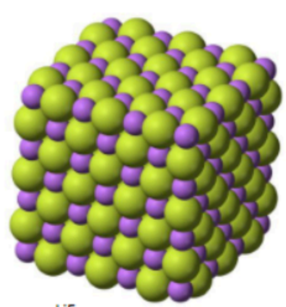


Atoms vibrate in place in more random arrangements

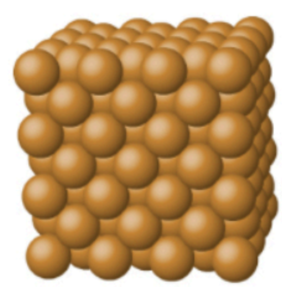




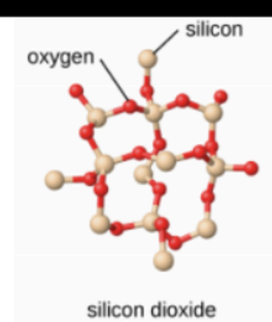
Iodine



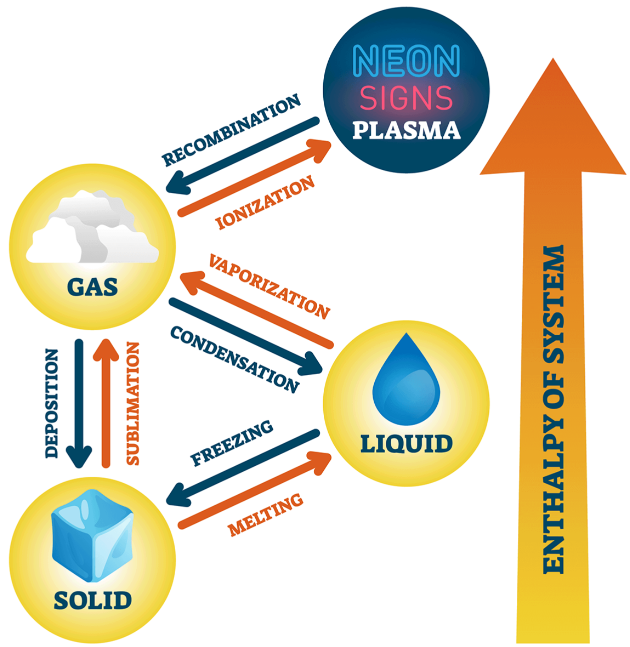
LiF



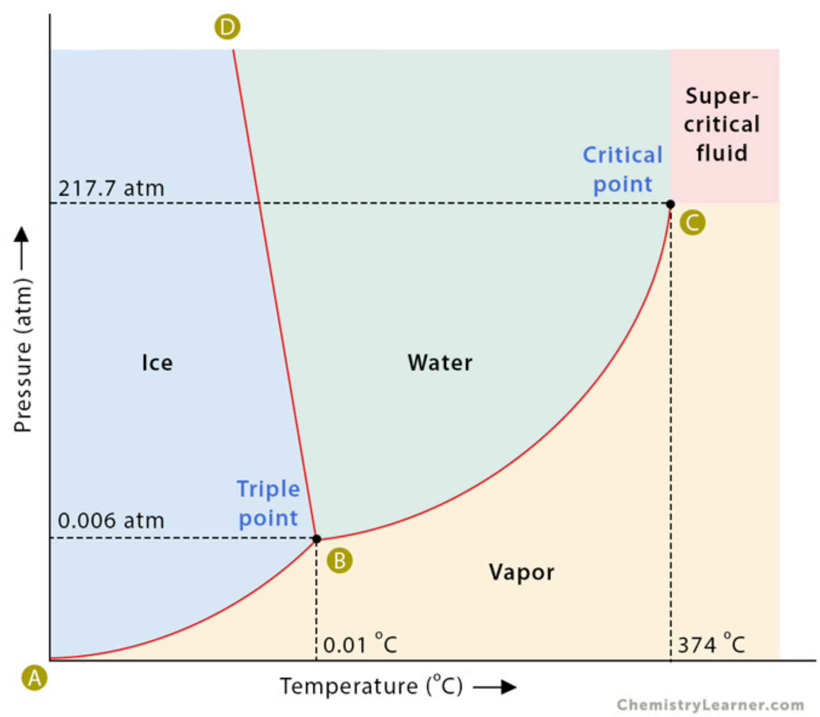
Cu

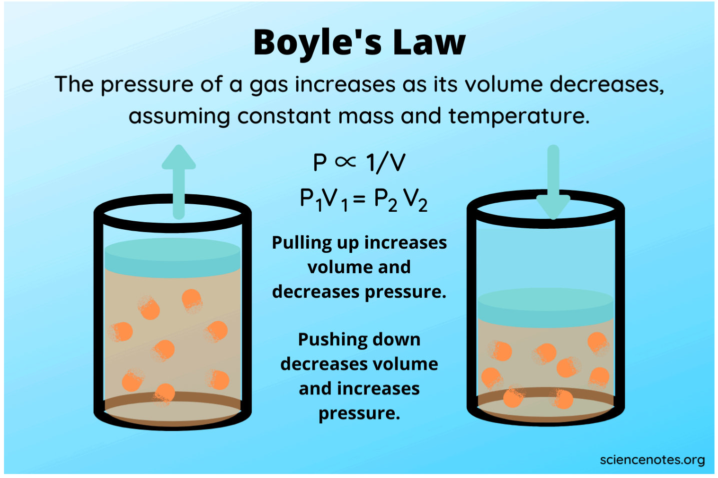


PHASE CHANGES



Phase Diagram of Water




Boyle's Law
The pressure of a gas increases as its volume decreases, assuming constant mass and temperature.
$P \propto 1/V$
$P_1V_1 = P_2V_2$
Pulling up increases volume and decreases pressure.
Pushing down decreases volume and increases pressure.
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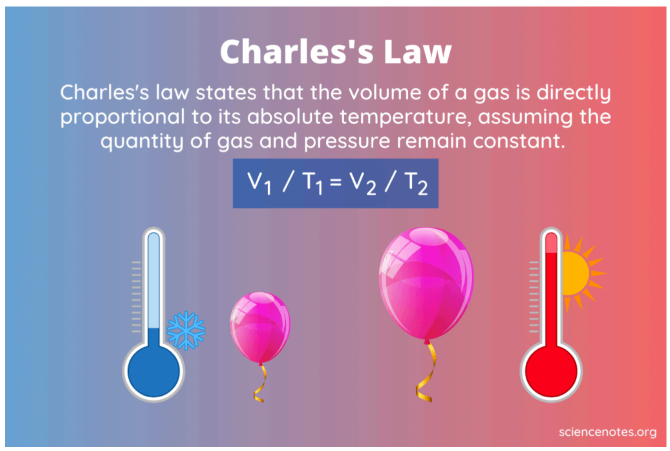
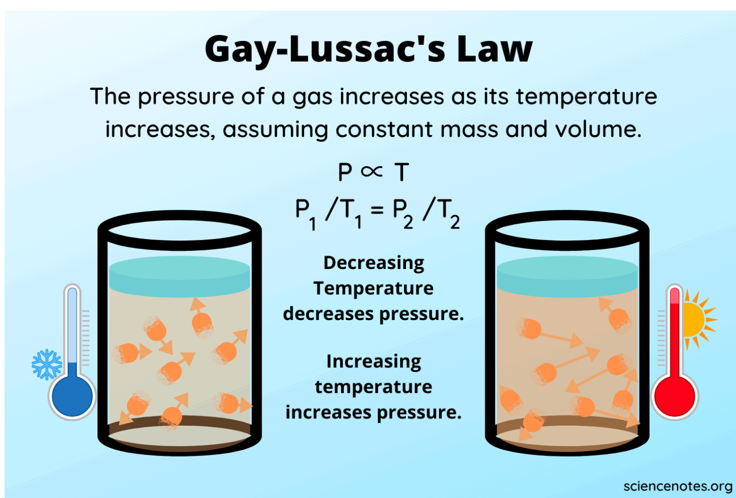

Charles's Law
Charles's law states that the volume of a gas is directly proportional to its absolute temperature, assuming the quantity of gas and pressure remain constant.
$V_1 / T_1 = V_2 / T_2$
sciencenotes.org


Gay-Lussac's Law
The pressure of a gas increases as its temperature increases, assuming constant mass and volume.
$P \propto T$
$P_1 / T_1 = P_2 / T_2$
Decreasing Temperature decreases pressure.
Increasing temperature increases pressure.
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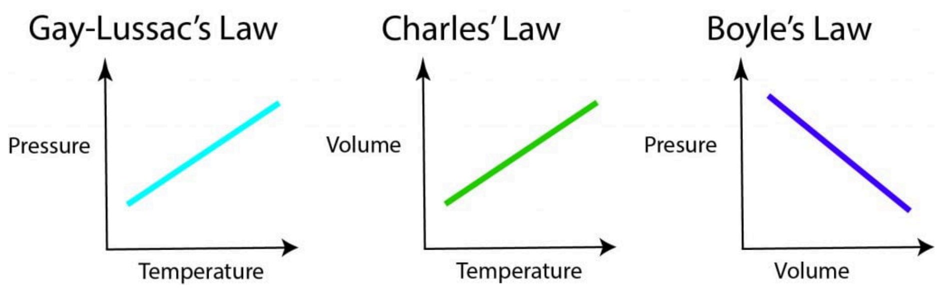


Gas Law	*Formula*
Boyle's law	$P_1V_1 = P_2V_2$
Charles's law	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
Gay-lussac's law	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$
Combined law	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
Ideal gas law	$PV = nRT$

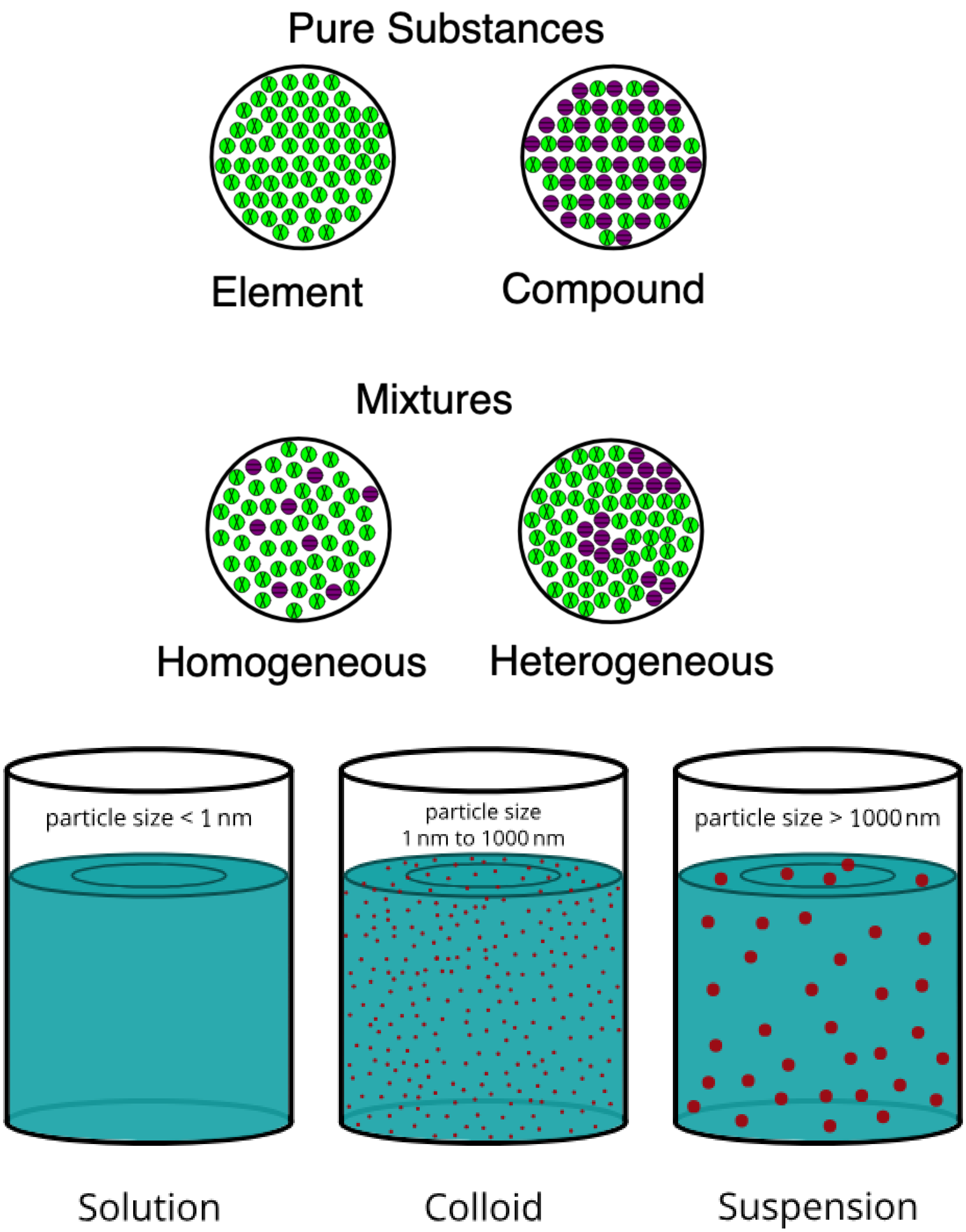
Ideal Gas Law

The ideal gas law is the equation of state of an ideal gas that relates pressure, volume, quantity of gas, and absolute temperature.

$$PV = nRT$$

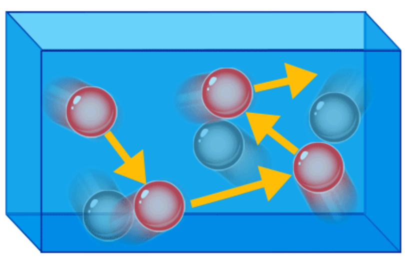
P = pressure
V = volume
n = number of moles of gas
R = ideal gas constant
T = absolute temperature

Although it applies to ideal gases, it approximates the behavior of many real gases.

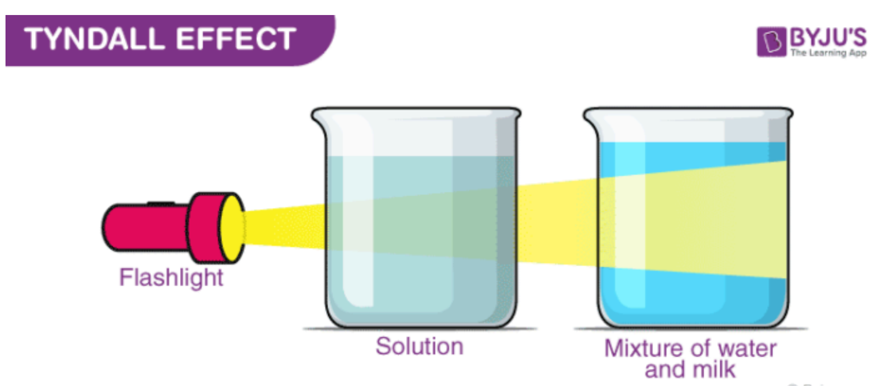

Pure Substances
Element
Compound
Mixtures
Homogeneous
Heterogeneous
particle size < 1 nm
particle size
1 nm to 1000 nm
particle size > 1000 nm
Solution
Colloid
Suspension

Dispersed phase	Dispersion medium	Type of colloid	Example
Solid	Solid	Solid sol	Some coloured glasses, and gem stones
Solid	Liquid	Sol	Paints, cell fluids
Solid	Gas	Aerosol	Smoke, dust
Liquid	Solid	Gel	Cheese butter, jellies
Liquid	Liquid	Emulsion	Milk, hair cream
Liquid	Gas	Aerosol	Fog, mist, cloud, insecticide sprays
Gas	Solid	Solid sol	Pumice stone, foam rubber
Gas	Liquid	Foam	Froth, whipped cream, soap-lather

The random movement of particles in a colloid caused by collisions between the particles



Brownian motion



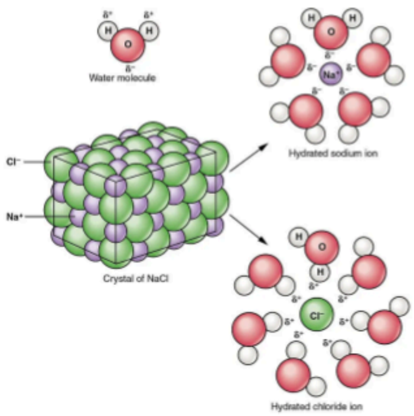
Miscible, immiscible, soluble or insoluble

Solutes ↓	polar solvent	nonpolar solvent
polar liquid	miscible	immiscible
nonpolar liquid	immiscible	miscible
polar solid	soluble	insoluble
nonpolar solid	insoluble	soluble
ionic solid	Check Solubility Rules!	insoluble

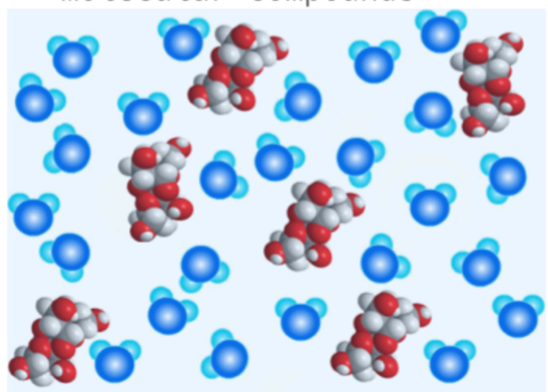
Concentration Description	Ratio
Percent by mass	Mass of solute/mass of solution x 100
Percent by volume	Volume of solute/volume of solution x 100
Molarity	Moles of solute/liter of solution
Molality	Moles of solute/kilogram of solvent
Mole fraction	Moles of solute/(moles of solute + moles of solvent)

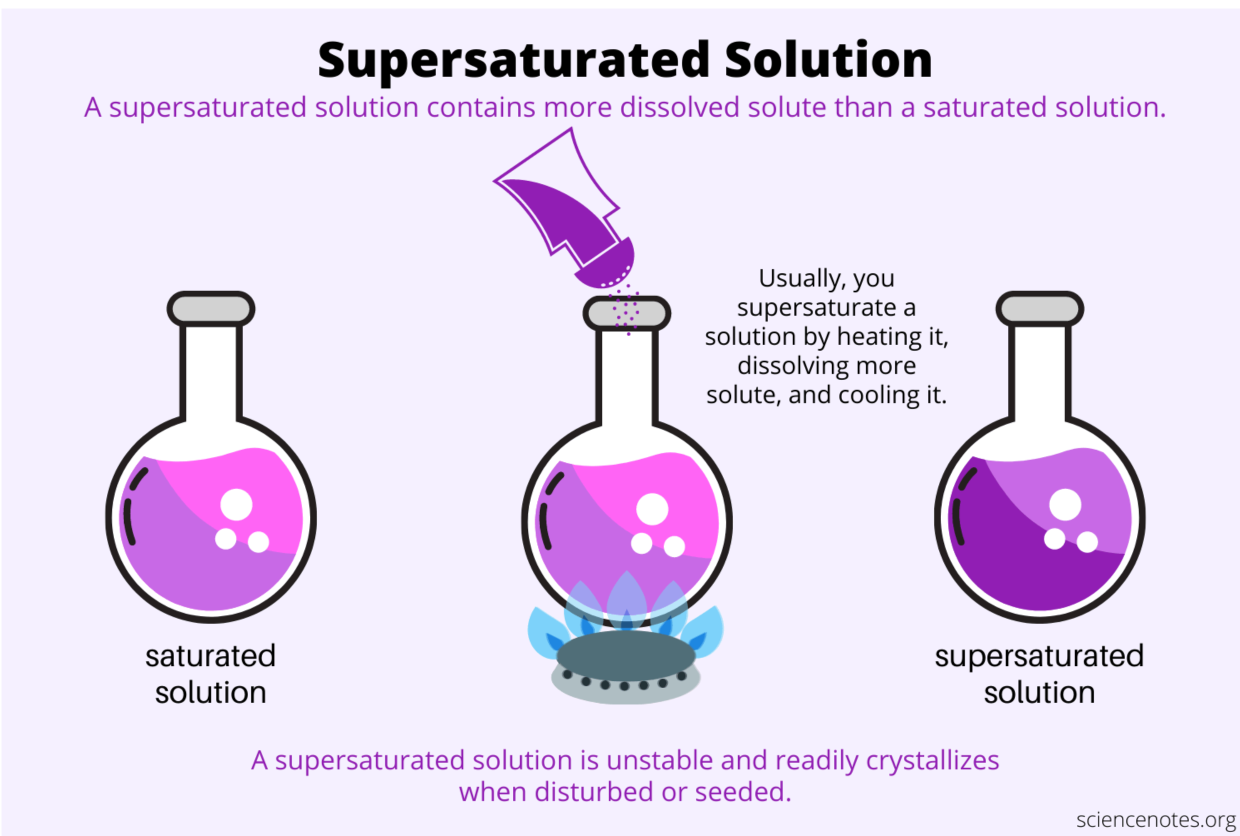
SOLVATION

Aqueous solution of ionic compounds



Aqueous solution of molecular compounds

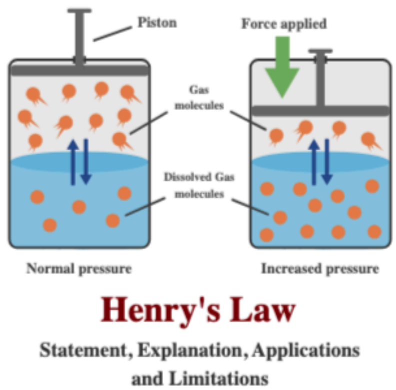


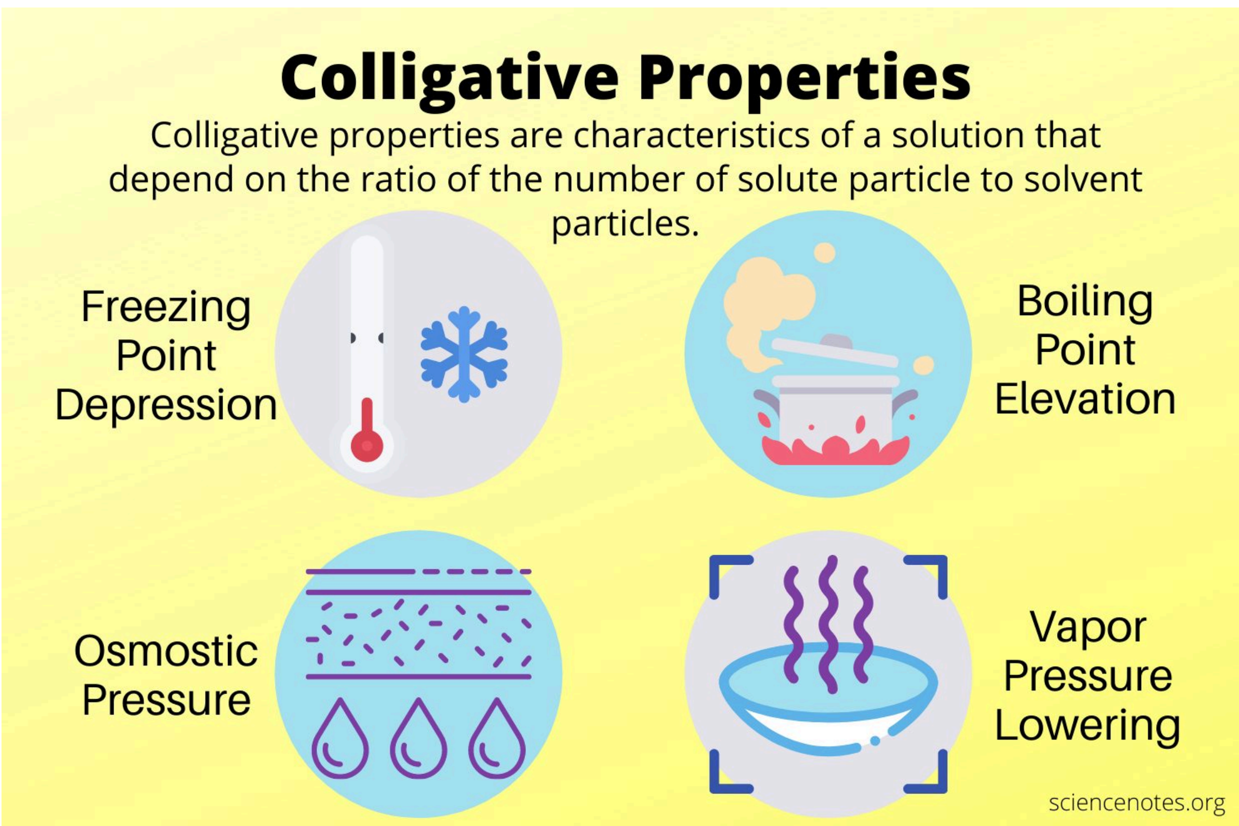


Solubility of gases

Solubility of gases decreases as temperature increases

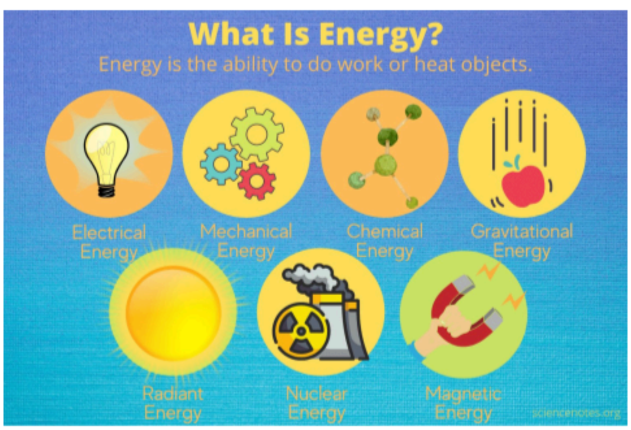
Solubility relationship to pressure is found in Henry's Law

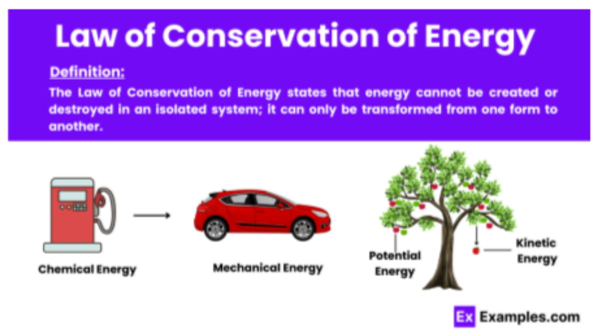


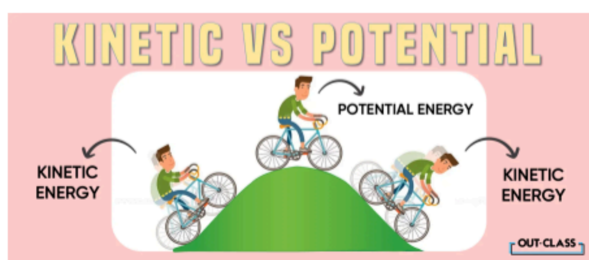


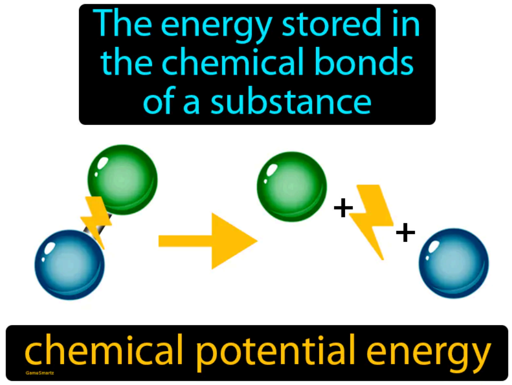
$$\Delta T_b = m \cdot K_b$$

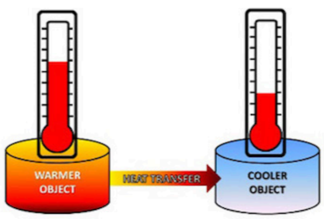
$$\Delta T_f = m \cdot K_f$$

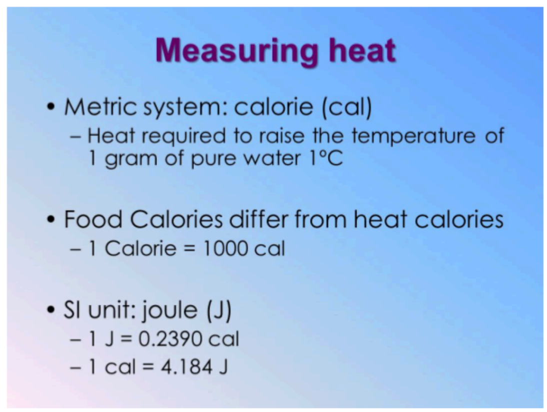


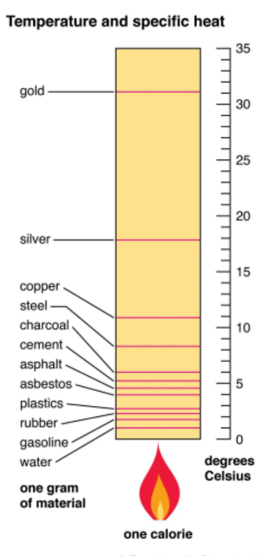





The energy stored in the chemical bonds of a substance
chemical potential energy


WARMER OBJECT
HEAT TRANSFER
COOLER OBJECT


Measuring heat
• Metric system: calorie (cal)
– Heat required to raise the temperature of 1 gram of pure water 1°C
• Food Calories differ from heat calories
– 1 Calorie = 1000 cal
• SI unit: joule (J)
– 1 J = 0.2390 cal
– 1 cal = 4.184 J


Temperature and specific heat
gold
silver
copper
steel
charcoal
cement
asphalt
asbestos
plastics
rubber
gasoline
water
one gram of material
one calorie
degrees Celsius
35
30
25
20
15
10
5
0
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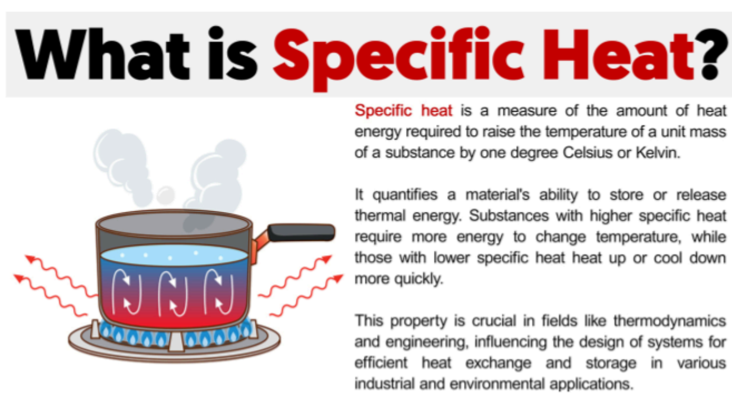
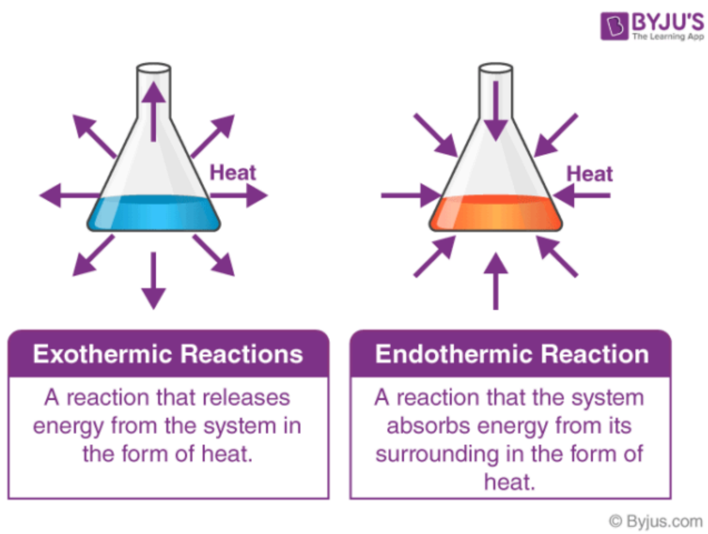

What is Specific Heat?
Specific heat is a measure of the amount of heat energy required to raise the temperature of a unit mass of a substance by one degree Celsius or Kelvin.
It quantifies a material's ability to store or release thermal energy. Substances with higher specific heat require more energy to change temperature, while those with lower specific heat heat up or cool down more quickly.
This property is crucial in fields like thermodynamics and engineering, influencing the design of systems for efficient heat exchange and storage in various industrial and environmental applications.

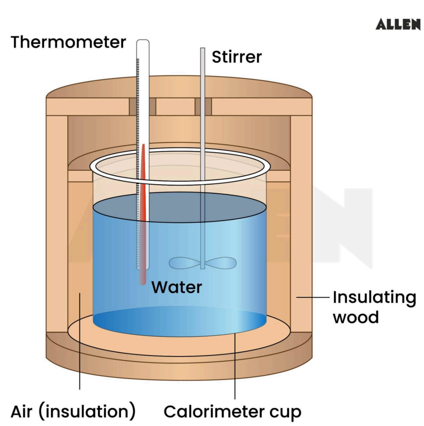
$Q = m\,c\,\Delta T$

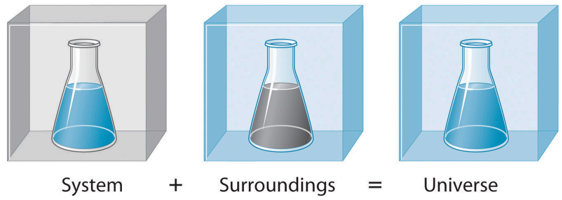
Q = Heat (cal or J)
m = Mass (g)
c = Specific heat (J/g°K)
ΔT = Change in temperature

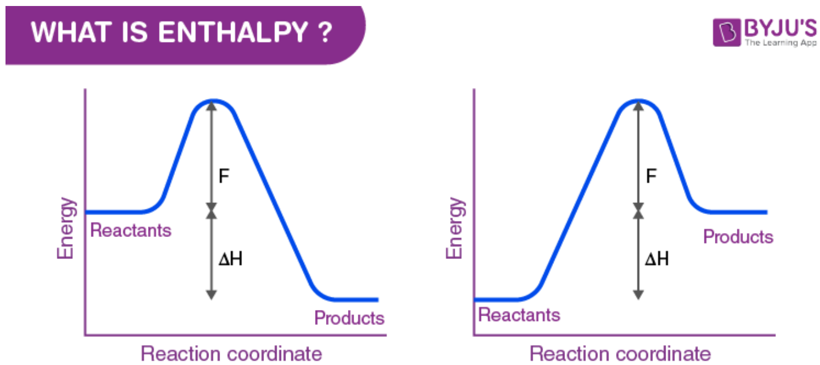
If Q is **positive**, the substance **absorbed** heat.
If Q is **negative**, the substance **released** heat.

1 cal = 4.18 J
1000 cal = 1 kcal
0 °C = 273 K









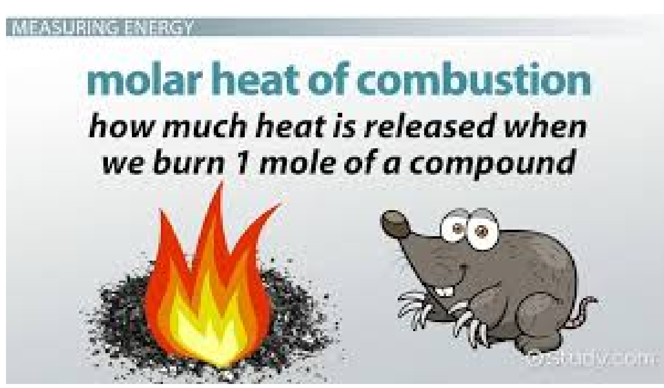
Thermochemical equations

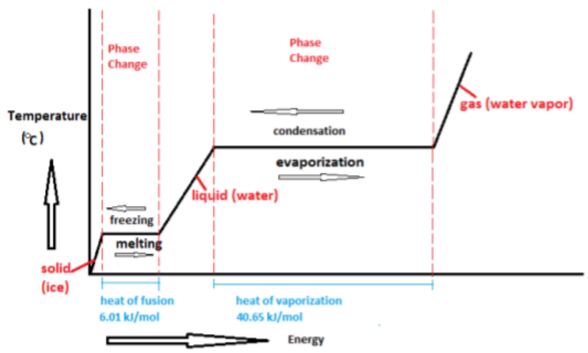
- A typical chemical equation is $S + O_2 \rightarrow SO_2$
- It is called a "thermochemical equation" when we add information about ΔH …

  $S + O_2 \rightarrow SO_2 \quad \Delta H = -\ 296.9\ kJ$
- If we change the equation, then the ΔH also changes …

  $SO_2 \rightarrow S + O_2 \quad \Delta H = +\ 296.9\ kJ$
- If the reaction is reversed the sign is reversed
- Also, if numbers in the equation change, so will the amount of energy produced/absorbed:

  $2S + 2O_2 \rightarrow 2SO_2 \quad \Delta H = -\ 593.8\ kJ$





Molar heat of vaporization: heat required to vaporize one mole of a liquid (- heat of condensation)

Molar heat of fusion: heat required to melt one mole of a solid substance (- heat of solid)

Changes of State

- The vaporization of water and the melting of ice can be described by the following equations:
- $H_2O(l) \rightarrow H_2O(g)$ $\Delta H_{vap} = 40.7$ kJ/mol
  - One mole of water requires 40.7 kJ to vaporize.
- $H_2O(s) \rightarrow H_2O(l)$ $\Delta H_{fus} = 6.01$ kJ/mol
  - One mole of ice requires 6.01 kJ to melt.

Hess's Law

- **Hess's law of heat summation** states that for a chemical equation that can be written as the sum of two or more steps, the enthalpy change for the overall equation is the sum of the enthalpy changes for the individual steps.