General Chemistry

State of Matter

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Chapter Description

- <u>Expected Outcome:</u>

  At the end of the lecture, the students should be able to understand and solve the problems regarding on Molecular Kinetic Theories, Gas Ideal Gas Equation, Liquid and Solution, Phase Diagram Solid.

- <u>References:</u>

1) Stephen B. Barone. Introduction to general chemistry. Blackwell Science.
2) James E. Bradry General Chemistry: Principles & Structure. John Wiley.

Contents

- Molecular Kinetic Theory
- Gas
- Ideal Gas Equation
- Liquid and Solution
- Phase Diagram
- Solid

General Properties of Gas

- Gas particles are far apart and will fill available space.
- Gas will take the volume and shape of their containers.
- Gas be compressed.
- Gas has relatively low density.

Boyle's Law

At constant temperature, the volume of a fixed amount of gas is inversely proportional to the gas pressure

$V \alpha \frac{1}{P}$ **(no of mole and temperature are constant)**

$PV = k$

Where:
k = constant
V = volume
P = pressure
T = temperature
n = number of moles

Boyle's Law

$$P_1 V_1 = P_2 V_2$$

- Where
- P_1 = initial pressure
- V_1 = initial volume
- P_2 = final pressure
- V_2 = final volume

Charles's law

At constant pressure, the volume of a fixed amount of gas is proportional to the absolute temperature of the gas (in Kelvin).

$V \propto T$ (no of mole and pressure constant)

$$\frac{V}{T} = k$$

Where :

k = constant
T = absolute temperature (K)
V = volume

Charles's law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

- Where V_1 = initial volume
- T_1 = initial temperature
- V_2 = final volume
- T_2 = final temperature

Boyles law and Charles law

Charles's law : $V \propto T$

$$V \propto \frac{T}{P}$$

$$V = k\frac{T}{P}$$

$$\frac{PV}{T} = k$$

Boyles's law : $V \propto \frac{1}{P}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Avogadro's law

- At constant pressure and temperature, the volume of a gas is will be proportional to the number of moles of the gas.

$V \alpha n$ (P and T are constant)

$V = k\ n$

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$\frac{V}{n} = k$$

where :
n = number of moles
k= constant

Ideal Gas Equation

Boyle's Law: $V \propto \frac{1}{P}$

Charles' Law: $V \propto T$

Avogadro's Law: $V \propto n$

$$V \propto \frac{nT}{P}$$

$$V = R\,\frac{nT}{P}$$

$$PV = nRT$$

Where :

R = gas constant

T = Temperature(K)

n = number of moles

V = volume

P = Pressure

Ideal gas equation

R value

Unit Pressure		Value of R	
atm		**0.08206**	
Nm^{-2} **or** **Pa**		**8.314**	

Gas Density

$$PV = nRT$$

$$PV = \left(\frac{m}{M_r}\right)RT$$

$$P = \frac{mRT}{VM_r}$$

$$P = \frac{dRT}{M_r}$$

$$d = \frac{PM_r}{RT}$$

where,

d = density of a gas

Daltons law of partial pressure

- The total pressure of a mixture of non reacting gases is the sum of the partial pressures of each of gas in the mixture

  - For a mixture of 3 gases, A,B and C :

$$P_T = P_A + P_B + P_C$$

Van der walls equation

Since real gas does not exhibit ideal gas behavior

at high pressure and low temperature. the ideal gas equation (PV=nRT) needs to be adjusted

In adjusting the equation, two parameters need to

be reconsidered :

- attractive forces between the gas molecules
- volume of the gas molecules

Liquid

It is a definite volume but not a definite shape

-Particles are arranged closely but not rigidly.

-Particles are held together by a strong intermolecular forces.

-Fit the shape of its container and is confined to a certain volume

Viscosity of a liquid

The higher the viscosity, the slower flowcity of the liquid.

Liquid compressibility

Particles are packed closely together ,thus, there is very little empty space between the molecules.

Liquid Diffusion

Occur because molecules are not tightly packed and can move randomly around one another.

Properties of solid

1. Particles are closely arranged and regularly in order
2. Rigid
3. Definite shape and volume.
4. Strong forces between the particles.
5. High densities.
6. Incompressible.
7. Diffusion is extremely slow.

Fusion process

- Solid is changing into a liquid
- When a solid substance is heated :
  - its particles gain energy
  - therefore able to vibrate more rapidly
  - at certain temperature, the kinetic energy is higher enough to overcome the intermolecular forces of attraction between solid particles.
  - the particles are free to move and the solid start to melt

Melting point – the temperature at which solid and liquid coexist in equilibrium

Solidification process

Liquid is changing into a solid

- when the temperature of a liquid is lowered, the kinetic energy of the liquid particles decreases
- the liquid particles vibrate at a slower rate
- when the intermolecular forces are strong enough to hold the particles together in a fixed and orderly arrangement, the liquid freezes.

Sublimation process

- The process by which a substance changes directly from solid to the gaseous state without passing through the liquid state.
- Occurs on solid with weak intermolecular forces of attraction

Phase diagram

Describes **stable phases** and **phase changes** of a substance as a function of **temperature** and **pressure**

Regions of Diagram

- Three main regions :
Solid, liquid and gas.

- A particular phase is stable in any combination of pressure and temperature.

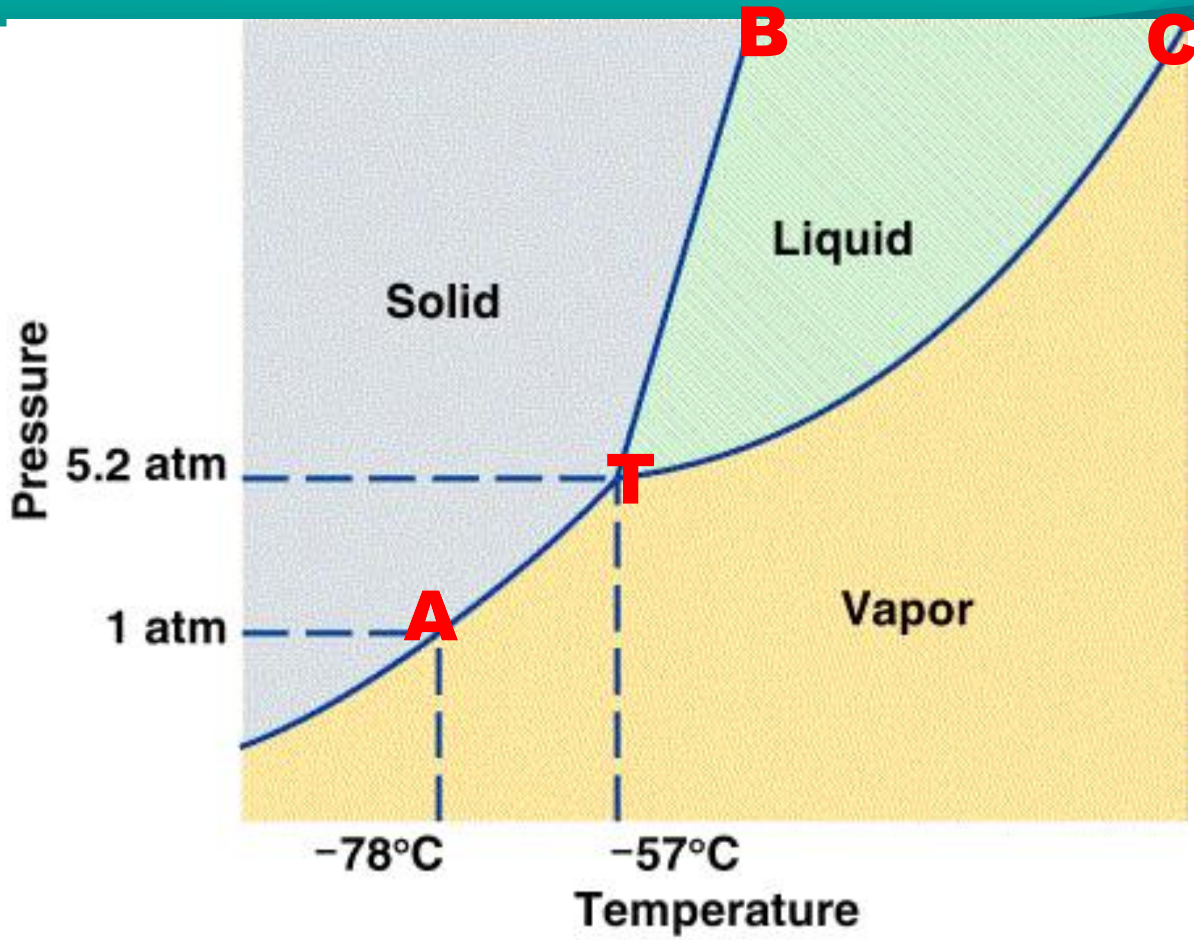
Point T

- Aka - **triple point**
- point where the 3states of a substance are in equilibrium.

Point C

- Aka **the critical point**
- Vapour cannot be condensed to a liquid.

Phase Diagram of CO_2



Author Information

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