6. GASEOUS STATE - Study Material

Boyle's Law states that

"The pressure of a given mass of an ideal gas is inversely proportional to its volume at a constant temperature."

$$V \propto \frac{1}{P} \qquad P_1V_1 = P_2V_2 = k$$

- **Robert Boyle**

Charle's Law states that

"The volume of a fixed mass of a gas is directly proportional to the temperature."

$$V \propto T \qquad \frac{V_1}{T_1} = \frac{V_2}{T_2} = k$$

- **J.A.C. Charles**

Gay-Lussac's Law states that

"At constant volume, the pressure of a fixed mass of a gas is directly proportional to temperature."

$$P \propto T \qquad \frac{P_1}{T_1} = \frac{P_2}{T_2} = k$$

- **Joseph Gay-Lussac**

Avogadro's Hypothesis states that

"Equal volume of all gases under the same conditions of temperature and pressure contain equal number of molecules."

$$V \propto n \qquad \frac{V_1}{n_1} = \frac{V_2}{n_2} = k$$

Dalton's Law of partial pressure

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

$$p_{total} = p_1 + p_2 + p_3$$

- **John Dalton**

Diffusion and Effusion

The property of gas which involves the movement of the gas molecules through another gases is called Diffusion. Effusion is another process in which a gas escapes from a container through a very small hole.

Graham's Law of Diffusion

"The rate of diffusion or effusion is inversely proportional to the square root of Molar mass."

$$Rate\ of\ Diffusion \propto \frac{1}{\sqrt{M}}$$

Compressibility Factor

The deviation of real gases from ideal behavior is measured in terms of a ratio of PV to nRT. This is termed as compressibility factor.Mathematically

$$Z = \frac{PV}{nRT}$$

For ideal gases PV = nRT, hence the compressibility factor, Z=1 at all temperatures and pressures.

Joule-Thomson effect

The phenomenon of lowering of temperature when a gas is made to expand adiabatically from a region of high pressure into a region of low pressure is known as Joule-Thomson effect.

Inversion Temperature

The temperature below which a gas obeys Joule-Thomson effect is called inversion temperature (T_i).

$$T_i = \frac{2a}{Rb}$$

DERIVATION OF IDEAL GAS EQUATION

The gaseous state is described completely using the following four variables T, P, V and n and their relationships were governed by the gas laws below,

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

$$Charles\ Law \qquad V \propto T$$

$$Avogadro's\ Law \qquad V \propto n$$

Combining these equations,

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

$$V = \frac{nRT}{P}$$

where R is the proportionality constant called universal gas constant.

$$PV = nRT$$