Q3: Deduce the gas law's from Kinetic gas equation?

Ans: → **Boyle's law:**

From the Kinetic gas equation we know,

$$PV = \frac{1}{3} m n u^2$$

If total mass of the gas is M

then, $M = m \cdot n$

$$\therefore PV = \frac{1}{3} M u^2$$

or $$PV = \frac{2}{3} \times \frac{1}{2} M u^2$$

or $$PV = \frac{2}{3} [K.E.]$$ $\left[\frac{1}{2} Mu^2 = \text{Kinetic energy}\right]$

According to postulate Kinetic energy is directly proportional to absolut temperat Hence, at constant temperature Kinet energy is constant.

$\therefore PV = \text{Constant}$; when temperat is constant.

This is Boyle's law.

Charle's Law: →

From above equation

$$PV = \frac{2}{3} [K.E.]$$

or $$V = \frac{2}{3} \cdot \frac{1}{P} [K.E.]$$

If P is constant we may write

$$V = \text{constant} \times [K.E.]$$

$$\therefore V \propto [K.E.]$$

But according to postulate

$[K.E.] \propto T$

Hence, $V \propto T$; when Pressure is constant

This is Charle's law.

Avagradro's Hypothesis :

Let us consider two gases. Gas no. 1 and gas no 2. Using suffixes 1 and 2 respectivily for the gases the kinetic gas equation may be written as,

$$P_1V_1 = \frac{1}{3} m_1 n_1 u_1^2 \quad \text{--- (i)}$$

$$P_2V_2 = \frac{1}{3} m_2 n_2 u_2^2 \quad \text{--- (ii)}$$

Equal volume of two gases at the same temperature and pressure are considered

Hence $P_1V_1 = P_2V_2$

Thus $\frac{1}{3} m_1 n_1 u_1^2 = \frac{1}{3} m_2 n_2 u_2^2$

or, $m_1 n_1 u_1^2 = m_2 n_2 u_2^2 \quad \text{--- (iii)}$

Because both the gases are at equal temperature the kinetic energy per molecule should also may be equal.

$$\frac{1}{2} m_1 u_1^2 = \frac{1}{2} m_2 u_2^2$$

or, $m_1 u_1^2 = m_2 u_2^2 \quad \text{--- (iv)}$

Dividing equation (iii) by (iv) we get

$$\frac{m_1 n_1 u_1^2}{m_1 u_1^2} = \frac{m_2 n_2 u_2^2}{m_2 u_2^2}$$

or, $n_1 = n_2$

Hence equal volume of gases at the same temperature and pressure is contain the same number of molecules. This is Avogadoo's Hypothesis.

We know that

$$PV = \frac{1}{3} mnu^2$$

The total mass of the gas is M.

Hence $M = m \cdot n$.

$$\therefore PV = \frac{1}{3} M u^2$$

or $u^2 = \frac{3PV}{M}$ [But $\frac{M}{V} = D$ density]

or $u^2 = 3P\frac{1}{D}$

or $u = \sqrt{3P\frac{1}{D}}$

If pressure is constant.

$$u = \frac{\text{Constant}}{\sqrt{D}}$$

$$\therefore u \propto \frac{1}{\sqrt{D}}$$

It is obvious that rate of diffusion r is directly proportional to u.

$$r \propto u.$$

Hence $r \propto \frac{1}{\sqrt{D}}$

Hence, rate of diffusion of a gas is inversaily proportional to the squair root of its density.

This is Graham's law of diffusion.