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Deg I Chem. Hons, Paper – I

Topic :– Gaseous state

Root mean square Velocity :–

It is the under root of the mean of the squres of all the Velocity of molecules of the gas.

Suppose in a gas n_1, n_2, n_3, n_4 -- molecules are having velocities u_1, u_2, u_3, u_4 ------ respectively then the root mean square velocity of all the molecules will be

$$C = \sqrt{\frac{n_1u_1^2 + n_2u_2^2 + n_3u_3^2 + n_4u_4 + ----}{n_1 + n_2 + n_3 + n_4 + --------}}$$

Root mean square velocity from Kinetic gas equation :–

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

For 1 mole of Ideal gas $PV = RT$

One mole of gas Contains Avogadro's number of molecules ie N molecules

$$N = 6.022 \times 10^{23}$$

Hence for 1 mole Ideal gas the Kinetic gas equation $PV = \frac{1}{3} mNC^2$

or $$RT = \frac{1}{3} mNC^2$$

$$c^2 = \frac{3RT}{mN} = \frac{3RT}{M}$$

$\therefore$ C (R.M.S. Velocity) $= \sqrt{\frac{3RT}{M}}$ —(1)

we know that $PV = RT$ for 1 mole gas

$\therefore$ C(R.M.S. velocity) $= \sqrt{\frac{3PV}{M}}$ —(2)

D (Density) $= \frac{M}{V}$ $\therefore \frac{1}{D} = \frac{V}{M}$

Putting these values in equation(2) we get

C(R.M.S. Velocity) $= \sqrt{\frac{3P}{D}}$ —(3)

Average Velocity (V) :-

It is the arithmetical mean of all the velocities of molecules.

Suppose in a gas n_1, n_2, n_3, n_4 ---- molecules are having velocities u_1, u_2, u_3, u_4 --- respectively then the average velocity of all the molecules

$$V = \frac{n_1 u_1 + n_2 u_2 + n_3 u_3 + n_4 u_4 + \cdots}{n_1 + n_2 + n_3 + n_4 + \cdots}$$

Kinetic energy of 1 mole gas :-

Total number of molecules Present in one mole of a gas is N (6.022×10^{23}) ie Avogadro's number.

$\therefore$ Kinetic energy per mole of the gas $(E) = \frac{1}{2} m N c^2$ —— (1)

The Kinetic gas equation for N molecule of a gas may be Written as

$$PV = \frac{1}{3} m N C^2$$

$$= \frac{2}{3} \times \frac{1}{2} m N c^2$$

$$= \frac{2}{3} \times \text{K.E of 1 mole gas} \quad \text{—(2)}$$

From Ideal gas equation $PV = RT$ [for 1 mole gas] (3)

Comparing equation (2) and (3) we have

$$RT = \frac{2}{3} \times \text{K.E of 1 mole gas}$$

$$\therefore \boxed{\text{K.E of 1 mole gas} = \frac{3}{2} RT}$$

K.E of one molecule of a gas $= \frac{3}{2}\left(\frac{R}{N}\right)T = \frac{3}{2} kT$

$\frac{R}{N} = k$ (Boltzmann constant)

$k = 1.38 \times 10^{-16}$ ergs/degree/mole