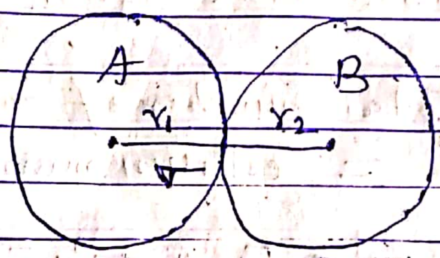
B·SC· III PAPER-5

Collision diameter:- A minimum distance between centre of two molecule taking part in collision is called collision diameter.



In above figure σ is the collision diameter which is closest approach distance between two molecule A and B.

Collision number:- Total number of molecules with which a single molecule collide per unit time in per unit volume is called collision number. It is generally denoted by Z

It is given by.

$$Z = \sqrt{2}\,\pi\,\sigma^2\,\bar{c}\,\rho$$

Where Z = collision number.

σ = collision diameter.

$\bar{c}$ = average velocity

ρ = no of molecules per unit volume of gas.

Collision frequency:-

It is total number of molecular collision occurring per unit volume in per unit time is called collision frequency. It is obtained by multiplying collision number with density of the gas (i.e. no's)

Thus Total number of collision per unit volume = collision number × ρ (density of gas)

$$Z = \sqrt{2}\, \pi \sigma^2 \bar{c} \rho^2$$

this is the collision occurring between two molecule and hence no of collision occurring single molecule will be half of the above given number.

$$Z_{11} = \frac{1}{2} \sqrt{2}\, \pi \sigma^2 \bar{c} \rho^2$$

$$\Rightarrow Z_{11} = \frac{1}{\sqrt{2} \times \sqrt{2}} \times \sqrt{2}\, \pi \sigma^2 \bar{c} \rho^2$$

$$\Rightarrow Z_{11} = \frac{1}{\sqrt{2}} \pi \sigma^2 \bar{c} \rho^2$$

If Two different gas is in the container Then

$$\boxed{Z_{12} = \sqrt{2}\, \pi \sigma^2 \bar{c}\, \rho_1 \cdot \rho_2}$$

Where ρ_1 = density gas 1

ρ_2 = density of gas 2

σ = collision diameter

$\sigma = r_1 + r_2$

Mean free path → It is minimum distance travelled by a molecule between two successive collision. It is denoted by λ

$$\lambda = \frac{\bar{c}}{Z_1} = \frac{\bar{c}}{\sqrt{2}\pi\sigma^2\bar{c}\rho}$$

(As by definition of collision number $Z_1 = \sqrt{2}\pi\sigma^2\bar{c}\rho$.) —— (IV)

We know $PV = nRT = nN_A KT$

N_A = Avogadro number

K = Boltzmann constant

$$P = \frac{nN_A}{V} KT = \frac{N KT}{V}$$

$N = nN_A$ = No of molecules in n mole.

and $\rho = \frac{N}{V}$

Thus $P = \rho KT$ or $\boxed{\rho = \frac{P}{KT}}$ —— (V)

Substituting value of ρ in eqn (IV)

$$\lambda = \frac{\bar{c}}{\sqrt{2}\pi\sigma^2\bar{c}\frac{P}{KT}} = \frac{KT}{\sqrt{2}\pi\sigma^2 P}$$

$$\boxed{\lambda = \frac{KT}{\sqrt{2}\pi\sigma^2 P}}$$