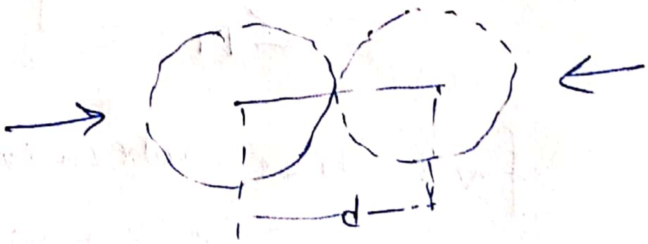
TDC-I
Paper-I

Physical Chemistry

Collision Parameters

* **Collision Diameter** = When two gas molecules approach each other, a point reached at which the mutual ~~b/w~~ repulsion b/w molecules becomes so strong that it causes reversal of the two molecules are at the point of their closest approach, Hence the distance between the centres of the two molecules at the point of their closest approach is called Collision Diameter

Effective Volume of molecules $= \frac{4}{3}\pi d^3$



* **Collision Number (Z_1)** = The number of molecules with which a single molecule will collide per unit time per unit volume is called Collision Number

$$Z_1 = \sqrt{2}\pi d^2 \langle c \rangle \rho$$

where d – collision diameter

$\langle c \rangle$ = Average velocity of molecules

ρ = no. of molecules per unit volume of gas.

Since each molecular collision involves two molecules, The Number of Collision of like molecules occurring per unit time per unit volume of the gas Then

$$Z_{11} = \frac{1}{2} \sqrt{2} \pi d^2 \langle c \rangle \rho^2$$

Collision frequency (Z_{11}) - It is defined as the number of molecular collision occurring per unit time per unit volume of gas.

$$Z_{11} = \frac{1}{2} \sqrt{2} \pi d^2 \langle c \rangle \rho^2$$

for unlike molecules

$$Z_{12} = \frac{1}{\sqrt{2}} \pi d^2 \langle c \rangle \rho_1 \times \rho_2$$

Since $P = \frac{n N_A K T}{V} = \frac{N K T}{V}$

where N = Total no. of molecules in n molecules of gas

ρ = No of molecules per unit volume

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

$$P = \rho K T$$

$$\rho = \frac{P}{KT}$$

Hence

$$Z_1 = \sqrt{2}\pi d^2 \langle c \rangle \frac{P}{KT} \quad (\sec^{-1})$$

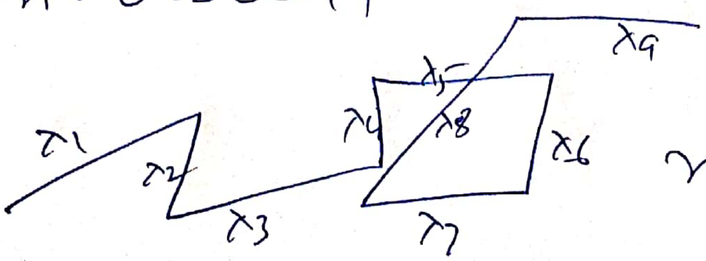
$$Z_{11} = \frac{\pi d^2}{\sqrt{2}} \langle c \rangle \frac{P^2}{(KT)^2} \quad (s^{-1} m^{-3})$$

Mean free path (λ) $\Rightarrow$ It is defined as The mean distance travelled by a gas molecules between successive collision.

$$\lambda = \frac{\langle c \rangle}{Z_1} = \frac{\langle c \rangle}{\sqrt{2}\pi d^2 \langle c \rangle \frac{P}{KT}} = \frac{KT}{\sqrt{2}\pi d^2 P}$$

Hence $\lambda \propto \frac{T}{P}$

The mean free path of a gas molecules at constant temperature is inversely proportional to the pressure



All free paths are not same hence mean free path is considered

$$\lambda = \frac{\lambda_1 + \lambda_2 + \lambda_3 + \cdots}{n}.$$