MEAN FREE PATH

Acc to the kinetic theory, the molecules of a gas are constantly moving in all directions and with various speed they frequently collide with one another when their speeds and directions change.

The mean free path is the average distance travelled by a molecule between two successive collisions with other molecules.

Expression for Mean free path →

Let us assume that all the molecules except one, are at rest and let d be the diameter of a molecule.
Let us now follow a single molecule of equivalent diameter 2d as it moves through a gas of point particles.

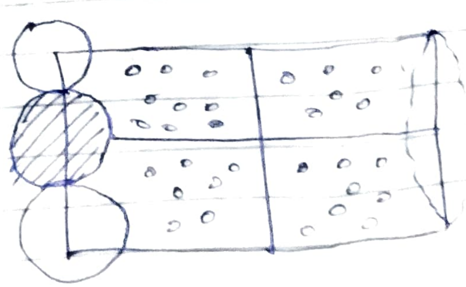
Average velocity $\bar{c} = \sqrt{\frac{8KT}{\pi m}}$

In time t it will sweep out a cylinder of cross sectional area $= \pi d^2$

and length $= \bar{c}t$

If there are n molecules per unit volume.

Volume $= \pi d^2 \times \bar{c} t$



No of collisions = n × volume

$= n \times \pi d^2 c t$

Mean free path λ = total distance covered in time t / no of collisions in time t

$$\lambda = \frac{ct}{n \times \pi d^2 c t} = \frac{1}{n \pi d^2}$$

If all other molecules are not in rest then

$$\boxed{\lambda = \frac{1}{\sqrt{2} \pi n d^2}} \quad \text{--- (1)}$$

$\because PV = NKT \Rightarrow P = \frac{NKT}{V} \Rightarrow P = nKT$

$$\Rightarrow n = \frac{P}{KT}$$

Put this value in eqn (1)

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

where K = Boltzmann constant

$$\lambda \propto \frac{1}{P}$$

$$\lambda \propto T$$

— x —