Ideal Gas

39-58   O-I

$$k = \frac{R}{N_A}$$

$$\frac{8.314 \, J/mol/k}{4.18}$$

(43)

$$KE_{1mol} = \frac{3}{2} RT$$

$$1 \, cal = 4.18 \, J$$

$$= \frac{3}{2} \times 2 \times 300$$

$$= 900 \, cal$$

Ideal Gas

(48)

(4)   6 $U_{rms} = 5\,m/sec$
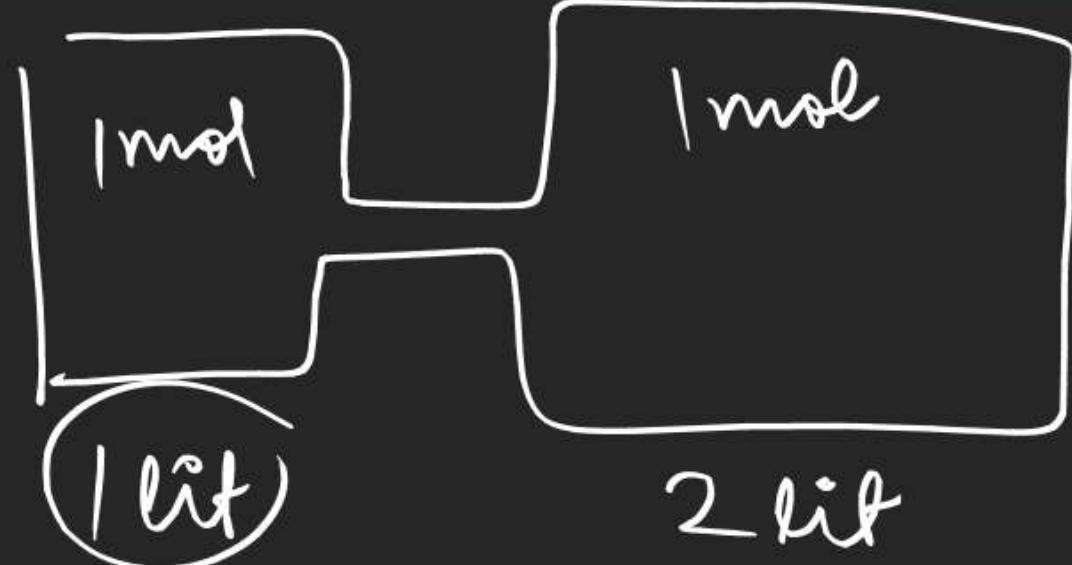
$7\,m/sec$ $x\,m/sec$

$$U_{rms} = \left[\frac{4 \times 7^2 + 6 \times x^2}{10}\right] = 25$$

$U_{rrms} = \sqrt{\dfrac{3RT}{M}}$

$$196 + 6x^2 = 250$$

$$6x^2 = 54$$

$$x^2 = 9$$

$$x = 3$$

Ideal Gas

$$\frac{PV}{n} = RT$$

(55)

1 mol   1 mol

1 lit   2 lit

$$V_{avg} = \quad 2\,V_{avg}$$

$$\sqrt{\frac{8}{\pi}\frac{P_1 V_1}{nM}} = 2 \times \sqrt{\frac{8}{\pi}\frac{P_2 V_2}{nM}}$$

(57) $U_{mps} = 400$

$$\frac{U_{rms}}{U_{mps}} = \sqrt{1.5}$$

4ω   452-
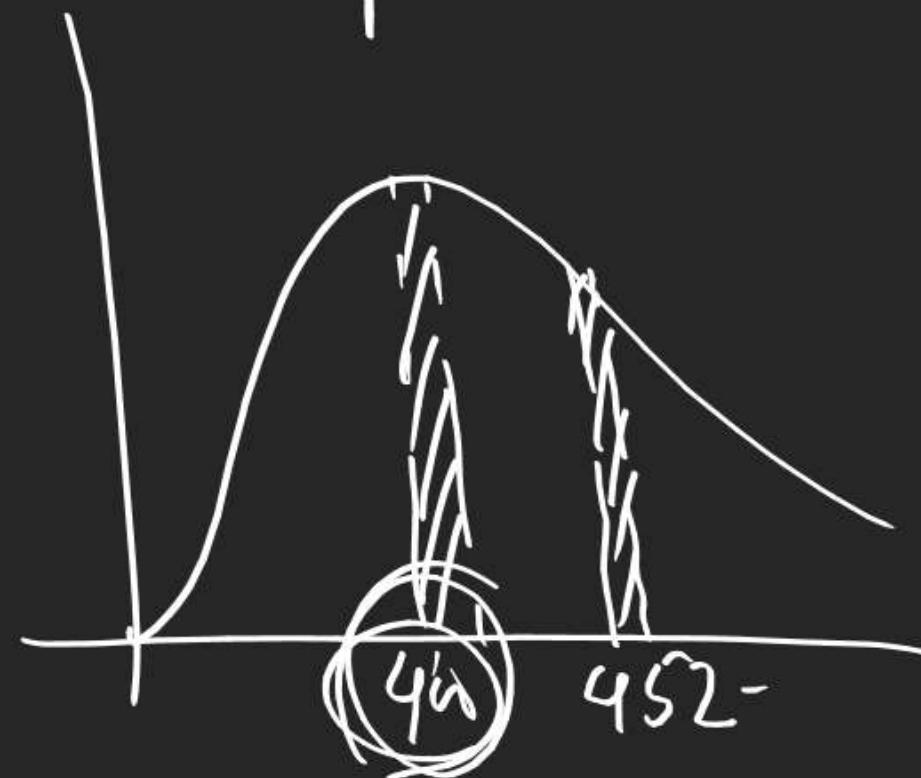
Ideal Gas

U_{mps} to $U_{mps} + f\,U_{mps}$

$$u = U_{mps} \qquad du = f\,U_{mps}$$

$U_{mps} - 0.02$ to $U_{mps} + 0.02$

$$u = U_{mps} \boxed{-0.02}$$

$$\underline{u \simeq U_{mps}}$$

~~58~~

(58)

$$\underline{du = 0.04}$$
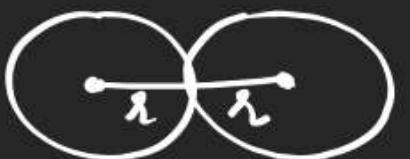
$$\frac{dN}{N} \propto \left(\boxed{\frac{M}{T}}\right)^{1/2}$$

$$\frac{\left(28/100\right)^{1/2}}{\left(56/200\right)}$$

Nishant Jindal

No. g (Bimolecular)
Collisions : ⟶

Collision
diameter $(\sigma) = 2r$
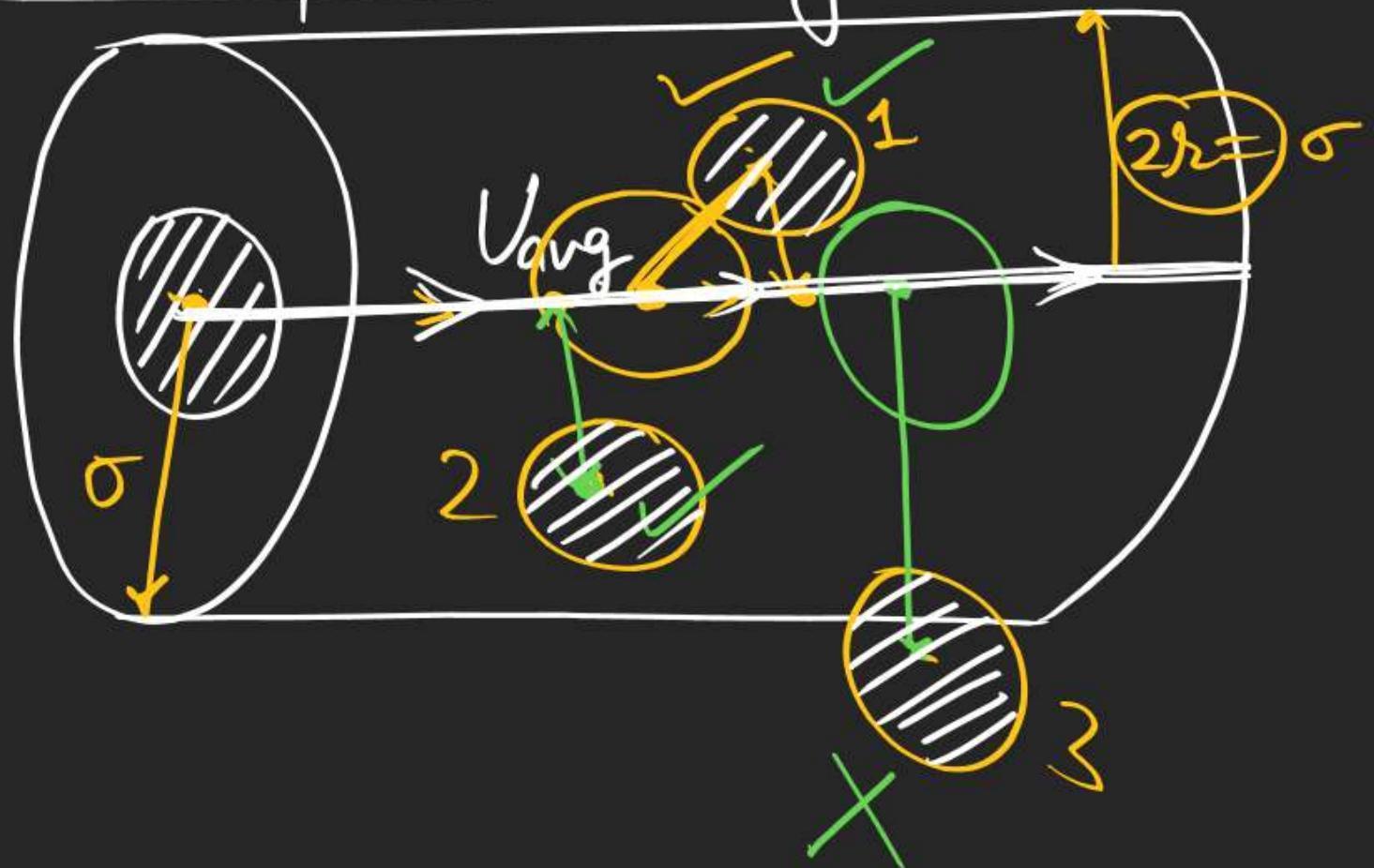
⟹ Molecules are considered to spherical & rigid.

Total 'N' molecules

V

V'
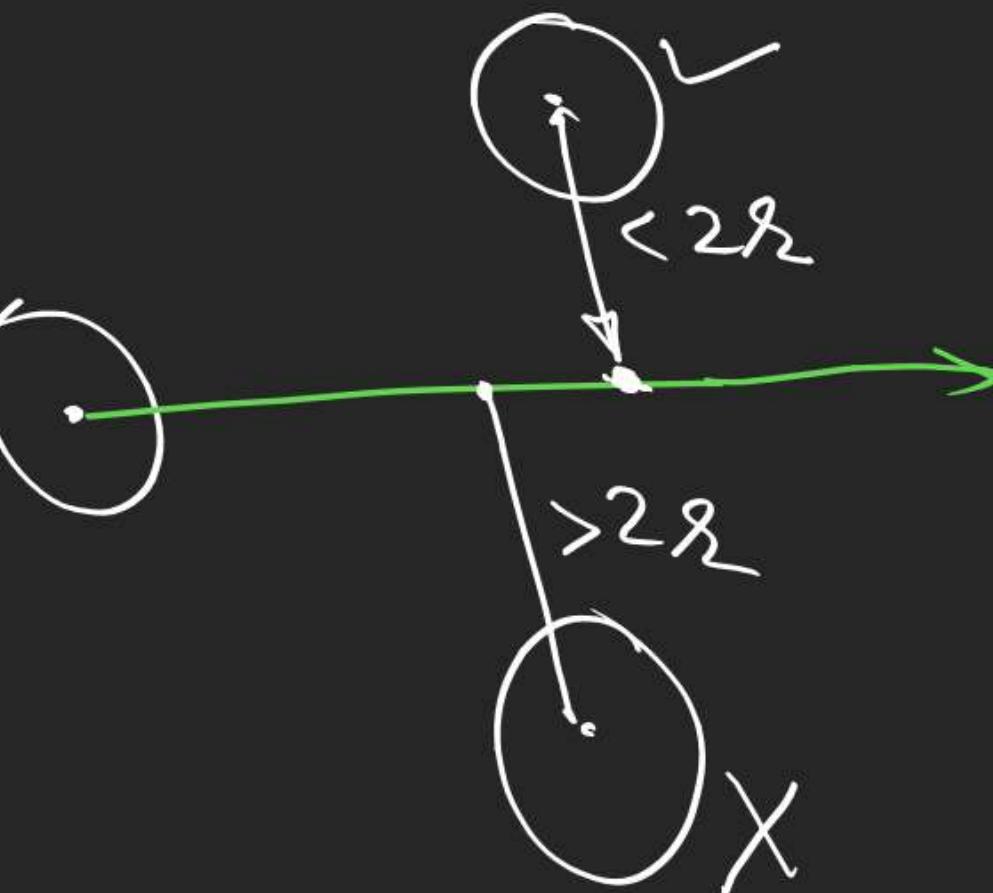
$N^* = \dfrac{N}{V} = \dfrac{\text{no. g molecules per}}{\text{unit volume}} = \dfrac{\text{number}}{\text{density}}$

$N^* V'$

Ideal Gas

Assumption : only one molecule is moving

V_{avg}

$2r = \sigma$

σ

1

2

3

distance travelled in one second = V_{avg}

$< 2r$

$> 2r$
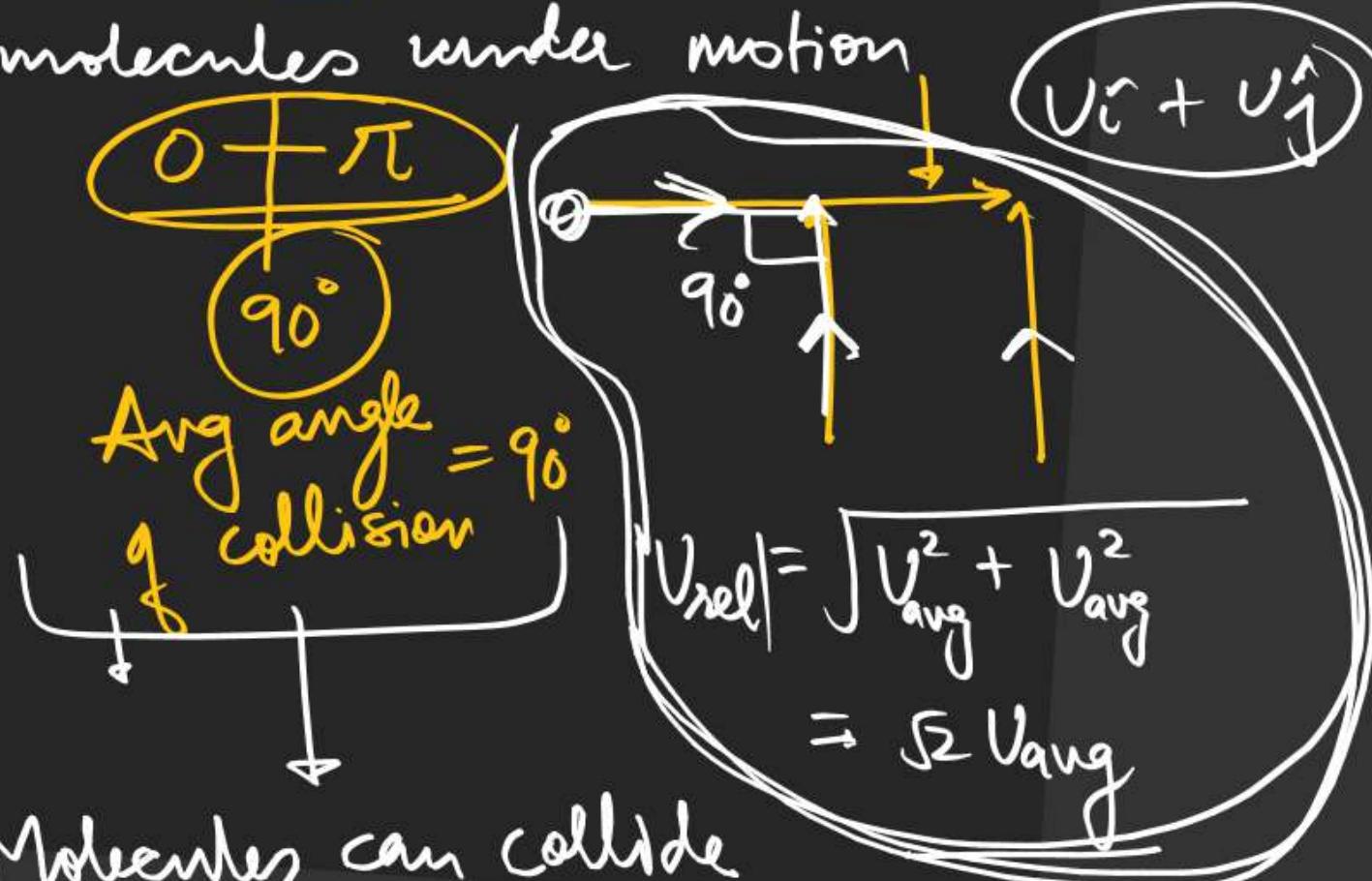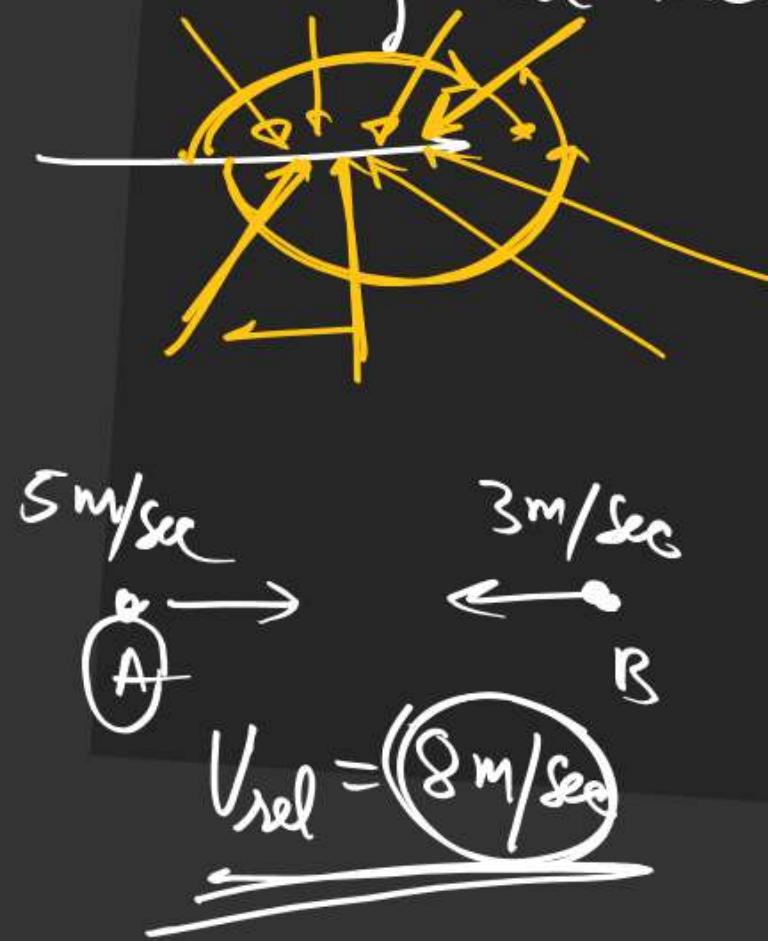
Ideal Gas
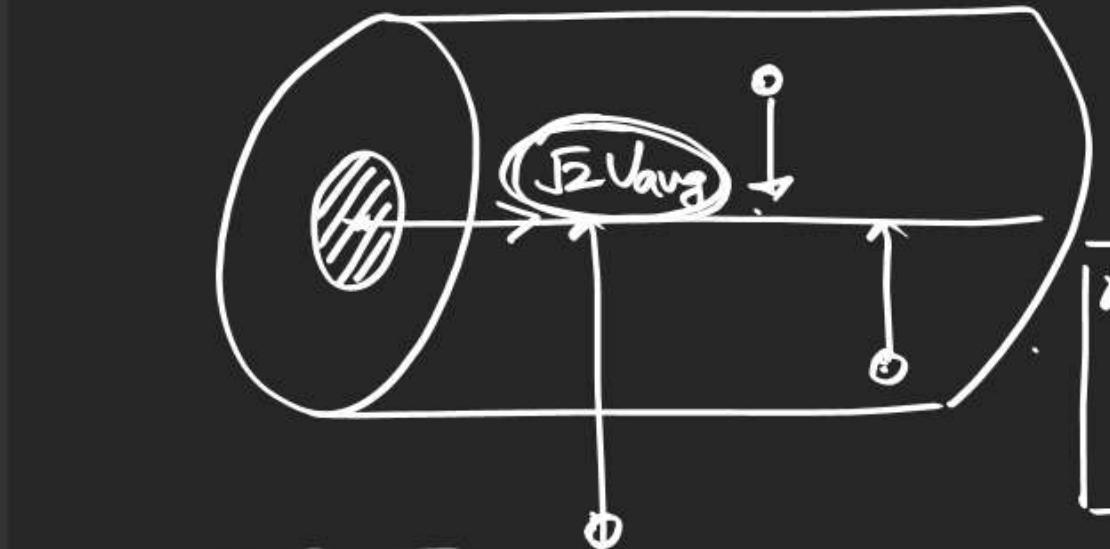
$$\text{Volume of Cylinder} = (\pi \sigma^2) V_{avg}$$

$$\text{molecules in cylinder} = (\pi \sigma^2 V_{avg}) N^* = \text{No. of collision by 1 molecule in one sec}$$

Nishant Jindal

Considering all the molecules under motion

$$U\hat{i} + U\hat{j}$$

$$0 - \pi$$

$$90°$$

Avg angle $= 90°$
of collision

$$|V_{rel}| = \sqrt{V_{avg}^2 + V_{avg}^2}$$

$$\Rightarrow \sqrt{2}\, V_{avg}$$

5 m/sec

3 m/sec

A

B

$$V_{rel} = 8\,m/sec$$
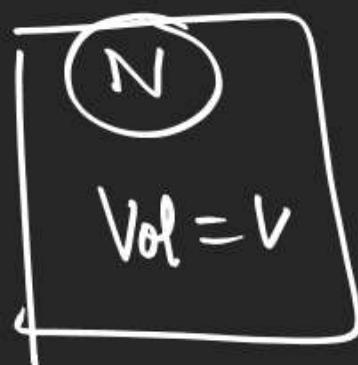
Molecules can collide at any angle from 0 to 180° with equal probability therefore avg angle of collision can be considered to be 90°
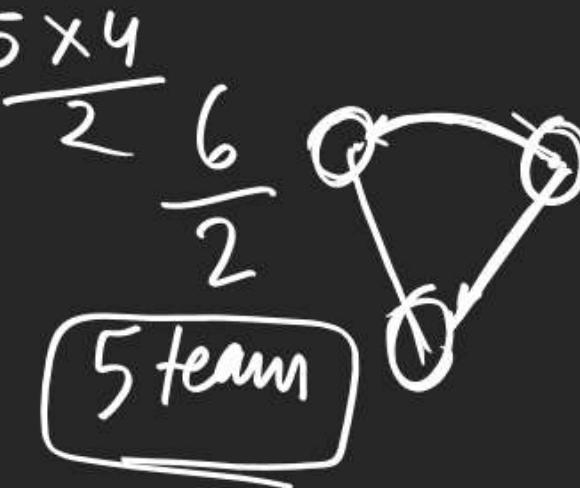
$$\text{vol. of cylinder} = \sqrt{2}\,\pi\sigma^2 V_{avg}$$

no. of collision per sec
by one molecule $= \sqrt{2}\,\pi\sigma^2 V_{avg}\, N^*$
$$= Z_1$$

$\boxed{N}$

$Vol = V$

$\text{Total collision per sec} = \dfrac{1}{2} N Z_1$
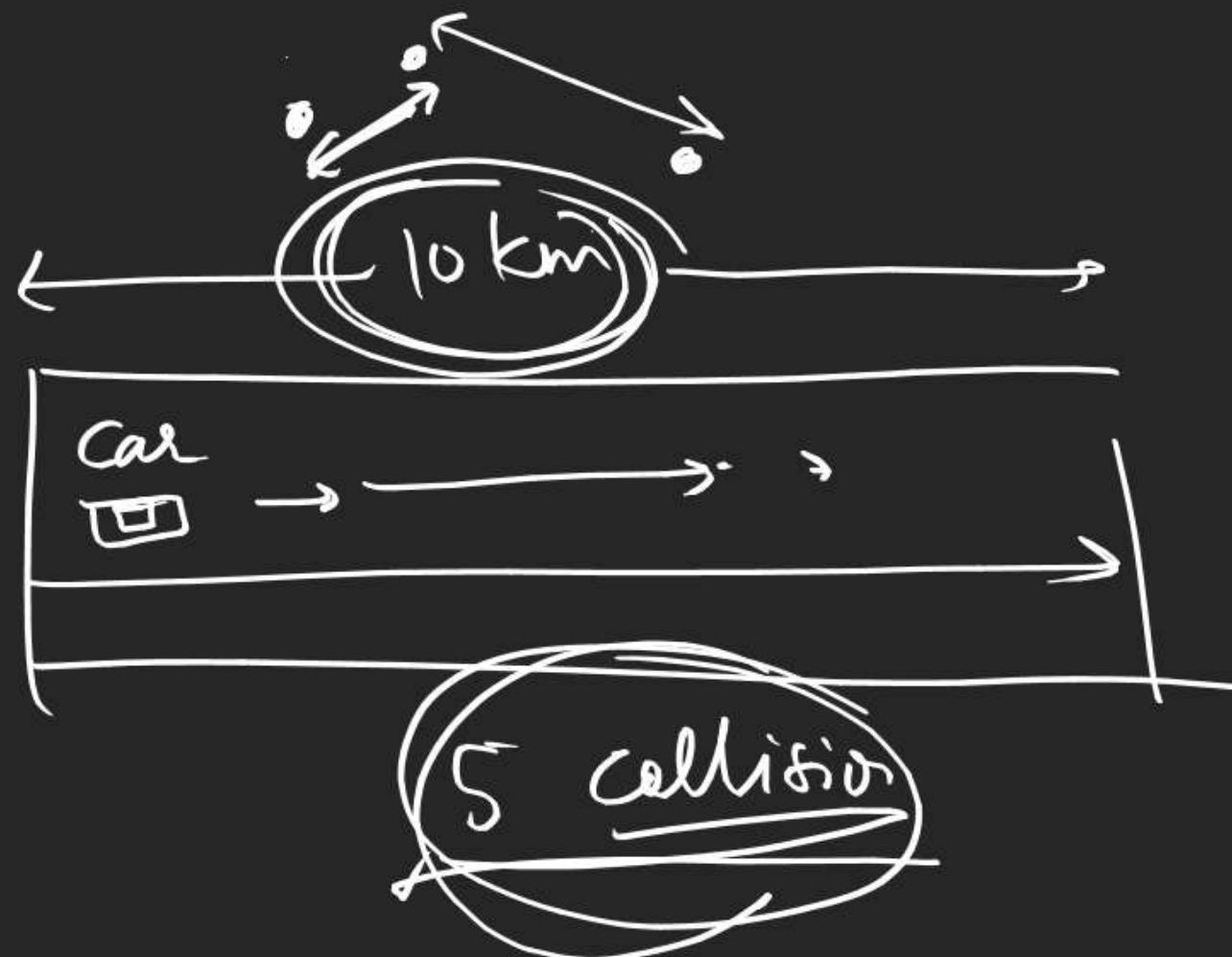
$\text{Total collision per second per unit volume} = \dfrac{1}{2}\dfrac{N}{V} Z_1 = \dfrac{1}{2} N^* Z_1$

$\dfrac{5\times 4}{2}$
$\dfrac{6}{2}$

$\boxed{5\ \text{team}}$

$$\text{Collision frequency} = Z_{11} = \dfrac{1}{\sqrt{2}}\pi\sigma^2 V_{avg}\,(N^*)^2$$

$\sqrt{2}V_{avg}$

Ideal Gas

Mean free path (λ) :— Avg distance bet^n molecules

or

Avg distance travelled by a molecule bet^n two successive collisions

$$\lambda = \frac{\text{distance travelled in one Sec}}{\text{no. of Collision in one Sec}}$$

$$\boxed{\lambda = \frac{V_{avg}}{Z_1}} = \frac{V_{avg}}{\sqrt{2}\,\pi\,\sigma^2\, V_{avg}\, N^*}$$

10 km

Car →

5 collision

$$\lambda = \frac{1}{\sqrt{2}\,\pi\,\sigma^2\,N^*}$$

$$Z_1 = \sqrt{2}\,\pi\,\sigma^2\,V_{avg}\,N^*$$

$$Z_{11} = \frac{1}{\sqrt{2}}\,\pi\,\sigma^2\,V_{avg}\,(N^*)^2$$

$$N^* = \frac{N}{V}$$

$$PV = nRT$$

$$PV = \frac{N}{N_A}RT$$

$$P = \left(\frac{N}{V}\right)\left(\frac{R}{N_A}\right)T$$

$$N^* = \frac{P}{kT}$$

Ideal Gas

$$Z_1 = \sqrt{2}\pi\sigma^2 \sqrt{\frac{8RT}{\pi M}} \times \frac{P}{kT}$$

$$\boxed{Z_1 \propto \frac{P}{\sqrt{T}}}$$

$$Z_1 \propto \frac{T}{V \times \sqrt{T}} \propto \frac{\sqrt{T}}{V}$$

$$\boxed{\begin{array}{c} S-1 \\ 0-1 \\ \hline J-M \end{array}}$$

$$Z_{11} \propto \sqrt{T} \left(\frac{P}{T}\right)^2$$

$$\boxed{Z_{11} \propto \frac{P^2}{T^{3/2}}}$$

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

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

$$\boxed{\lambda \propto V}$$