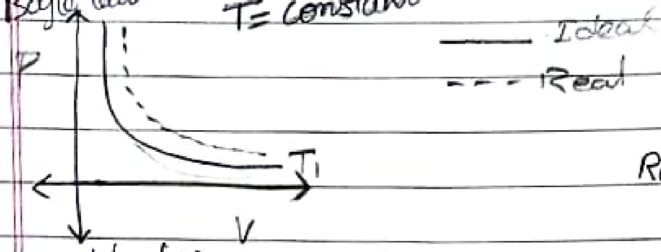
Kinetic Theory Of Gases

Gase laws

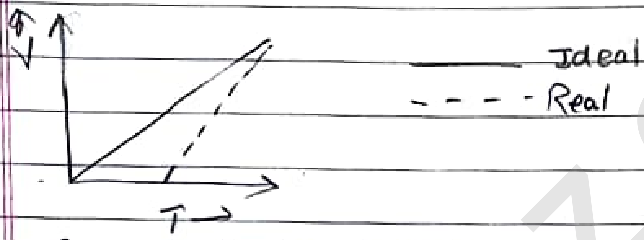
1) Boyle law T= constant



Real → [at high T / low P] → Ideal

2) Charle's law

P= constant



3) Avagadro's Hypothesis =)

↳ At constant, T & P, equal volume of gases contain equal no. of molecules.

	CO_2 n	NH_3 n	SO_2 n
	100 ml	100ml	100ml
nos of molecules =)	x	x	x

$V \propto n$

i.e $V \propto$ no. of molecules

★ Kinetic Theory of Gases

1) Gas is made up of atoms & molecules
2) Molecules of same gases are identical in all respects (mass, shape size)
3) Molecules are constantly in Random motion along st. line.

i.e Only translational motion

=) DOF = 3 for any gas

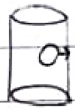
No Rotation
No Vibration

4) All the Collisions of gas molecules among themselves & wall of container is elastic in Nature.

i.e $\vec{P_i} = \vec{P_f}$ and $KE_i = KE_f$

5) Pressure of the gas is due to the collisions of molecules with wall of container.

P α no. of collisions of molecules per unit area.



$\frac{F}{A}=P$

6) The KE of gas depends only & only upon temperature (absolute) and doesn't depent on the nature of gas

$KE \propto T_{(absolute)}$
Ideal gas K

T = 0 K (Absolute zero)
KE = 0

7) The actual volume of gas molecules is negligible when compared to volume occupied by the gas.

8) There is no intermolecular force of attraction among molecules

9) Gravity is neglected

10) Molecules of gas are tiny rigid spheres of negligible volume

11) At Absolute zero, molecular motion stops

T=0K ~~KE~~ KE=0

Kinetic Gas Equation:

$$\boxed{P=\frac{1}{3}\frac{mNu_{rms}^2}{V}}$$

Remember

where P → pressure of gas
m → mass of 1 molecule of gas
N → no. of Molecules of gas
V → vol. of gas
u_{rms}^2 = Root mean square velocity of gas molecule

$P=\frac{1}{3}\frac{Nm}{V}u_{rms}^2$

$$P = \frac{1}{3}\frac{mN}{V}u_{rms}^2$$

for one mole of gas $N = N_A$

$$P = \frac{1}{3}\frac{mN_A}{V}u_{rms}^2$$

$$= \frac{1}{3}\frac{M}{V}u_{rms}^2$$

$$PV = \frac{2}{3}\times\frac{1}{2}Mu_{rms}^2$$

$$PV = \frac{2}{3}\underset{(1\,mole)}{KE}$$

$$\therefore \underset{(1\,mole)}{KE} = \frac{3}{2}PV$$ याद रखो।

1mole. $PV = nRT$

$PV = RT$ → ⇒ $KE \propto T$

⇒ $$\boxed{\underset{1mole}{KE} = \frac{3}{2}RT}$$ ⇒ $$\boxed{\underset{nmole}{KE} = \frac{3}{2}nRT}$$

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

∘ $$\boxed{\underset{1\,molecule}{KE} = \frac{3}{2}kT}$$ → ? ⇒ Thermo. → $\underset{nmole}{KE} = \frac{f}{2}nRT$

Ans

Here $\underbrace{f = 3}$ → ? → only trans motion Considered

$\underset{(not\ considered)}{f_{Rot}} \Leftarrow KE_{Trans}(\downarrow) = I\downarrow \Leftarrow r\downarrow \Leftarrow$ as Vol. of gas is negligible

R.M.S. velocity :

Root Mean Square

$$V_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + \dots + v_n^2}{n}}$$

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R.M.S Velocity of Gas Molecules

① $u_{rms} = \sqrt{\frac{3RT}{M}}$ $R = 8.314\ J/mol\,K$
$\hookrightarrow m/s$ $T =$ in kelvin
$M \rightarrow$ Molar mass in kg (ग्राम नहीं करना)

② $u_{rms} = \sqrt{\frac{3kT}{m}}$ $\rightarrow$ mass of 1 molecule in kg.

In terms of pressure and density.

$u_{rms} = \sqrt{\frac{3RT}{M}}$ $\cancel{Pd = \frac{P}{T}}$ $d = \frac{PM}{RT}$

$\Rightarrow \frac{RT}{M} = \frac{P}{d}$

③ $\boxed{u_{rms} = \sqrt{\frac{3P}{d}}}$

Q21. The rms speed of O_2 molecule in a gas at 27°C would be given by

Good approx

(a) 483 m/s b) 966 m/s c) 4.83 m/s d) 9.66 m/s.

$u_{rms} = \sqrt{\frac{3RT}{M}} = \cancel{\sqrt{3 \times 8 \times 300}} = \sqrt{\frac{3 \times 8.314 \times 300}{32 \times 10^{-3}}}$

$= \sqrt{\frac{3 \times \cancel{8} \times 300}{\cancel{32}_{4} \times 10^{-3}}} = \sqrt{\frac{900}{4} \times 10^{3}}$

$= \frac{30}{2}\sqrt{1000}$

$= \frac{300}{2}\sqrt{10} \simeq \frac{300}{2}\sqrt{9} = \frac{900}{2} = 450$

$\simeq 483\ m/s.$

Q.25) At what temperature will the r.m.s speed of O_2 molecules become just sufficient for escaping from the Earth's atmosphere? (Given. $m_{O_2} = 2.76 \times 10^{-26}$ kg $K = 1.38 \times 10^{-23}$ J/K)

a) 2.508×10^4 K c) 8.360×10^4 K

b) 5.016×10^4 K d) 1.254×10^4 K

$u_{rms} = 11$ Km/s

$$\sqrt{\frac{3KT}{m}} = 11 \times 10^3$$

$$\frac{3 \times 1.38 \times 10^{-23} \times T}{2.76 \times 10^{-26}} = 11 \times 11 \times 10^6$$

$$\frac{3 \times 1.38}{2.76} \times 10^3 T = 121 \times 10^6$$

$$\frac{3 \times 1.38}{2.76} T = 121 \times 10^3$$

~~$T = \frac{121 \times 10^3 \times 46}{69}$~~

$$69 \overline{)121} \quad 1.7$$
$$69$$
$$520$$
$$6$$
$$\times 46$$

$$T = \frac{121 \times 2}{3} \times 10^3$$

$$= \frac{242}{3} \times 10^3$$

~~$= 80.66 \times 10^4$~~

~~$\approx 80.360 \times 10^4$~~

$$= 80.66 \times 10^3$$

$$= 8.06 \times 10^4 \approx 8.360 \times 10^4 \text{ K}$$

$$3 \overline{)242} \quad 80.66$$
$$24$$
$$20$$
$$18$$
$$20$$

Molecular velocity

(1) **Average Velocity:**

$$V_{avg} = \frac{V_1 + V_2 + \dots + V_n}{n}$$

$$V_{avg} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8KT}{\pi m}} = \sqrt{\frac{8P}{\pi d}}$$

(2) **Root Mean square velocity:**

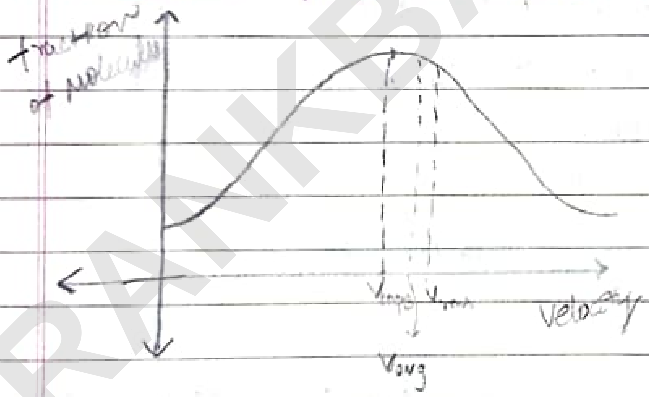
$$u_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3KT}{m}} = \sqrt{\frac{3P}{d}}$$

(3) **Most Probable velocity.**

Maximum fraction of molecule possess this velocity.

$$V_{mp} = \sqrt{\frac{2RT}{M}} = \sqrt{\frac{2RT}{m}} = \sqrt{\frac{2P}{d}}$$

Maxwell's Speed distribution law.



R A M

$V_{rms} > V_{avg} > V_{mps}$

$\sqrt{\frac{3RT}{M}} > \sqrt{\frac{8RT}{\pi M}} > \sqrt{\frac{2RT}{M}}$

$\sqrt{3} > \sqrt{2.5} > \sqrt{2}$

Mean Free Path

The avg. distance travelled by a molecules b/w two successive collisions is known as mean free path.

$$\lambda_m = \frac{\lambda_1 + \lambda_2 + \dots + \lambda_n}{n}$$

$$\boxed{\lambda_m = \frac{1}{\sqrt{2}\, n \pi d^2}}$$

→ dia. of molecule

Mean free path.

no. of molecules per unit volume [Number density]