D1 (H), Paper I, Group A.
Chapter's name: Gaseous State, DR. S.K. JHA

Postulates of Kinetic molecular theory of gases:-

In 1738 Bernauli tried to explain the properties of gases and gas laws theoretically but finally in 1857 Clausius gave his own concept regarding same, and he gave some points to explain the properties of gas & gas laws, which has received the name kinetic molecular theory of gases, which are as follows:-

1. All the gases are made up of extremely small particles called molecules.

ii) Effect of action of gravity is very negligible on gases so it diffuses against gravity.

iii) All the gaseous molecules are mobile inside container they move by the help of their kinetic energy. Kinetic energy of all molecules are not same rather they are different, so the molecules move with different speeds, & we calculate average kinetic energy at a given temperature

IV. Gaseous molecule move eiuside the Containe without any fixed direction so they Collied with each other even with the wall of Containe So it exert pressure.

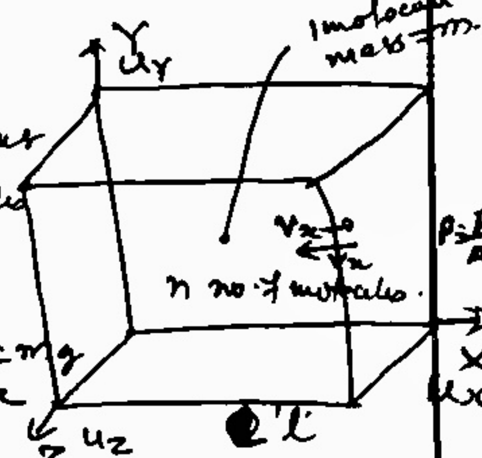
V. The Collision of gaseous molecule is perfectly elastic Collision.

* VI. Gaseous molecules are aparted from each other by large distance so the actual volume of a molecule of gas is negligible volume of the entire volume of the gas with respect to the

* VII. The force of attraction is negligible ~~with~~ among the gaseous molecule due to larger gap or distance.

Note Kinetic theory of gas is mainly for ideal gas For real gas last two points (VI) & (VII) are not valid.

Kinetic gas equation :→



let us suppose there is a Container which is cubic, it Contain n molecule of gas. In Container there are three Co-ordinate i.e X, Y & Z.

Mass of a molecule along x-direction = m

velocity of molecule = u_x

Starting Momentum (P_i) along x-axis = mu_{x_1}

Final Momentum (P_f) " " " $= -mu_{x_1}$ (Returning molecule)

$$P_f - P_i = \Delta P = mu_{x_1} - (-mu_{x_1}) = 2mu_{x_1}$$

Time taken for each Collision $= \frac{2l}{u_{x_1}}$

Force exerted on wall by molecule $= \dfrac{2mu_{x_1}}{\frac{2l}{u_{x_1}}}$

$$= \frac{m u_{x_1}^2}{l} \quad \text{—— 1}$$

velocity of particle is in all three direction x, y & z, and their velocities in all three directions are same so $u^2 = 3u_x^2$ $(\because u = u_{x_1} + u_{y_1} + u_{z_1})$ $(u_{x_1} = u_{y_1} = u_{z_1})$

Force exerted due to one molecule $= \frac{m}{l} \cdot \frac{1}{3} \cdot u_1^2$

F due to n molecules $= \frac{1}{3} \cdot \frac{m}{l} \cdot u^2 + \frac{1}{3} \frac{m}{l} \cdot u_2^2 + \frac{1}{3} \frac{m}{l} \cdot u_3^2$

$$F_{Net} = \frac{1}{3} \cdot \frac{m}{l} \cdot (u_1^2 + u^2 \dots u_n^2) \times n$$

$$F_{net} = \frac{1}{3} \cdot \frac{mn}{l} \cdot u^2$$

$$\text{Pressure}(P) = \frac{F}{A} = \frac{1}{3} \cdot \frac{mn}{l} \cdot u^2 \Big/ l \times l^2$$

$$P = \frac{1}{3} \cdot \frac{mnu^2}{l^3}$$

$$P = \frac{1}{3} \cdot \frac{mnu^2}{V}$$

$$\boxed{PV = \frac{1}{3} mnu^2}$$

In above equation: P = Pressure of molecule, V = volume.
m = Mass of the molecule, n = no. of molecules,
u = velocity (r.m.s).

RMS velocity: → (Root mean Square velocity): →

When we keep the gas in a container, the no. of molecules are numerous. the velocity of all particles are different in their magnitude and may be direction also. So first of all we assume the velocity of the molecule is $v_1, v_2, v_3 ---- v_n$, so it's square mean will be $\frac{v_1^2+v_2^2+v_3^2+ --- v_n^2}{n}$, and the root of mean square is $= \sqrt{\frac{v_1^2+v_2^2+v_n^2}{n}}$, this velocity is Called root mean square velocity.

$$\text{Hence, } rms = \sqrt{\frac{v_1^2+v_2^2+v_3^2+ -- v_n^2}{n}}$$

Q Suppose there are three molecules A, B, & C its velocity is 10, 15 & 20 m/s, what is the rms?

$$r.m.s = \sqrt{\frac{(10)^2+(15)^2+(20)^2}{3}} = \sqrt{\frac{100+225+400}{3}}$$

$$= \sqrt{\frac{725}{3}}$$

Even we calculate R.M.S velocity of ideal gas

$$r.m.s = \sqrt{\frac{3RT}{M}},$$

Where R = Molar gas Cott.
= 8.314 J K^{-1} /mol.
T = Temperature
M = Molar Mass of gas.

Rel. between ~~K.E~~ r.m.s & M: →

K.E = $\frac{1}{2}mv^2$ i.e $r.m.s = \sqrt{\frac{3RT}{M}}$ How it has came?

$$K.E\ total = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 + \frac{1}{2}mv_3^2 + \cdots \frac{1}{2}mv_n^2$$

$$= \frac{1}{2}m(v_1^2 + v_2^2 + v_3^2 \cdots v_n^2$$

$$= \frac{1}{2} \times m \times \frac{v_1^2 + v_2^2 + v_3^2 + \cdots v_n^2}{n} \times n$$ (multiply & divide by n up & down)

$$= \frac{1}{2} m v_{(rms)}^2 \times n$$

for 1 mole ~~mole~~ of gas $n = N_A$

K.E of one mole of ideal gas $= \frac{1}{2} m v_{rms}^2 \times N_A$

$$\frac{3}{2}RT = \frac{1}{2}MV^2 \qquad (m \times N = M)$$

$$V_{rms} = \sqrt{\frac{3RT}{M}}$$ Proved

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