15 - Ideal Gases

· 1 mol of any gas of any substance is the no. of atoms or molecules of that substance which are equal to the no. of atoms in 12g of C_{12}.

n = no. of molecules

N_a = Avagadro constant $= 6.023 \times 10^{23}$

$$n = \frac{N}{N_a}$$

N molecules

$^{14}_{7}N \rightarrow$ 14g of N = 1 mol

when $\frac{PV}{T}$ = constant, we have an ideal gas

P = Pressure in Pa

V = Volume in m^3

T = temp in Kelvin

$$P \cdot V = \underbrace{n}_{\text{no. of moles}} \cdot \overbrace{R}^{8.31\ J\ mol^{-1}} \cdot T$$

$PV = NKT$

K = Boltzmann constant

N

$$PV = NkT$$

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

$$P \cdot V = \frac{N}{N_a} \cdot R \cdot T$$

$$n = \frac{N}{N_a}$$

$$PV = n \cdot R \cdot T$$

Assumptions of Kinetic Theory of gases

1) A gas contains large no. of molecules or atoms which move at random speeds

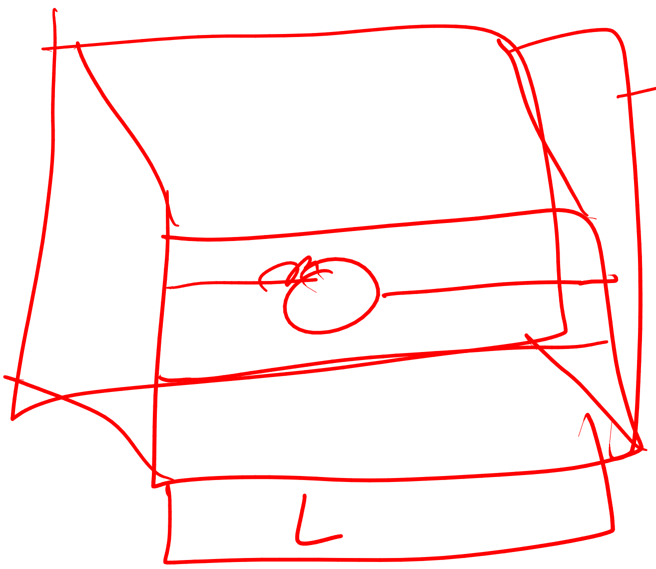
2) Collission b/w the molecules & b/w the molecules & the walls of a container are elastic

3) The forces b/w the molecules are negligible.

4) The volume of the molecules is very small or negligible compared to the vol occupied by the molecule

5) The time of collission b/w molecules or b/w molecules & the wall is very small compared to the time b/w collissions

$\boxed{15.3}$



$\rightarrow IM = MU$

$\Delta m = \frac{2mc}{T}$

$\text{Force} = \frac{2mc}{T}$

length = ~~2L~~

collisions $= 2L$

speed $c = 2L/T$

Derivation of $P = \frac{1}{3}\rho \langle c^2 \rangle$

when molecules strikes the wall at $\perp$

$$F = \frac{2mc}{T} = \frac{2mc^2}{2l} = \frac{mc^2}{L}$$

$$P = \frac{F}{A} = \frac{mc^2}{L^2 \cdot L} = \frac{mc^2}{L^3}$$ – Pressure due to one molecule

There are N molecules & each has a different velocity & average velocity is $\langle c^2 \rangle$

Nm = total mass of gas

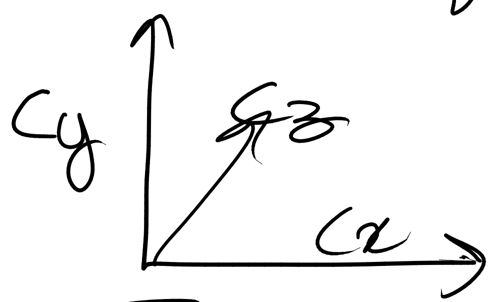
$$P = N \cdot \frac{mc^2}{L^3} = \frac{Nm\langle c^2 \rangle}{V}$$

$\frac{m}{V} = \rho$ = density of gas

Pressure exerted on wall x

$$= \frac{1}{3}\frac{Nm\langle c^2 \rangle}{V}$$

RMS



$\langle c_x^2 \rangle = \langle c_y^2 \rangle = \langle c_z^2 \rangle$

Vel c can be measured across 3 dimensions

Root mean sq $= \sqrt{\langle c^2 \rangle} = c$

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$c^2 = \langle c_x^2 \rangle + \langle c_y^2 \rangle + \langle c_z^2 \rangle$

$\langle c_x^2 \rangle = \frac{1}{3} c^2$

To find KE of one molecule

$$PV = \frac{1}{3} N m \langle c^2 \rangle = nRT = n \frac{R}{N} T$$

$$\frac{1}{2} m \langle c^2 \rangle = \frac{3 nRT}{2N}$$

$\frac{N}{n} = Na$ $\quad n = \frac{N}{Na}$

$$= \frac{3RT}{2\cancel{N}} \frac{\cancel{N}}{Na} = \frac{3RT}{2Na}$$

$$= \frac{3KT}{2}$$

$$PV = \frac{1}{3} N m \langle c^2 \rangle$$

$$P = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$$

$$P = \frac{1}{3} \rho \langle c^2 \rangle$$

N – no of molecules
V – volume
M – mass
Nm = total mass