ARJUNA NEET BATCH

States of Matter

LECTURE - 6

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Objective of today's class

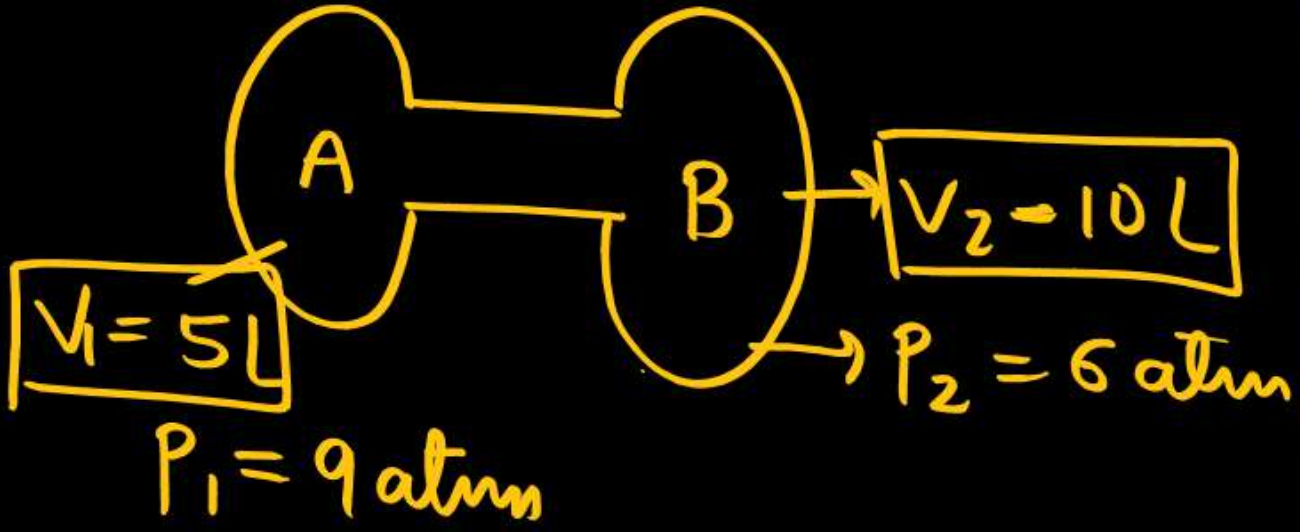
Gas Laws

HoW:

Q. The two bulbs of volume 5 litre and 10 litre containing an ideal gas at 9 atm and 6 atm respectively are connected. What is the final pressure in the two bulbs if the temperature remains constant?

(a) 15 atm ~~(b)~~ 7 atm

(c) 12 atm (d) 21 atm



$V_3 = V_1 + V_2$

$$P_1V_1 + P_2V_2 = P_3V_3$$

$$9 \times 5 + 6 \times 10 = P_3(15)$$

$$\frac{45+60}{15} = P_3$$

$$P_3 = \frac{\cancel{105}^{\cancel{21}\ 7}}{\cancel{15}_{\cancel{3}}}$$

$$\boxed{P_3 = 7 \text{ atm}}$$

Q. The density of neon will be highest at

(a) STP
~~(b)~~ 0°C and 2 atm
(c) 273°C and 1 atm
(d) 273°C and 2 atm

$d = \frac{PM}{RT}$

$d \propto P$

$d \propto \frac{1}{T}$

P ↑ :

(a) STP

P = 1 atm T = 0°C

~~(b)~~ $\boxed{T = 0°C}$ $\boxed{P = 2\ atm}$

(c) T = 273°C P = 1 atm

(d) T = 273°C $\boxed{P = 2\ atm}$

gp-18

He

$\boxed{Ne}$

Ar

Kr

Xe

Rn

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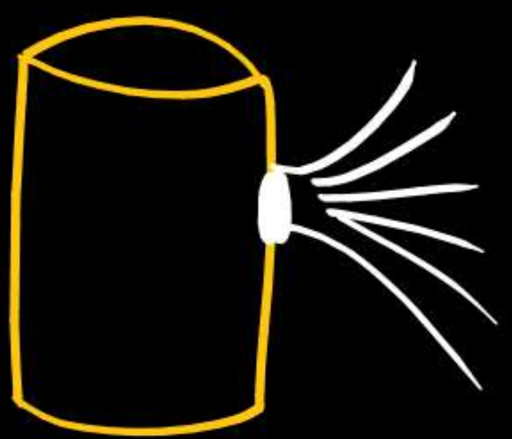
Q. A vessel has 6 g of oxygen at a pressure P and temperature 400 K. A small hole is made in it so that O_2 leaks out. How much O_2 leaks out if the pressure is P/2 and temperature 300K?

(a) 5 g (b) 4 g

(c) 2 g (d) 3 g



$W_{O_2} = 6$ gm

$P_1 = P$

$T_1 = 400K$

$P_2 = \frac{P}{2}$ atm

$T_2 = 300K$

$W_2 = ?$

$$\frac{P_1 \cancel{V_1}}{n_1 T_1} = \frac{P_2 \cancel{V_2}}{n_2 T_2}$$

$$\Rightarrow \frac{\cancel{P} \times \cancel{3}2}{\cancel{6} \times \cancel{4}00} = \frac{\cancel{P} \times \cancel{3}2}{\cancel{2} \times \omega_2 \times \cancel{300}}$$

$$\boxed{\omega_2 = 4\ g}$$

$\Rightarrow \omega_1 - \omega_2$

$\Rightarrow 6 - 4$

$\Rightarrow 2$ gm

Q. Two non-reactive gases A and B are present in a container with partial pressure 200 and 180 mm of Hg. When a third non-reactive gas C is added then total pressure becomes 1 atm then mole fraction of C will be

(a) 0.75 (b) 0.5

(c) 0.25 (d) Cannot be calculated

A → $p_A = 200$ mm of Hg

B → $p_B = 180$ mm of Hg

C → $p_C = ?$

$P_T = 1$ atm
$= 760$ mm of Hg

$p_C = X_C P_T$

$$\boxed{X_C = \frac{p_C}{P_T}}$$

$P_T = P_A + P_B + P_C$

$\Rightarrow 760 = 200 + 180 + P_C$

$\Rightarrow P_C = 760 - 380$

$\Rightarrow 380$ mm of Hg

$$P_C = X_C P_T$$

$$X_C = \frac{P_C}{P_T}$$

$$\Rightarrow \frac{38\cancel{0}}{76\cancel{0}}$$

$$\Rightarrow \frac{1}{2}$$

$$\Rightarrow \underline{\underline{0.5}}$$

Q. **Which of the following relation is correct for an ideal gas?**

(a) $\frac{V}{n} = \frac{P}{RT}$

(b) $\frac{MV}{m} = \frac{P}{RT}$

(c) $\frac{d}{M} = \frac{P}{RT}$

(d) *All of these*

$\Rightarrow \boxed{PV = nRT}$

$\Rightarrow \boxed{d = \frac{PM}{RT}}$

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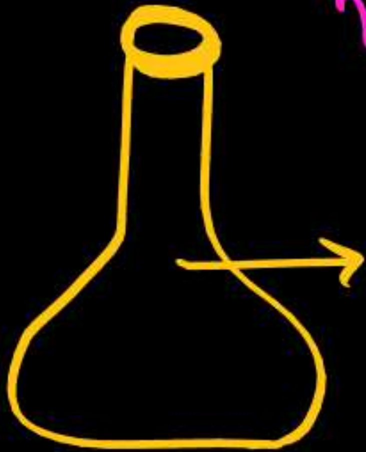
Q. The partial pressure of hydrogen in a flask containing 2g H_2 and 32g SO_2 is

(a) $1/16^{th}$ of total pressure (b) $1/9^{th}$ of total pressure

(c) $2/3^{rd}$ of total pressure (d) $1/8^{th}$ of total pressure



$n_{H_2} = \frac{2}{2} \Rightarrow 1$

2g H_2 + 32g SO_2

$n_{SO_2} = \frac{32}{64} = \frac{1}{2}$

$\boxed{n_{SO_2} = 0.5}$

Acc. to Dalton's Law of partial pressure

$$\boxed{p_{H_2} = X_{H_2} P_T}$$

$$X_{H_2} = \frac{n_{H_2}}{n_{H_2} + n_{SO_2}}$$

$$X_{H_2} = \frac{1}{1+0.5} = \frac{1}{1.5} = \frac{1\times 2}{3}$$

$$\boxed{p_{H_2} = \frac{2}{3} \times P_T}$$

Q. What percent of a sample of nitrogen must be allowed to escape if its temperature, pressure and volume are to be changed from 220° C, 3 atm and 1.65 litre to 110° C, 0.7 atm and 1.00 litre respectively?

(a) 81.8%
(b) 71.8%
(c) 76.8%
(d) 86.8%

$\boxed{\text{\% of gas escaped}}$

$\Rightarrow \left(\frac{n_1 - n_2}{n_1}\right) \times 100$

$\Rightarrow \left(\frac{n_1}{n_1} - \frac{n_2}{n_1}\right) \times 100$

$\Rightarrow \left(1 - \frac{n_2}{n_1}\right) \times 100 = ?$

$T_1 = 220°C$ (273) $= 493\,K$

$P_1 = 3$ atm

$V_1 = 1.65$ L

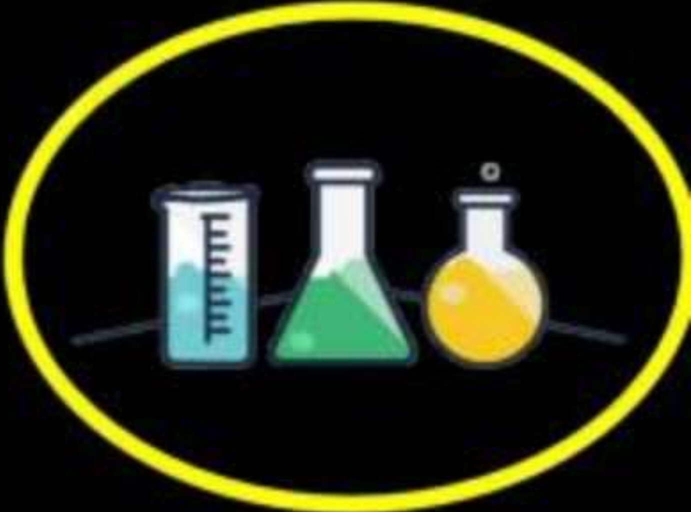
$n_1 = ?$

$T_2 = 110\,°C$ (273) $= 383$

$P_2 = 0.7$ atm

$V_2 = 1.00$ L

$n_2 = ?$



$$\Rightarrow \frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$$ ((combined gas law)

$$\Rightarrow \frac{n_2}{n_1} = \frac{P_2 V_2 T_1}{P_1 V_1 \times T_2}$$

$$\Rightarrow \frac{n_2}{n_1} = \frac{0.7 \times 1 \times 493}{3 \times 1.65 \times 383}$$

$$\Rightarrow \boxed{\frac{n_2}{n_1} = 0.1820}$$

% of gas escaped $= \left(1 - \frac{n_2}{n_1}\right) \times 100$

$$\Rightarrow (1 - 0.1820) \times 100$$

$$\Rightarrow \underline{\underline{81.8\%}}$$

Q. 4g argon (Atomic mass = 40) in a bulb at a temperature of TK has a pressure P atm. When the bulb was placed in hot bath at a temperature 50°C more than the first one. 0.8g of gas had to be removed to get the original pressure. T is equal to

(a) 510 K
(b) 200 K
(c) 100 K
(d) 73 K

← Hot bath

→ 4 gm Ar

$T_1 = T\,K$

$P_1 = P$ atm

$T_2 = (T + 50)\,K$

$w_2 = 4 - 0.8 = 3.2\,g$

$P_2 = P$ atm

$T = ?$

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*

$$\Rightarrow \frac{\cancel{P_1} V_1}{n_1 T_1} = \frac{\cancel{P_2} V_2}{n_2 T_2}$$

$n \Rightarrow \text{mole} = \frac{w}{MM}$

$$\Rightarrow \frac{\cancel{V_1}}{n_1 T_1} = \frac{\cancel{V_2}}{n_2 T_2}$$

$$\Rightarrow n_2 T_2 = n_1 T_1$$

$$\Rightarrow \frac{32}{\cancel{40} \times 10} \times (T+50) = \frac{4}{\cancel{40}} \times T$$

$$\Rightarrow 32T + 32 \times 50 = 40T$$

$$1600 = 8T$$

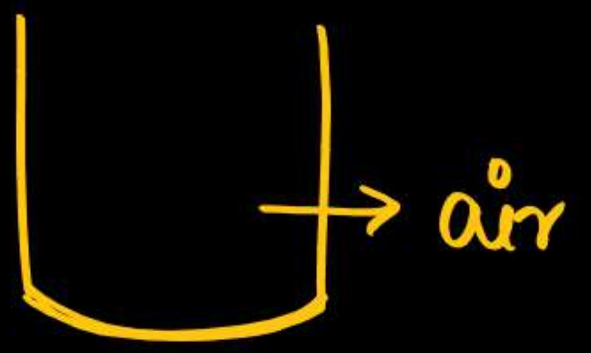
$$\frac{16\cancel{00}}{\cancel{8}} = T$$

$$\boxed{200\,K = T}$$

Q. A flask containing air (open to atmosphere) is heated from 300 K to 500 K. Then percentage of air escaped to the atmosphere is

(a) 20 (b) 40

(c) 60 (d) 80



$T_1 = 300\text{ K}$ $T_2 = 500\text{K}$

% of air escaped $\Rightarrow \left(\dfrac{n_1 - n_2}{n_1}\right) \times 100$

$\Rightarrow \left(\dfrac{n_1}{n_1} - \dfrac{n_2}{n_1}\right) \times 100$

$\Rightarrow \left(1 - \underbrace{\dfrac{n_2}{n_1}}_{=\,?}\right) \times 100$

$$\Rightarrow \frac{\cancel{P_1 V_1}}{n_1 T_1} = \frac{\cancel{P_2 V_2}}{n_2 T_2}$$

$$\Rightarrow n_2 T_2 = n_1 T_1$$

$$\Rightarrow \frac{n_2}{n_1} = \frac{T_1}{T_2}$$

$$\Rightarrow \frac{n_2}{n_1} = \frac{3\cancel{00K}}{5\cancel{00K}}$$

% of air escaped $\Rightarrow \left(1 - \frac{n_2}{n_1}\right) \times 100$

$$\Rightarrow \left(1 - \frac{3}{5}\right) \times 100$$

$$\Rightarrow \left(\frac{5-3}{5}\right) \times 100$$

$$\Rightarrow \frac{2}{\cancel{5}} \times \cancel{100}^{20}$$

$$\Rightarrow 40\%$$

Q. Air contains 23% oxygen and 77% nitrogen by weight. The percentage of O_2 by volume is

(a) 28.1 (b) 20.7

(c) 21.8 (d) 23.0

$\%(w/w)_{O_2} = 23\%$

$\boxed{23\text{ g of } O_2}$ ⓟnt in 100 g of Solution

$\%(w/w)_{N_2} = 77\%$

$\boxed{77\text{ g } N_2}$ ⓟnt in 100 g of Sol^n.

Acc to Avogadro Law

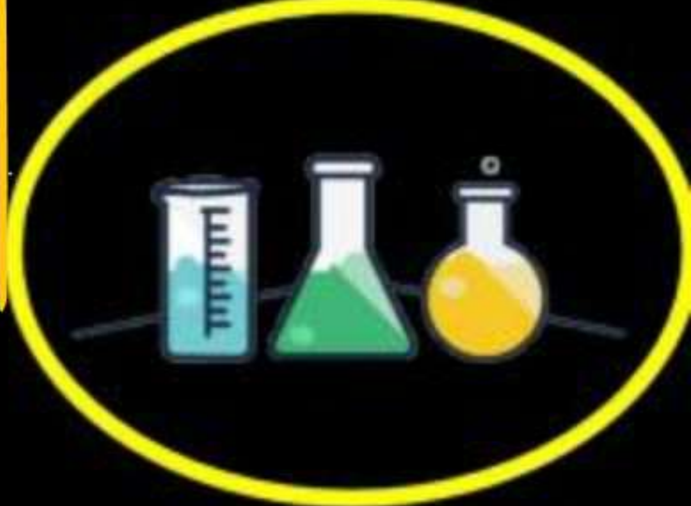
$V \propto n$ $P, T = \text{const}$

$\%V \propto \%n$

$$\%n_{O_2} = \frac{n_{O_2}}{\text{Total moles}} \times 100$$

$$n_{O_2} = \frac{23}{32}$$

$$n_{N_2} = \frac{77}{28}$$



$$\% \, n_{O_2} = \left(\frac{\frac{23}{32}}{\frac{23}{32} + \frac{77}{28}} \right) \times 100$$

$$= ? = \% \, V$$

Q. When the temperature of certain sample of a gas is changed from $\boxed{30°C}$ to $\boxed{606\ K}$ and its pressure is reduced to half, the volume of gas changed from V to V^2. The value of V is

(a) 2 dm^3

(b) 4 dm^3

(c) 8 dm^3

(d) Unpredictable

$T_1 = 30°C + 273$
$\Rightarrow 303\,K$

$P_1 = P$ atm

$V_1 = V$

$T_2 = 606\,K$

$P_2 = \frac{P}{2}$

$V_2 = V^2$

Combined gas Eq^n

$$\frac{P_1V_1}{\cancel{n_1}T_1} = \frac{P_2V_2}{\cancel{n_2}T_2}$$

$$\Rightarrow \frac{\cancel{P}\times \cancel{V}}{\cancel{303}} = \frac{\cancel{P}\times V^{\cancel{2}}}{2\times \cancel{606}}$$

$V = 4\,dm^3$

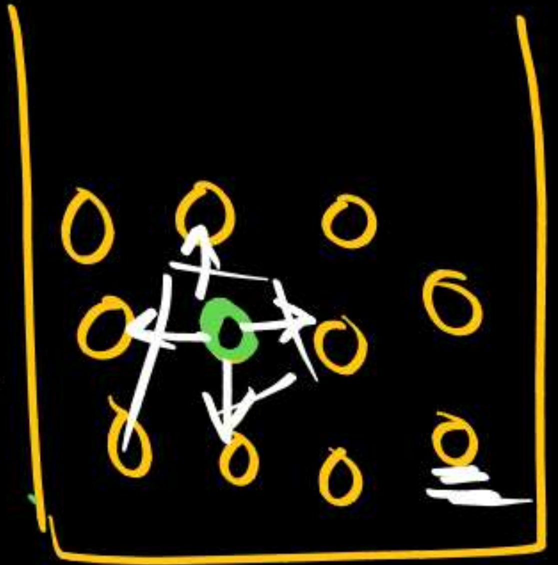
Kinetic Theory of Gases

Rough

① Gases are consist of very small but identicle particle called Molecules.

② There is no force of attraction between the gas molecules.

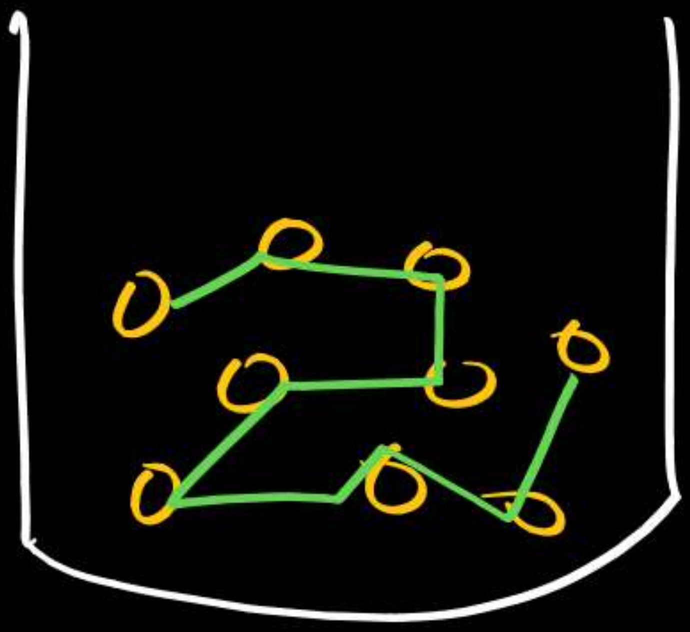
③ The actual Volume of a gas molecule is very small or negliable as compared to total space b/w them.



net force $=0$

(4) Collision b/w the gas molecules is perfectly Elastic.

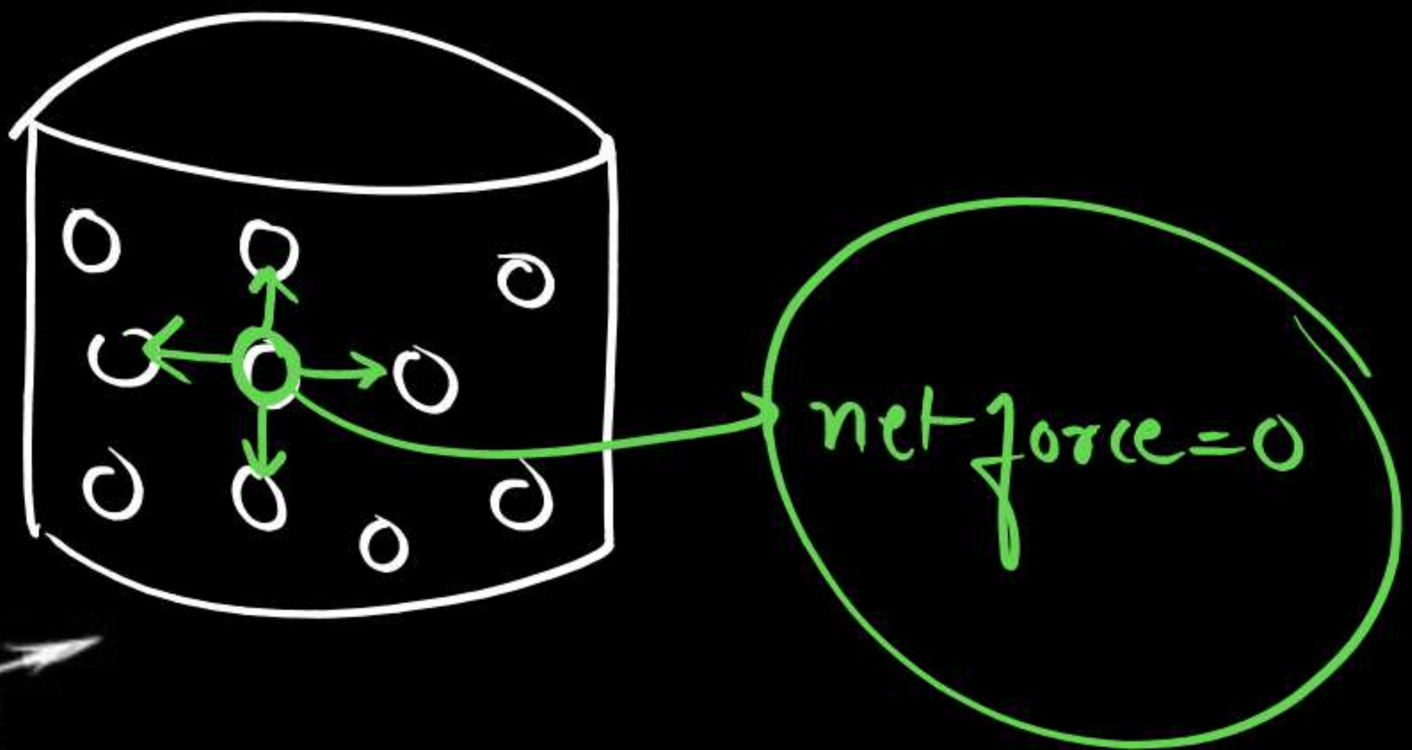
(5) Zigzag path.

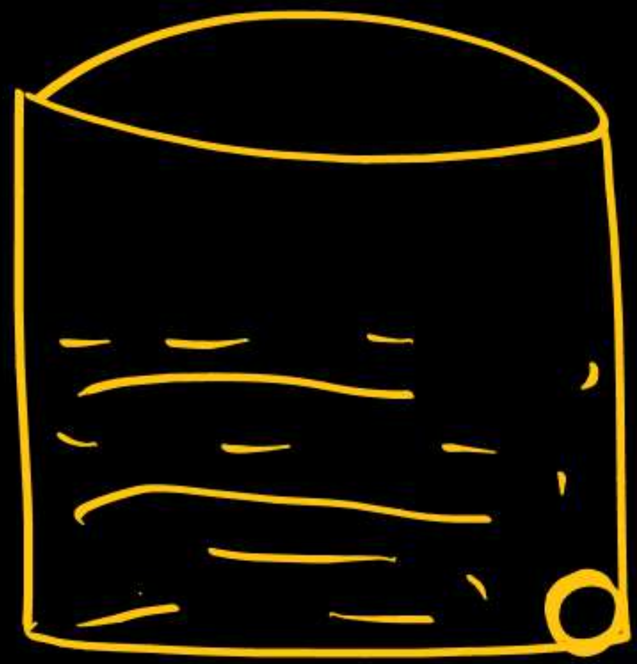


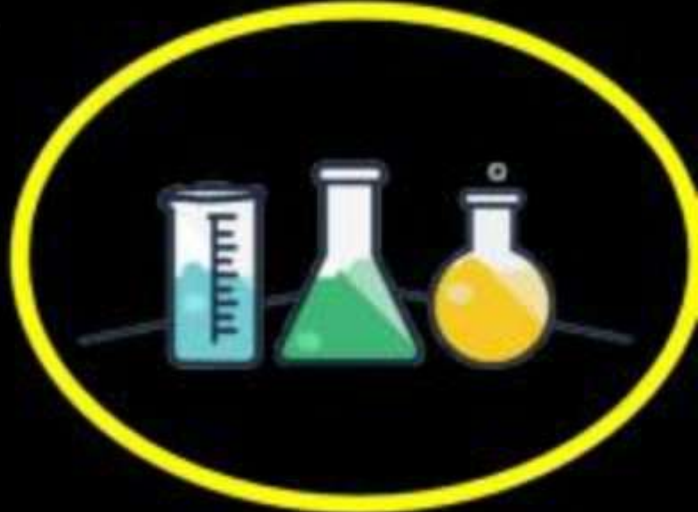
(6) $\boxed{K.E. \propto Temperature}$

KINETIC MOLECULAR THEORY OF GASES

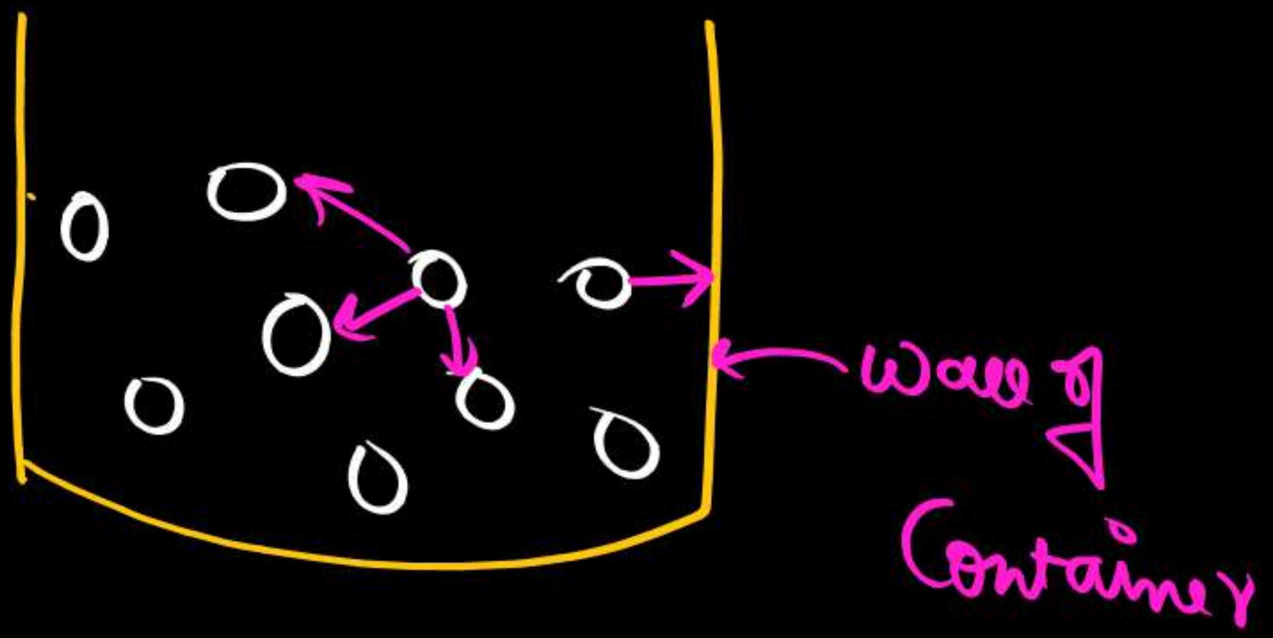
- Actual volume of gas molecules is negligible in comparison to the total volume of the gas.
- No force of attraction between the gas molecules.



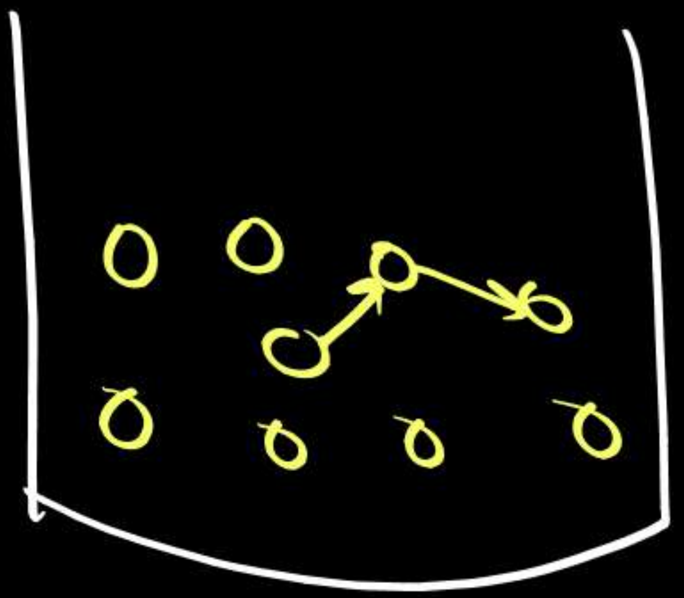




- Due to no force of attraction between the gas molecules, the gases easily expand and occupy all the space available to them on heating.
- Particles of gas are in constant random motion.
- Particles of gas collide with each other and with the walls of the container.



- Collisions are perfectly elastic.
- When the gas molecules collide with each other they pass on their energies. There is transfer of energy from one colliding molecule to the each other but the total energy of molecules before and after the collision remains the same therefore, the collisions are called perfectly elastic. So, there is no net loss of energy.



- As there is no loss of kinetic energy, therefore the motion of molecules do not cease so, the gases never settle down.
- Different particle of the gas, have different speeds.
- Different particle of gas possess different kinetic energies, therefore they have different speeds at a particular time.

❖ Support for assumption: This postulate is reasonable as when the molecules collide, they change their speed. Even though the initial speeds are same, but after collisions there is transfer of energy from one molecule to the other. So, as the energy changes after the collisions, so do the speeds. But the distribution of speeds remains constant at a particular temperature.

❖ The average kinetic energy of the gas molecules is directly proportional to the absolute temperature.

$\boxed{K.E \propto \text{Temp.}}$

V_{MPS}
V_{AV}
V_{RMS}

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thanks
for watching

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