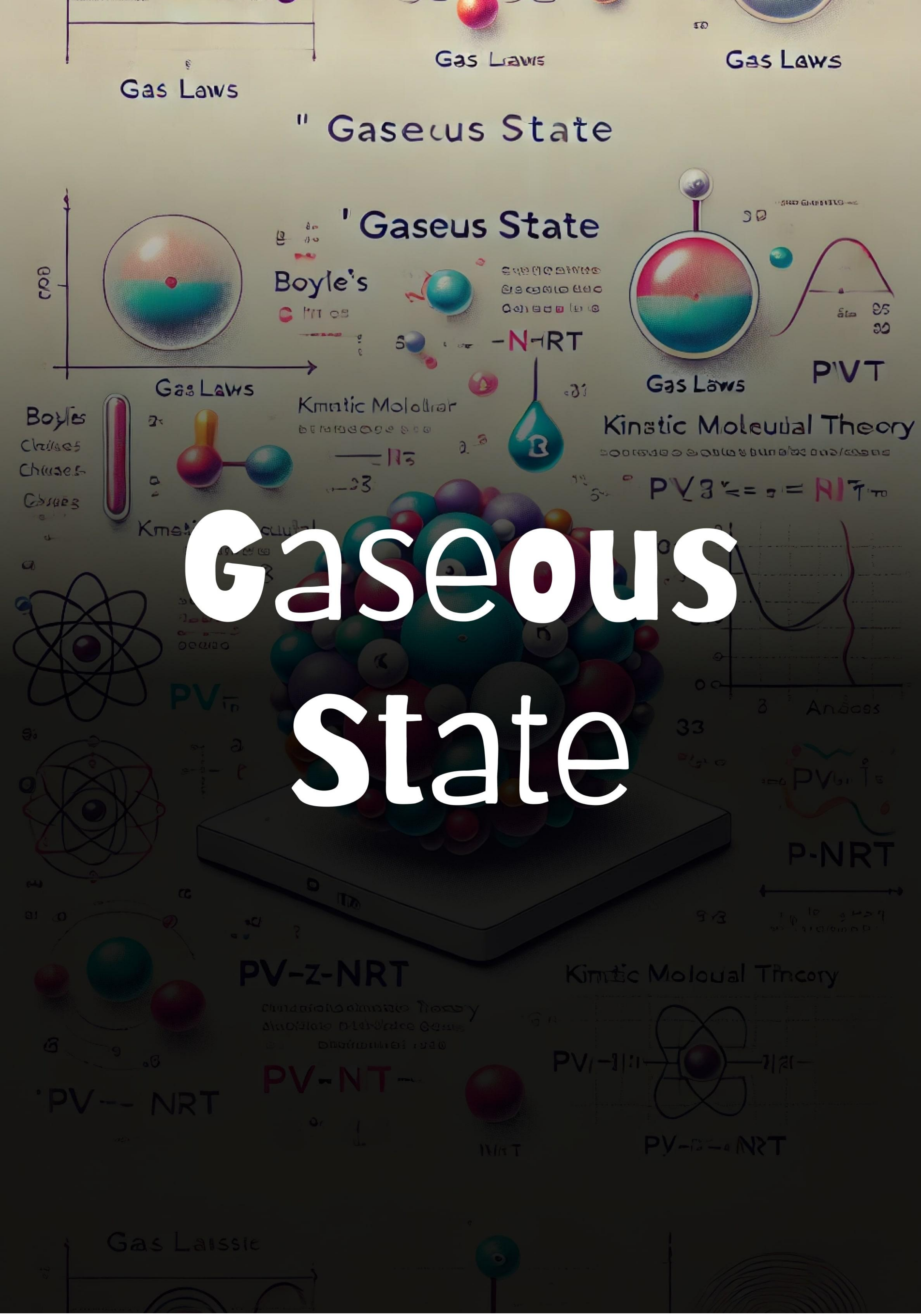
Gaseous State



GASEOUS STATE

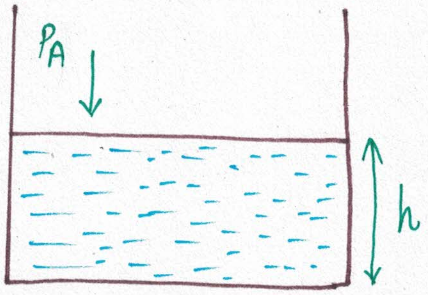
PRESSURE

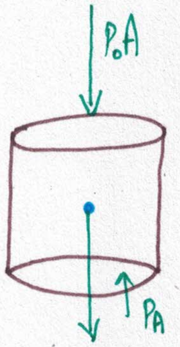
It is force per unit area. $\boxed{P = \frac{F}{A}}$ → scalar Quantity

Unit is N/m² (Pascal)

a. Due to Liquid column

Pressure in the same horizontal line are equal.





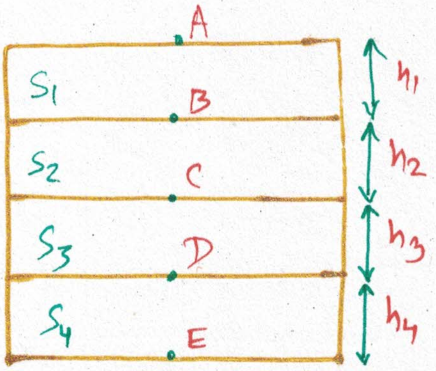
$mg = (\rho_L A h)g$

$$PA = P_0A + (\rho_L A h)g \Rightarrow \boxed{(P)_{bottom} = P_0 + \rho_L g h}$$

P_0 = Atmospheric Pressure

Pressure due to liquid column = $(\rho_L g h)$ = Gauge Pressure

Q.

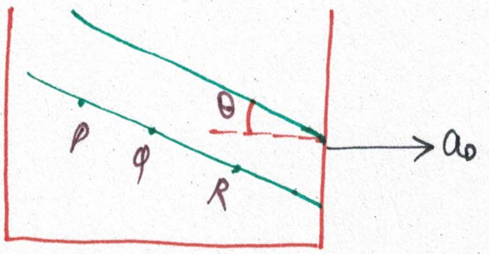


What will be pressure at point A, B, C, D, E, Z.

A. $P_A = P_0$ $\quad P_B = P_0 + \rho_1 h_1 g$ $\quad P_C = \rho_0 + (\rho_1 h_1 + \rho_2 h_2)g$

$P_D = P_0 + (\rho_1 h_1 + \rho_2 h_2 + \rho_3 h_3)g$ $\quad P_E = P_0 + (\rho_1 h_1 + \rho_2 h_2 + \rho_3 h_3 + \rho_4 h_4)g$

$P_Z = P_0 + (\rho_1 h_1 + \rho_2 (h_2 - x))g$

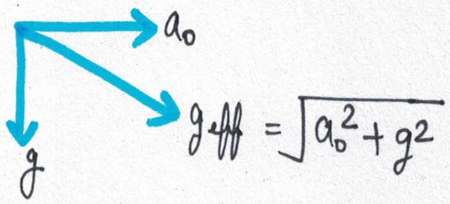


$P_P = P_Q = P_R$

$\tan\theta = \frac{a_0}{g}$

Thus $P_A \neq P_B \neq P_C$ as **h** is greater for **A**

$\therefore P_A > B > P_C$

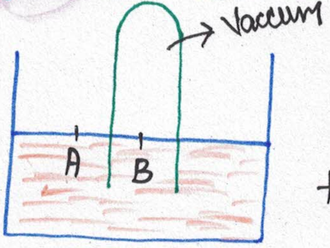


▷ Thus, Pressure will be same at the same level only in the case of the non-accelerated frames.

$\rho_{H_2O} = 1 g/ml$ $\quad \rho_{Hg} = 13.6 g/ml$

Measurement of Atmospheric Pressure

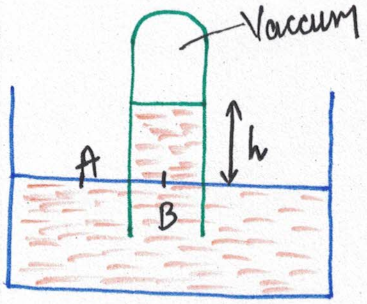
It is measured by a barometer.



$P_A = P_0$ but $P_B = 0$

thus

the Liquid goes $\overset{}{\text{to}}$ up to balance it



$P_A = P_B$

$\therefore P_0 = \rho g h$

h= 76 cm if Hg taken

$\rho = 13.6$ g/ml , $g = 9.8$ m/s

1 atm= 76 cm of Hg = $13.6 \times 10 \times 76 \times 10^{+5} = 1.01 \times 10^5$ N/m2

$\boxed{1 \text{ atm} = 1.01 \times 10^5 \text{ Pascal}} \rightarrow$ Mercury

- Mercury is used as it doesn't stick to the walls of the container (cohensive force).
- For Water ;

$$(P)_{Hg} = (P)_{H_2O}$$

$$(76 \times 13.6) = (h)(1)$$

$$\boxed{h = 10.33 \text{ m}}$$

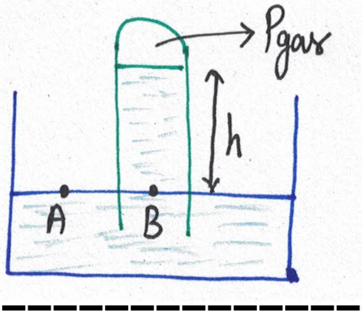
- Between water and glass molecules, theries an adhesive force (it sticks to walls of container).

Q Calculate the height if the liquid has $\rho = 10$ g/ml

Ans:- $(P_{Hg}) = (P)_l \Rightarrow (76 \times 13.6) = (10)(h)$

$$\boxed{h = 1.033 \text{m}}$$

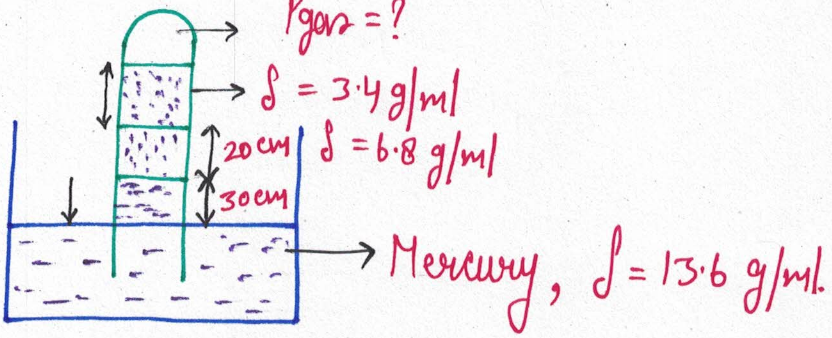
Faulty Barometer



$P_A = P_B$

$$\boxed{P_0 = P_{gas} + \rho g h'}$$

Q1.



$P_{gas} = ?$

Ans:- $\overset{10}{\cancel{(20)}}\cancel{(6.8)} = \overset{2}{\cancel{(13.6)}}(h_1) \longrightarrow h_1 = 10\text{ cm}$

$(20)\cancel{(3.4)} = \overset{4}{\cancel{(13.6)}}(h_2) \longrightarrow h_2 = 5\text{ cm}$

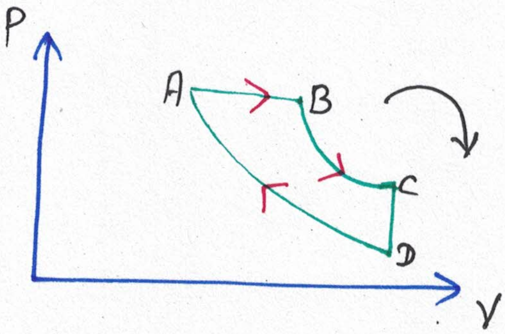
$\therefore 76\text{ cm} = 10\text{ cm} + 5\text{ cm} + 30\text{ cm} + P_{gas}$

$$\boxed{P_{gas} = 31\text{ cm}}$$

$$\boxed{\rho = \frac{PM}{RT} = \left(\frac{m}{V}\right)}$$

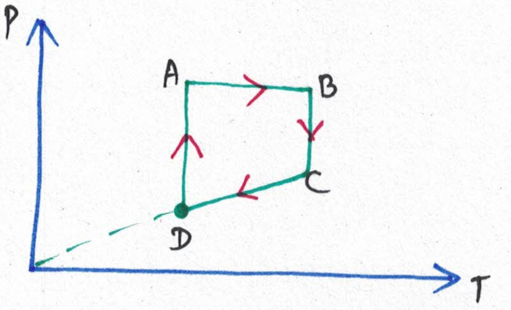
Q.

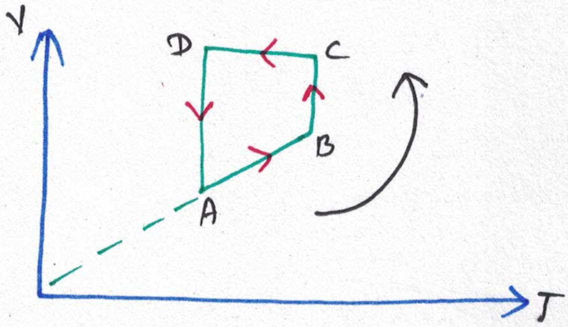
BC, DA → Isothermal

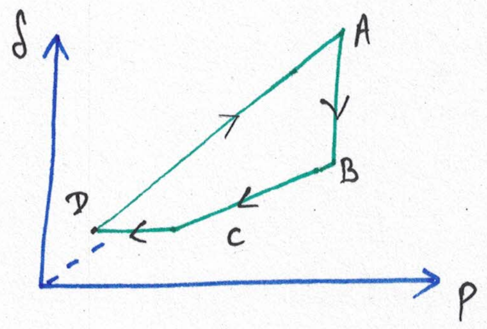


P — T
V — T
ρ — P
ρ — T

Ans:-



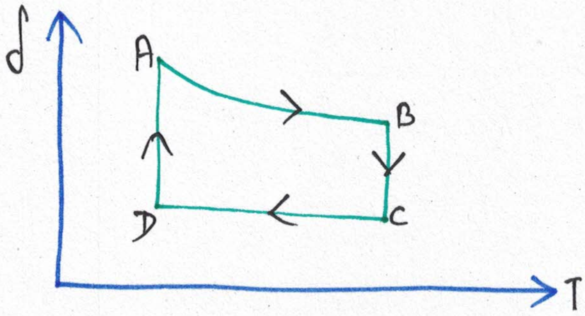




$$\rho = \left(\frac{PM}{RT}\right)$$

BC → Isothermal

$$\frac{\rho \propto P}{P\downarrow,\ T}$$

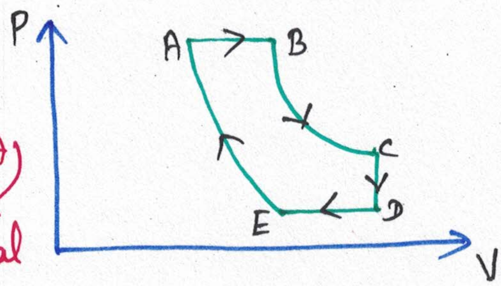


$$\rho \propto \left(\frac{P}{T}\right)$$

We Only take gaseous moles, not of solids or Liquids.

Q

BC, EA → Isthermal

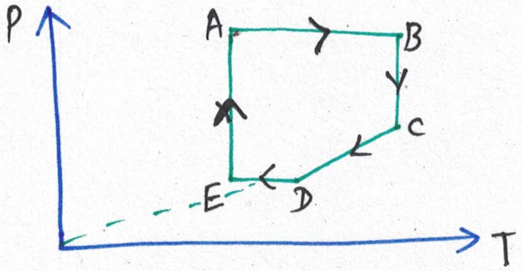


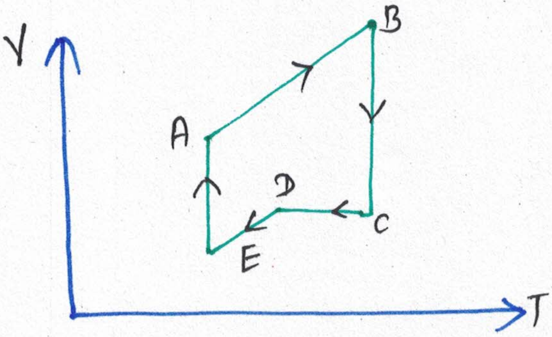
P-T

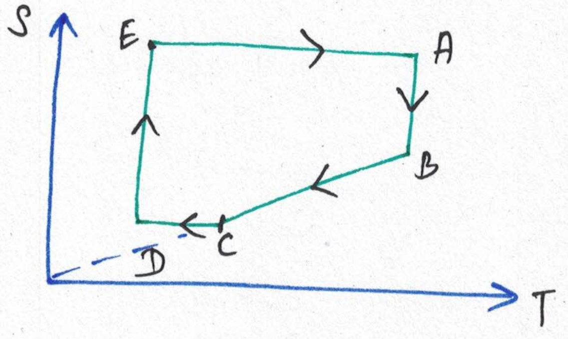
V-T

ρ-P, P-T

Ans:-

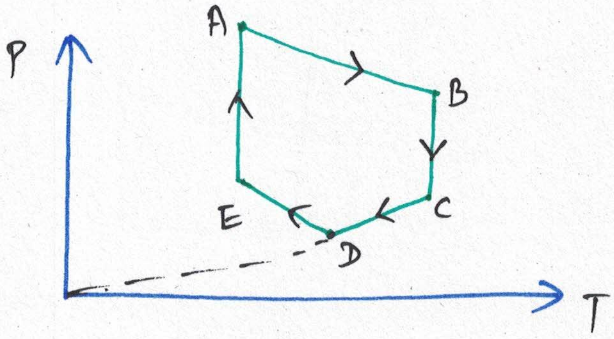






$\rho \propto \frac{P}{T} \propto \frac{1}{V}$

$P\downarrow$



$\rho \propto \frac{P}{T} \propto \frac{1}{V}$

$P\downarrow$ $V=K$, $T=K$, $V\downarrow$ $\rho\uparrow$

Boyle's Law – $P \propto 1/V$

Charle's Law – $V \propto T$

Gaylussac's Law – $P \propto T$

Avogadro's Law – $\frac{V}{n}$ = Constant $\Rightarrow V \propto n$

$R = 1/12 = 0.0821$ lt atm/mole K

$= 25/3 = 8.31$ J/mole K

$= 2$ Cal/mole K

DOTTON'S LAW

$$P_{Total} = \underbrace{P_A + P_B + P_C + \text{------}}_{\text{Partial Pressures}}$$

▷ $(\text{Partial Pressure})_A = (\text{mole fraction})_A \cdot P_{Total}$

▷ $A_n \rightleftharpoons nA$

a

$a-x \qquad nx$

$a-ax \qquad na\alpha$

$x = a\alpha$

$a \rightarrow x$

$1 \rightarrow x/a = \alpha$

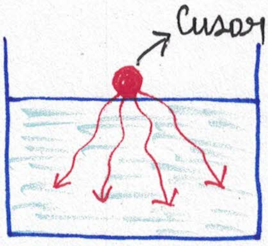
Mass conservation

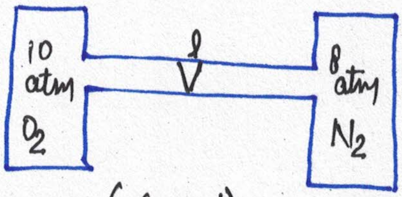
$(a)(M)_{A_n} = (a - a\alpha + na\alpha)M_{max}$

Graham's Law of Diffusion

▷ It is a spontaneous movement of particles from higher concn to lower concn.

▷





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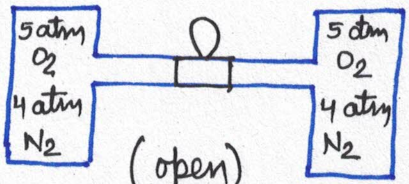


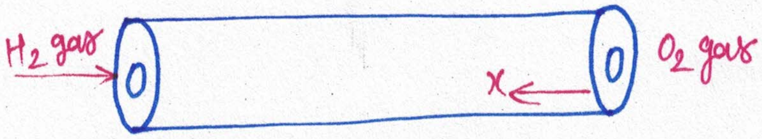
(open)

▷ At constant pressure and temp, rate of diffusion of gas will be inversely proportional to square root of density of gas.

$$r \propto \frac{1}{\sqrt{M}} \propto \frac{1}{\sqrt{\rho}}$$

▷ $$\text{Rate} = \frac{dV_{out}}{dt} = \frac{dn_{out}}{dt} = \frac{dx}{dt}$$

1M narrow tube consists two holes at end, as shown in figure. Calculate the pt. where hydrogen and oxygen gas meet first.



Ans:- $r \propto \frac{d}{\sqrt{M}} \Rightarrow \frac{x}{\sqrt{32}} = \frac{1-x}{\sqrt{2}} \Rightarrow x = 4-4x$

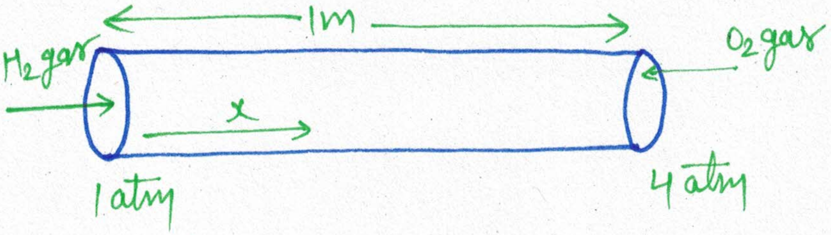
$x = 4/5\ m$

$$\boxed{x = (1/5)\,m \text{ from } O_2 \text{ gas}}$$

Most gen^n formula for rate of diffusion:-

$$r \propto \frac{PA}{\sqrt{MT}}$$

where P = Partial pressure of gas,
A = Area of cross-section of the hole
M = mol wt of gas,
T = Temp in K



Find it = ?

Ans:- $x = \frac{(1)(A)}{\sqrt{(2)(T)}}$ $\left(\frac{x}{1-x}\right) = 1$

$1-x = \frac{(4)\cancel{(A)}}{\sqrt{(32)\cancel{(T)}}}$ $x = 1/2\ m$

Q. Rate of diffusion of any unknown gas is 1/3 rd. wrt. H_2 gas. What should be its molecular mass.

A. $r_1 = \frac{1}{3} r_{H_2} \Rightarrow \frac{1}{\sqrt{M}} = \frac{1}{3\sqrt{2}} \Rightarrow M = 18g$

KTC

- There are some assumptions :-

A. Each gas consists a Large no. of very small particles called molecules. each molecule will consists of same shape, size, mass, it's volume will be neglected.

B. The motion of each molecule will be straight live, no NLM will be vali

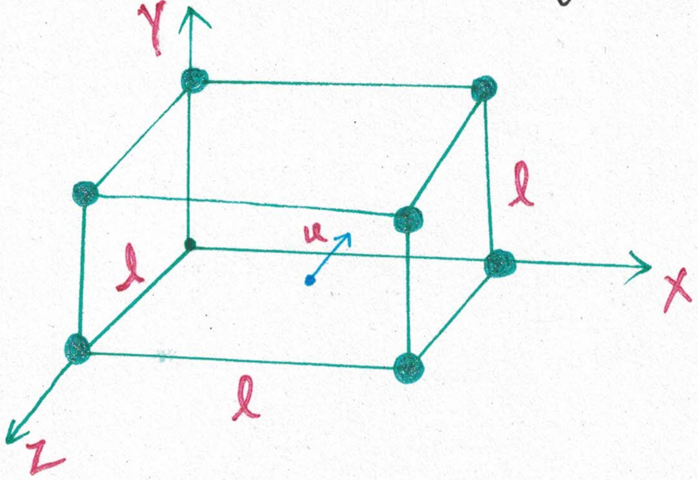
C. Effect of gravity is neglected.

D. All collisions during motion will be completely elastic (bet^n molecules & (molecules and wall).

E. The kinetic energy of each molecule will depend only on Temp.

F. It is conservation force - field hence no energy Loss.

G. There is no att^n force between gaseous molecules.



$$\vec{u} = u_x(\hat{i}) + u_y(\hat{j}) + u_z(\hat{k})$$

$$\vec{P_i} = mu_x(\hat{i})$$
$$\vec{P_f} = mu_x(\hat{i})$$

$$\Delta\vec{P} = -2mu_x(\hat{i}) \quad , \quad \Delta t = \left(\frac{2l}{u_x}\right)$$

$$F = \frac{|\Delta\vec{P}|}{\Delta t} = \frac{2mu_x}{(2l/u_x)} = \left(\frac{mu_x^2}{l}\right)$$

$$\vec{u_1} = u_{x_1}(\hat{i}) + u_{y_1}(\hat{j}) + u_{z_1}(\hat{k})$$

$$\vec{u_2} = u_{x_2}(\hat{i}) + u_{y_2}(\hat{j}) + u_{z_2}(\hat{k})$$

$$\vdots$$

$$\vec{u_n} = u_{x_n}(\hat{i}) + u_{y_n}(\hat{j}) + u_{z_n}(\hat{k})$$

$$\therefore f = \frac{m}{l}\left[u_{x_1}^2 + u_{x_2}^2 + --- u_{x_n}^2\right]$$

▶ Here, we take $(u_x = u_y = u_z)$

$$u_1^2 = u_{x_1}^2 + u_{y_1}^2 + u_{z_1}^2$$
$$u_2^2 = u_{x_2}^2 + u_{y_2}^2 + u_{z_2}^2$$
$$\vdots$$
$$u_3^2 = u_{x_n}^2 + u_{y_n}^2 + u_{z_n}^2$$

$$\therefore \left(\frac{u_1^2 + u_2^2 + \ldots u_N^2}{n}\right) = \left(\frac{u_{x_1}^2 + u_{x_2}^2 + \ldots u_{x_n}^2}{n}\right) + \left(\frac{u_{y_1}^2 + u_{y_2}^2 + ---}{n}\right) \ldots + \left(\frac{u_{z_1}^2 + --- + u_{z_n}^2}{n}\right)$$

$$\boxed{\vec{u}^2 = \bar{u}_x^2 + \bar{u}_y^2 + \bar{u}_z^2}$$

If we take; $\bar{u}^2 = \bar{u}_x^2 + \bar{u}_y^2 + \bar{u}_z^2$

$$\bar{u}^2 = 3\bar{u}x^2$$

$$\therefore P = \frac{F}{A} = \frac{m}{l \times l \times l}\left(\bar{u}x^2\right) \qquad N = \frac{mN}{V} \cdot \frac{1}{3} \cdot (\bar{u})^2$$

$$P = \frac{1}{3}\frac{mN}{VN_A}u^2 N_A$$

$$\boxed{P = \frac{1}{3}\frac{nM}{V}(\bar{u})^2}$$

M = Molecular Mass.

$$V_{rms} = \sqrt{(\bar{u})^2} = \sqrt{\left(\frac{3PV}{nM}\right)} = \sqrt{\frac{3(nRT)}{(nM)}}$$

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

KE of one molecule

$$\therefore \frac{1}{2} \cdot \cancel{M} \cdot \frac{3RT}{\cancel{M}} = \frac{3}{2}(nRT)$$

$$\boxed{K_E = \left(\frac{3}{2}\right) nRT}$$

n = moles

$$K_E = \left(\frac{3}{2}\right)\left(\frac{R}{N_A}\right)(T)n = \left(\frac{3}{2}KT\right)n$$

$\longrightarrow$ Bollzman's Constant

$$(KE)_x = (KE)_y = (KE)_z = \left(\frac{1}{2}KT\right)n$$

Most Probable speed :- Pascal

It is the velocity of the gaseous molecule which is possessed by max. no. of gaseous molecules.

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

— Take the Mass in kg

Avg speed :-

It is the arithmatic mean of velocities of all gaseous molecules.

$$V_{avg} = \sqrt{\frac{8RT}{\pi M}}$$

What will be KE of 1 molecule if its consists of avg. velocity ?

Ans:- $K_E = \frac{1}{2} m V_{avg}^2 = \left(\frac{1}{\cancel{2}}\right)(\cancel{m})\left(\frac{\overset{4}{\cancel{8}}RT}{\pi \cancel{m}}\right)\left(\frac{1}{N_A}\right)$

$$\boxed{KE = \frac{4KT}{\pi}}$$

There are 10 particles moving with velocities (2,3,3,4,3,3,4,3,5) m/s Calculate

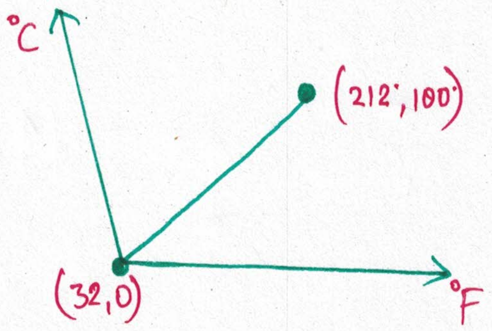
Ans:- (i) U_{mp} (ii) U_{avg} (iii) U_{rms}

(i) $U_{mp} = 3$ (ii) $U_{avg} = 3.2$ m/s

(iii) $\sqrt{\frac{8+45+32+25}{10}} = \sqrt{11}$ m/s.

A kinetic gas eqⁿ obeying ideal gas con'g be liquefied at any temp.

☆ °C ⟶ °F



0°C = 32°F

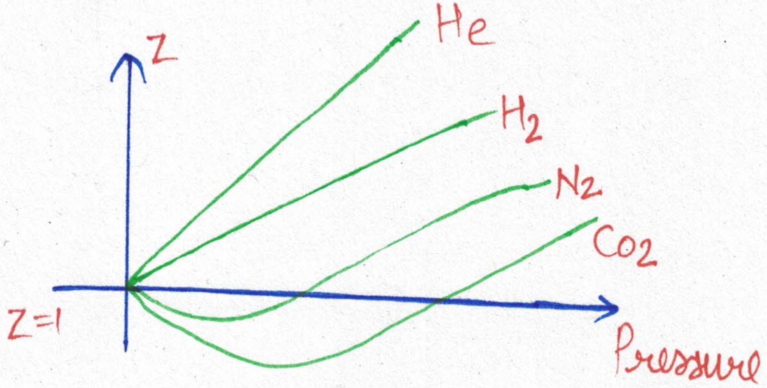
100°C = 212°F

using slope form find relation.

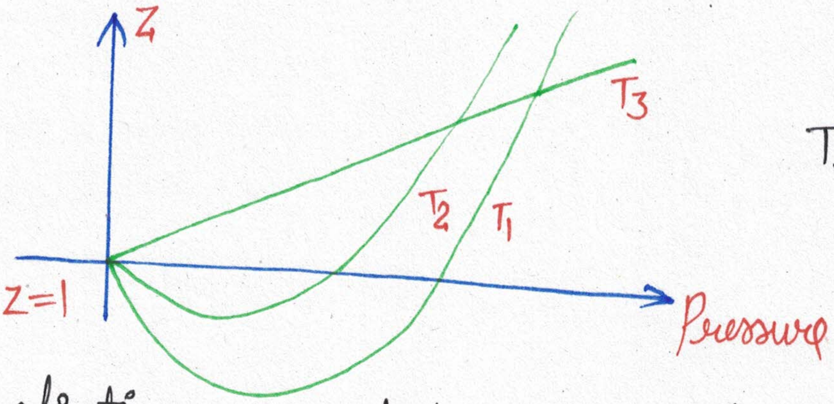
☆ $$\boxed{Z = \frac{V_{real}}{V_{ideal}}}$$

He, H_2 → can't liquified

↳ at particular temp.



Same as at diff temp

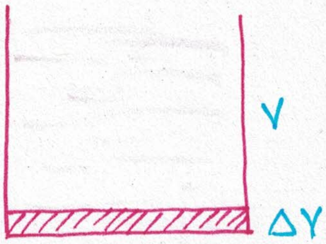


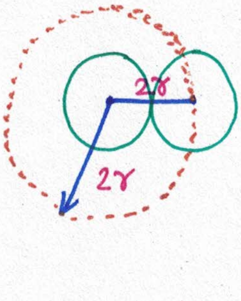
$T_3 > T_2 > T_1$

Thus, for liquefication, $Z<1$ and temp must be lowered.

VANDER WAAL'S EQ^n

There is an att^n force between molecules.





$$b = \frac{1}{2} \times \frac{4}{3} \times \pi (2r)^3 \times N_A = 4 \times \left(\frac{4}{3}\pi r^3\right) \times N_A$$

$$\boxed{b = 4\,(\text{volume of (molecule)} \times N_A}$$

$\Delta V = nb$

$$\boxed{V_{ideal} = V - nb}$$

Volume Correction

b → Size
a → Attraction

PRESSURE CORRECTION

Pideal:- $P + \Delta P$ gaseous molecules attract each other by that force given by any gaseous molecule to the wall will be less, hence pressure will be less, so, we get a correction in pressure.

$$P_{ideal} = P + \Delta P$$

Experimentally ; $\Delta P \propto$ density of gaseous molecules

$$\therefore \Delta P \propto \left(\frac{n^2}{V^2}\right),$$

$$\boxed{\Delta P - \frac{an^2}{V^2}}$$

Pressure Correction

n = no. of moles of gas.

$$\boxed{\left(P + \frac{an^2}{V^2}\right)\left(V - nb\right) = nRT}$$

→ Real gas
→ eq ①

- (a,b) are Vander waal's constant. As value of a↑, the molecules attract each other.

$$(V/n) = V_m = \text{Molar Volume}$$

eq.① Divide by n ⟶ $$\boxed{\left(P + \frac{a}{V_m^2}\right)\left(V_m - b\right) = RT}$$

ⓐ At Low pressure :

$$\left(P + \frac{a}{V^2}\right)\left(V - b\right) = RT \Rightarrow PV + \frac{a}{V} = RT$$

$$\frac{PV}{RT} + \frac{a}{RT \cdot V} = 1$$

$Z < 1$

$$Z = 1 - \frac{a}{VRT}$$

Phase change → Constant (temp, Pressure)

ⓑ At High pressure :

$$(P)(V - b) = RT \Rightarrow PV - Pb = RT \Rightarrow \frac{PV}{RT} - \frac{Pb}{RT} = 1$$

$$\boxed{Z = 1 + \frac{Pb}{RT}}$$

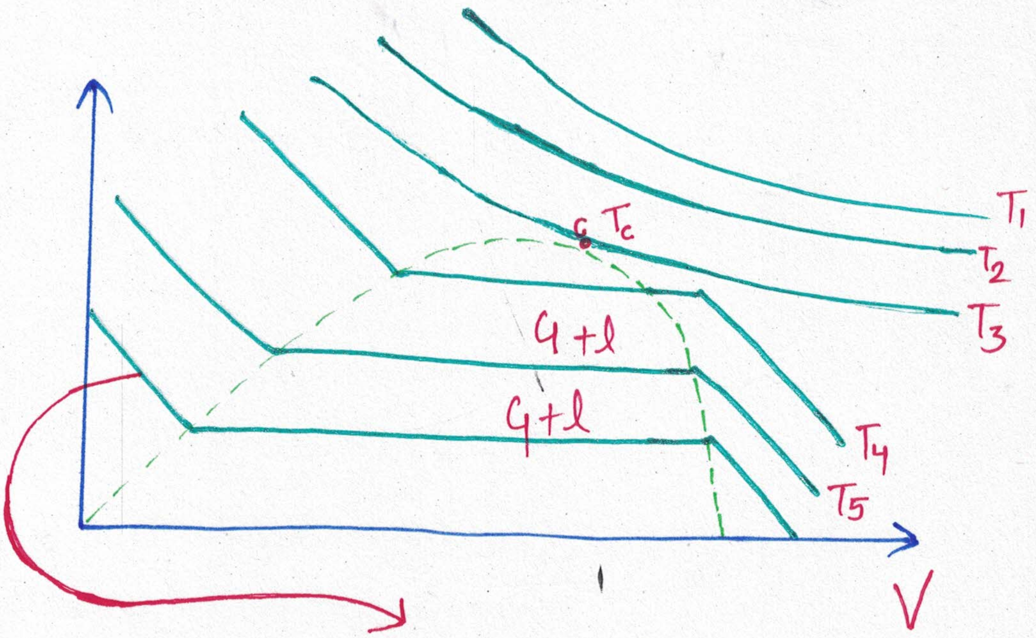
$Z > 1$

H_2 and He gas :

$a = 0$

$$(P)(V - b) = RT \Rightarrow Z > 1$$

LIQUEFICATION OF GAS



These are isotherms :- Here majoritavily is liquid, thus, pressure requirement is high.

- Below pt. c, any temp will be favorable for liquilification of gas, below T_c only the gas, can be liquiefied. T_c = Critical temp. Corresponding pressure and volume is called **critical pressure and critical volume.**

- Only real gas can be liquified

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT \xrightarrow{} \text{Cubic has one root.}$$

$$\Rightarrow PV^3 - (Pb + RT)V^2 + aV - ab = 0$$

$3\alpha = \left(\frac{Pb+RT}{P}\right)$, $\quad 3\alpha^2 = \frac{a}{P} \rightarrow ①$ $\quad \alpha^3 = \left(\frac{ab}{P}\right) \rightarrow ②$

② ÷ ① $\quad \boxed{\alpha = 3b}$, $\boxed{V_c = 3b}$

3. $9b^2 = \frac{a}{P} \Rightarrow \boxed{P_c = \frac{a}{27b^2}}$, $\boxed{T_c = \frac{8a}{27bR}}$

Y $\quad Z = \frac{P_cV_c}{RT_c} = \frac{\left(\frac{\cancel{a}}{27\cancel{b}^2}\right)(3\cancel{b})}{R\left(\frac{8\cancel{a}}{27\cancel{b}R}\right)} = 3/8$

$Z = 3/8$ At pt. c → for any gas

→ Not dependent on { a, b, R } etc.

REDUCED PRESSURE

- $\boxed{P_r = \frac{P}{P_c}}$ $\quad \boxed{T_r = \frac{T}{T_c}}$ $\quad \boxed{V_r = \frac{V}{V_c}}$

- $\left(P + \frac{a}{V^2}\right)(V-b) = RT$

- $\left[\left(P_r \cdot \frac{a}{27b^2}\right) + \frac{a}{V_r^2(3b)^2}\right]\left[3bV_r - b\right] = RT_r \cdot \left(\frac{8a}{27bR}\right)$

Reduced terms $\quad \boxed{\left(P_r + \frac{3}{V_r^2}\right)\left(3V_r - 1\right) = 8T_r}$

→ Valid for all states.

VIRIAL EQ^n

$$Z = 1 + \frac{B}{V} + \frac{C}{V^2} + \frac{D}{V^3} + \text{- - - - } \infty$$

B = second virial coeff.

C = Third virial coeff.

$$\left(P + \frac{a}{V^2}\right)\left(V - b\right) = RT$$

$$\boxed{T_B = \frac{a}{bR}}$$

At this temp, the gas behaves as an ideal gas.

▷

$$\left(P + \frac{a}{V^2}\right)\left(V - b\right) = RT$$

$$\Rightarrow \frac{PV}{RT} + \frac{aV}{V^2RT} = \left(\frac{V}{V-b}\right)$$

$$\Rightarrow Z + \left(\frac{a}{RTV}\right) = \frac{1}{\left(1 - \left(\frac{b}{V}\right)\right)}$$

By binomial

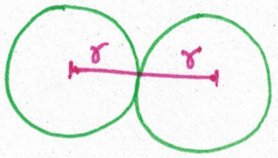
$$\Rightarrow Z + \left(\frac{a}{RTV}\right) = \left(1 + \frac{b}{V}\right)$$

$$\Rightarrow Z = \cancel{1} + \left(b - \frac{a}{RT}\right)\frac{1}{V} = \cancel{1}$$

$$\boxed{T_B = \frac{a}{bR}}$$

COLLISION PARAMETERS

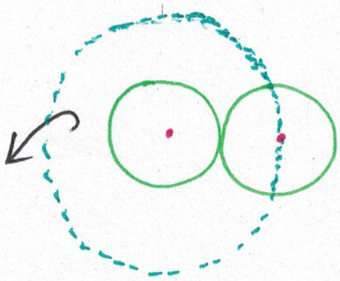
a. Collision Diameter



It's denoted by "σ"

$\sigma = d = (2r)$

b. Cross-Section for collision



This excluded Volume

c. Mean free Path

It is avg velocity of molecule w.r.t. collision number.

Collision Number :- Denoted by "Z". It's no. of collisions by one gaseous molecules registered by other gaseous molecules in one second.

Experimentally ;

$$\boxed{Z = \sqrt{2}\,\pi \sigma^2 \bar{u} N}$$

where σ = collision diameter

$\bar{u}$ = u_{avg}

N = no. of gaseous molecules per unit volume.

$Z \propto$ Pressure of gas

$Z \propto \dfrac{1}{\sqrt{\text{Temperature}}}$

Mean free path is the avg distance travelled by the gaseous molecules during collision in unit time.

$$\lambda = \frac{\bar{u}}{Z} = \frac{\cancel{\bar{u}}}{\sqrt{2}\,\pi \sigma^2 \cancel{\bar{u}} N} \Rightarrow \boxed{\lambda = \frac{1}{\sqrt{2}\,\pi \sigma^2 N}}$$

Lighter gas have more free path.

d. Collision Free

It is no. of collision taking place per second per unit volume.

EUDIOMETRY

At Constant pressure and temp, $\boxed{V \propto n}$

There are some solu^n which can absorb gases.

eg:-

	Gas	Solution
@.	CO_2, SO_2	Aq. KOH

ⓑ O_2 Alkaline pyragallol.

ⓒ O_3 Turpentine oil

ⓓ H_2O can be absorbed by anhy. $CaCl_2$, Conc. H_2SO_4

Inversion Temperature = (2)(Boyle temp)

The Mean translational K.E of the molecules is proportional to the absolute temperature.

At const. volume, for a fixed no. of moles of a gas, the pressure of a gas ↑ with the rise in temp. due to the increase in avg. mol speed.

The pressure of a fixed amount of an ideal gas is proportional to temperature (False).

Frequency of collision and their impact both ↑ in proportional to the $\sqrt{T}$ (True)

GASEOUS STATE

"SHORT NOTES"

DIPERSION FORCES/LONDON FORCES – Non Polar.

eg:- He, N_2, Cl_2 $\propto \left(\frac{1}{r^6}\right)$

DIPOLE-DIPOLE FORCES – Polar

eg:- H_2S, HCL, HF $\propto \frac{1}{r^6}$ (Rotating), $\propto \frac{1}{r^3}$ (Not rotating)

DIPOLE-INDUCED DIPOLE – Polar and non-polar.

$\left(\propto \frac{1}{r^6}\right)$

HYDROGEN BONDING – FON. 11 elements → Gases

State of matter depends on entermolecular forces and the thermal energy.

1 atm = 760 torr = 1 bar = 760 mm

$$\boxed{\rho = \frac{PM}{RT}}$$

- ✲ Boyle's Law $(P \propto 1/V)$ $P_1V_1 = P_2V_2 = \dots$ (Isotherms)
- ✲ Charles Law $(P \propto T)$ Pressure = constant
- ✲ Avogadro's Law $(V \propto n)$ at constant (P, T)
- ✲ Gaylussai's Law $(P \propto T)$ Isochores

Concept of open Vassel

$$n_1T_1 = n_2T_2$$

Payload or lifting capacity of gas :-

Payload = (Mass of air displaced - Mass of gas - Mass of the balloon)

NaOH / KOH = CO_2 H_2S SO_2 SO_3

Alkaline Pyrogallol = O_2

Terpentine oil = O_3

PRESSURU -

Dalton's Pressure - $P_A = X_A \cdot P$, $P_B = X_B \cdot P$

Vapoure Pressure - $\underset{\text{gas}}{P_{moisture}} = \underset{\text{gas}}{P_{dry}} + \underset{\text{vapour}}{P_{H_2O}}$

Grahm's Law of Diffusion / Effusion -

$$\text{Rate} = \frac{Vol}{t} = \left(\frac{n}{T}\right) = \left(\frac{\overset{\text{distance}}{d}}{T}\right) \propto \frac{1}{\sqrt{M}} \propto \frac{1}{\sqrt{e}}$$

$$r \propto \text{Area}, \quad r \propto P \longrightarrow \left(\frac{r_1}{r_2}\right) = \frac{P_1 A_1}{P_2 A_2} \sqrt{\frac{M_2}{M_1}}$$

CTG

$$\boxed{F = \frac{\partial m}{l}\left(u^2_{rms}\right)} \qquad \boxed{PV = \left(\tfrac{1}{3}\right)(m)\underset{\text{(no. of gas molecules)}}{(n)}\left(u^2_{rms}\right)}$$

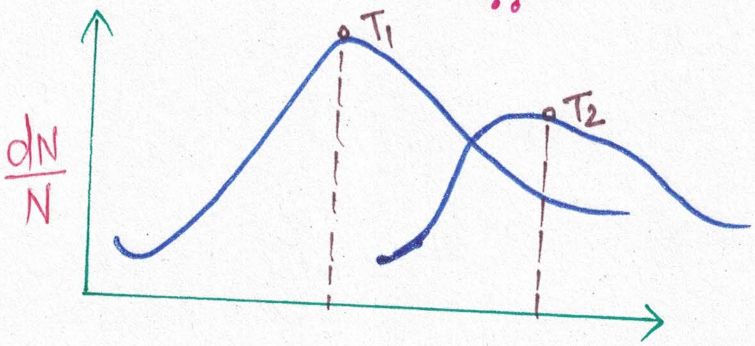
$KE \propto T$, $PV = \frac{2}{3} KT$

$$\boxed{KE = \tfrac{3}{2} nRT}$$

$$\lambda = \frac{h}{\sqrt{2mKE}} = \frac{h}{\sqrt{2 \cdot m \cdot \frac{3}{2} nRT}} = \frac{h}{\sqrt{3MRT}}$$

MAXWELL'S DISTRIBUTION CURVE

➡ $T_2 > T_1$



Area = 1

➡ $u_{mp} = \sqrt{\frac{2RT}{M}}$, $u_{rms} = \sqrt{\frac{3RT}{M}}$, $u_{avg} = \sqrt{\left(\frac{8RT}{\pi M}\right)}$

REAL GASES

✚ $$Z = \frac{\text{Volume of real gas}}{\text{Volume of ideal gas}}$$

$$Z = \left(\frac{PV_m}{RT}\right)$$

(H_2, He) have always the $Z > 1$.

✚ For NH_3, Z is less as compared to other gases and is more compressible and more liquifable.

REAL GAS EQ^n

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

$b = 4NA$ (vol. of each mol), (Large b, Larger size)

$a \propto$ Nature of gas, $a\uparrow$, Inward pull ↑, Forces of att^n ↑

At extremely low pressure and high temperature the gas will be ideal gas.

$$\boxed{T = \frac{a}{bR}}$$

, Andrews studied isotherms of CO_2 at diff. temp.

LIQUIFACTION

ⓐ By ↓ temp.

ⓑ By applying higher pressure.

Critical (temp, P, V) are the variable above which the gas can't be Liquefied.

$$\boxed{V_c = 3b} \qquad \boxed{P_c = \frac{a}{27b^2}} \qquad \boxed{T_c = \frac{8a}{27bR}}$$

$$\boxed{V_c = 3b} \qquad \boxed{a = 3P_cV_c^2}$$

$Z = \left(3/8\right) = 0.375$ ⟶ Compressibility Factor

The gas with higher critical temperature is liquified more easily.

Liquification $\propto T_c$

The gas like CO_2, NH_3, H_2S, SO_2 are liquified easily ⟶ "Temp. gases."

The gases like O_2, He, N_2 are not liquified more easily → "Permanent gases."

$SO_3 \longrightarrow Sp^3$ (Liquid & solid) ⟶ Linear polymer.

$SO_3 \longrightarrow Sp^2$ (Vapour)

When compounds with the 2P-3P are there, further they go in solid phase, they exist as polymers.