DATE : __/__/____
PAGE : _____

1-1/18

STATES OF MATTER

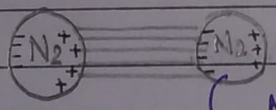
- GASEOUS STATE

$N_2(g)$	$HCl(g)$	$HCl(g) + N_2(g)$

↳ container

* Van der waals' forces = Attractive forces
= weak forces

(1) LONDON-DISPERSION FORCE
↳ b/w 2 Non-Polar Particles

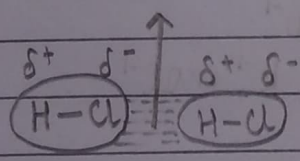


↳ Momentarily Dipole

* Interaction energy $\propto \frac{1}{r^6}$

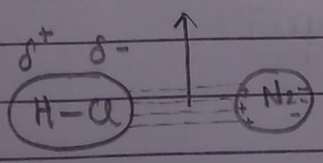
Internuclear dist

(2) DIPOLE-DIPOLE INTERACTION



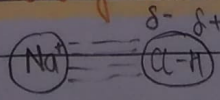
* Interaction energy $\propto \frac{1}{r^6}$ = For Rotating Dipoles
$\frac{1}{r^3}$ = For Static dipoles

(3) DIPOLE-INDUCED DIPOLE INTERACTION ~~(H-bonding)~~



* Interaction energy $\propto \frac{1}{r^6}$

NOTE: Ion-Dipole Interaction is Not considered as Van-der waal's force.
↓
Strong Interaction



Good Write

DATE : ___/___/____
PAGE : _____

• IDEAL-GAS

*There is NO-INTERMOLECULAR FORCE OF ATTRACTION amongst ideal gas Molecules

✓ Actual volume of ideal gas ~~is~~ ZERO molecule is taken as ZERO.

• NON-IDEAL (REAL) GAS

★ There must be some Intermolecular force of attraction Amongst Gas Molecules

★ Actual Volume can't be ZERO.

IDEAL-GAS equation : $PV = nRT$ — Ideal Gas Eq^{n}

P = pressure exerted by molecules of gas on the wall of the container when there is NO INTERMOLECULAR FORCE OF ATTRACTION

V = Volume available for Random movement

n = no. of Moles

R = universal Gas constt = $8.314\ JK^{-1}mol^{-1}$

$= 0.0821\ L\text{-}atm\ K^{-1}mol^{-1}$

★ 1L-atm = 101.3 J

★ 4.18 J = 1 Cal

T = Temp. on Kelvin scale (ABsolute Temp.)

∵ $PV = nRT$

$\Rightarrow \frac{PV}{nT} = R = \text{constt}$

★ $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} = \ldots\ldots = R = \text{constt}$

Good Write

10-1:20 PM

DATE: ___/___/_____
PAGE: _____

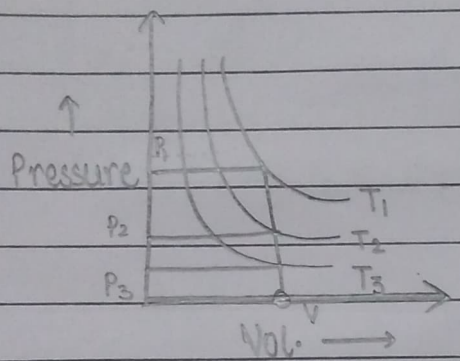
Law

* Boyle's Temp. ⇒ constt T & n

i.e. $P_1V_1 = P_2V_2 = K$

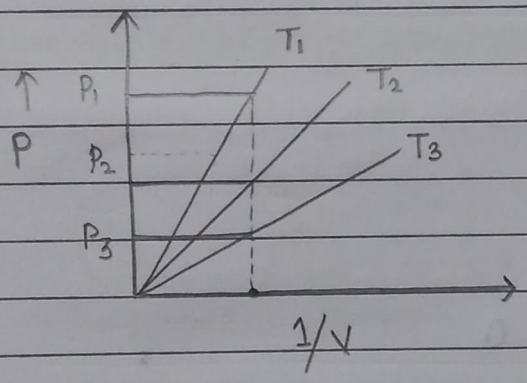
$V \propto \frac{1}{P}$

* GRAPH:



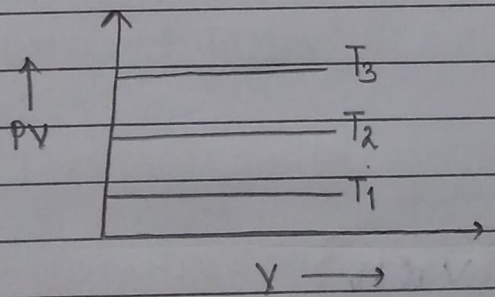
$P_1 > P_2 > P_3$

$\therefore T_1 > T_2 > T_3$



$P_1 > P_2 > P_3$

$\therefore T_1 > T_2 > T_3$



* $T_3 > T_2 > T_1$

* Charle's Law (constt P & n)

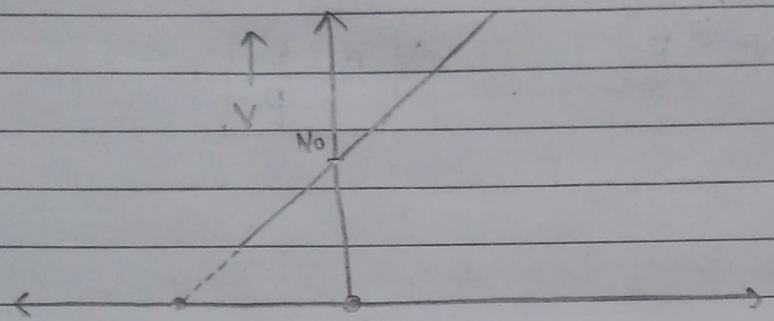
$\therefore \frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$ ⇒ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ = constt

⇒ $V \propto T$ [@ constt P, n]

Good Write

DATE : ___/___/____
PAGE : _____

GRAPH



★ Vol. of Ideal Gas = 0 @ -273.15°C

★ Absolute Zero Temp.

★ volume @ 0°C = V_0

★ volume @ 1°C = $V_0 + V_0 \times \frac{1}{273}$

★ Vol. @ 5°C = $V_0 + V_0 \times \frac{5}{273}$

★ Vol. @ -10°C = $V_0 - V_0 \times \frac{10}{273}$

★ Vol. @ -273°C = $V_0 - V_0 \times \frac{273}{273} = 0$

↓

its zero for ideal gas

AVOGADRO'S LAW (constt P & T)

$$\frac{V_1}{n_1} = \frac{V_2}{n_2} = \text{----} = \text{constt}$$

$V \propto n$

$\because PV = nRT$

$\Rightarrow P = \frac{nRT}{V}$

$\Rightarrow P = \frac{m}{V} \cdot \frac{RT}{M}$ ($\frac{m}{V} \propto \delta$)

$\Rightarrow P = \frac{DRT}{M}$

$\Rightarrow D = \frac{PM}{RT}$

Good Write

DATE: __/__/____
PAGE: _____

$$\frac{P_1 M_1}{D_1 T_1} = \frac{P_2 M_2}{D_2 T_2} = \dots = R$$

↳ Intensive Property.

Ques^{n}: Calculate Density (g/L) of CO_2 gas @ NTP. (+273 K)

NTP ↓ 1 atm.

$\frac{PM}{RT} = D$ (P: 1 atm, M: 44 g, T → 273 K, R → 0.082 L-atm K^{-1} mol^{-1})

$\Rightarrow \frac{1 \times 44}{0.082 \times 273}$ g/L

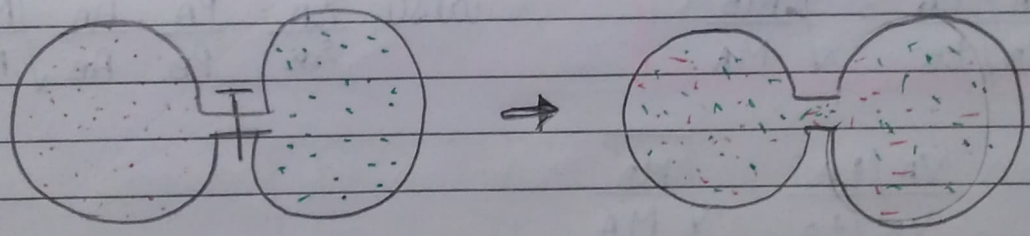
$\Rightarrow \frac{44}{22.396} = \frac{44}{22.4} = 1.9 \text{ m/V} = D$

$\Rightarrow 40 \approx 2$ g/L

(work)

$$\begin{array}{r} 82 \\ 556 \overline{)} \; 2 \\ 2184 \\ \hline 2396 \end{array} \; 5$$

★GRAHAM'S LAW OF EFFUSION & DIFFUSION:



- Phenomenon of intermixing of gases w/o the Help of any external factor is called DIFFUSION.

- Phenomenon of movement of gas from its Higher Pressure region to its lower Pressure region through a fine Hole is called EFFUSION.

↳ Like one way traffic

@ constt T & P

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

r = rate of Diffusion / Effusion

M = Molecular mass of gas

Good Write

DATE: __/__/____
PAGE: _____

* $r = \frac{V}{t}$ — Volume Diffused or effused / Time Taken

* $r = \frac{n}{t}$ → no. of moles diffused or effused

@ constt T & P

* $\frac{r_A}{r_B} = \sqrt{\frac{M_B}{M_A}}$ @ constt T & P

* $\frac{r_A}{r_B} = \frac{P_A}{P_B}\sqrt{\frac{M_B \times T_A}{M_A \times T_B}}$ (if temp & Pressure are Not constt)

* $\frac{V_A/t_A}{V_B/t_B} = \sqrt{\frac{M_B}{M_A}}$ also. $\frac{r_A}{r_B} = \frac{P_A}{P_B} \cdot \frac{A_A}{A_B}\sqrt{\frac{M_B}{M_A}}$

Q. 43
pg 139

$$\frac{V_A/t_A}{V_B/t_B} = \sqrt{\frac{M_B}{M_A}}$$

$$\frac{16/t}{V_{CO_2}/t} = \sqrt{\frac{44}{32}}$$

$$\Rightarrow \frac{(16)^2}{V_{CO_2}^2} = \frac{44}{32}$$

$$\Rightarrow \frac{256 \times 32^8}{44_{11}} = V_{CO_2}$$

$$\Rightarrow \frac{2048}{11}$$

$$\Rightarrow \sqrt{186.}$$

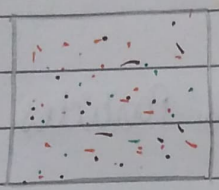
Good Write

DATE: __/__/____
PAGE: _____

1-2/19

Dalton's Law of Partial Pressure.

Total Pressure Exerted by the Mixture of Non-Reacting gases is Equal to the sum of partial Pressures (P) in the Mixture.
↓
of the gas



$$\star\ P_{Total} = p_A + p_B + p_C + \cdots$$

Except:

$NH_3 + HCl \longrightarrow NH_4Cl$ } Reactive

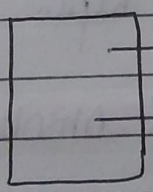
$SO_2 + Cl_2 \longrightarrow SO_2Cl_2$

$$p_A = P_T \cdot \chi_A$$
$$p_B = P_T \cdot \chi_B$$

$$\Rightarrow \frac{p_A}{p_B} = \frac{\chi_A}{\chi_B} = \frac{n_A}{n_B}$$

Vol. ?
Shouldn't be Inverse

Ques^n:



$CO(g) = 28$
$N_2(g) = 56$

$P_T = 10$
$p_{CO}, p_{N_2} = ?$

$$p_{CO} = \frac{10}{3} \qquad p_{N_2} = \frac{20}{3}$$

pg 130

Q. 7 $W_{CH_4} = W_{O_2}$

$$\frac{W}{16} : \frac{W}{32}$$

$$p_O = P_T \cdot \chi_O$$
$$p_O = P_T \frac{1}{3} \quad \text{Opt ②}$$

DATE: ___/___/____
PAGE: _____

Q.8 pg 130 $n_{H_2} = 2g$ $n_{H_2} = 1$ $n_{SO_2} = 32g$ $n_{SO_2} = \frac{1}{2}$ $p_{H_2} = ?$

$P_T \cdot \frac{1}{3/2} \Rightarrow \frac{2}{3} P_T$ Opt ③

★ Kinetic Energy Molecular Theory of gases:
(ASSUMPTIONS)

(1) All gas molecules are m/up of very small Particles called MOLECULES.

(2) All gas molecules are in random motion & They Exert pressure by colliding with the wall of containes.

(3) ★ wrong There is No Intermolecular Force of attraction Amongst gas Molecules.

(4) Collision amongst gas Molecules are perfectly elastic.

(5) ★ wrong Actual volume of gas molecules is Negligible as compared to the vol. of conkainer in which gas is kept.

(6) Average Kinetic Energy of gas molecules ∝ Absolute Temp.

$\Rightarrow E_K \propto T$

★ Based on Assumptions of KTG an eq^n is derived Called: KINETIC GAS EQUATION.

$$pV = \frac{1}{3} m N u^2 \quad \hookrightarrow (1)$$

- p = pressure
- V = Vol. → ①
- m = mass of A Molecule
- N = NO. of Molecules
- u = Root Mean Square Speed

Good Write

Cofsile

DATE: __/__/____
PAGE: _____

* $M \times N_A = M$ ↗ Molar mass

$$pV = \frac{1}{3} M u^2 \quad \text{(for 1 mole)}$$

$$\Rightarrow RT = \frac{2}{3} \times \underbrace{\frac{1}{2} M u^2}_{E_k}$$

* $PV = RT$

$$\Rightarrow RT = \frac{2}{3} E_k$$

$$E_k = \frac{3}{2} RT \quad \text{(for 1 mole)}$$

Average kinetic energy per mole

For 1 molecule

$$E_k = \frac{3}{2} \frac{R}{N_A} T = \frac{3}{2} kt$$ ↗ Boltzmann constt

* $E_k = \frac{3}{2} kT$ *

Average kinetic energy per molecule

MOLECULAR SPEEDS:

1. ROOT MEAN SQUARE SPEED:

* $V_{rms} = \sqrt{\frac{V_1^2 + V_2^2 + V_3^2 + \cdots + V_n^2}{n}}$

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

Good Write

DATE : ___/___/____
PAGE : _____

(2) AVERAGE SPEED

$$V_{avg} = \frac{V_1 + V_2 + \cdots + V_n}{n} \Rightarrow \boxed{V_{avg} = \sqrt{\frac{8RT}{\pi M}}}$$

(3) MOST PROBABLE SPEED

→ It is the speed occupied by Max. No. of Molecules.

$$\boxed{V_{mps} = \sqrt{\frac{2RT}{M}}}$$

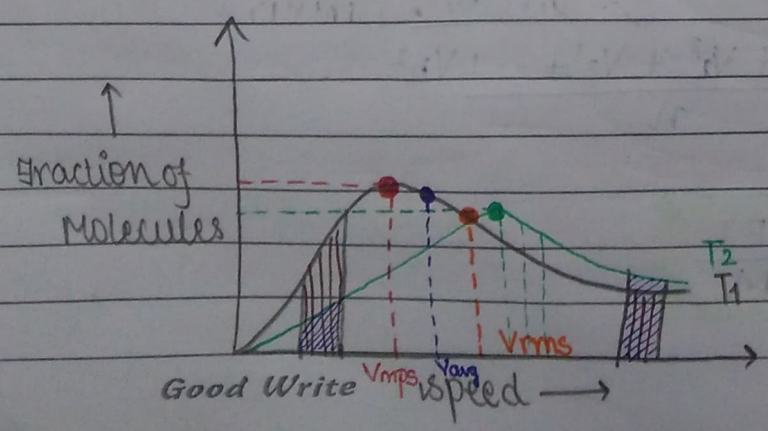
i.e. Molecular speeds $\propto \sqrt{\frac{T}{M}}$

$$\underset{\text{rms}}{\frac{R}{\sqrt{\frac{3RT}{M}}}} > \underset{\text{avg}}{\frac{A}{\sqrt{\frac{8RT}{\pi M}}}} > \underset{\text{mps}}{\frac{M}{\sqrt{\frac{2RT}{M}}}}$$

$$\frac{\sqrt{3}}{\sqrt{2}} : \sqrt{\frac{8}{\pi} \times \frac{1}{\sqrt{2}}} : \frac{\sqrt{2}}{\sqrt{2}}$$

learn 1.224 : 1.128 : 1

MAXWELL BOLTZMANN DISTRIBUTION OF MOLECULAR SPEEDS:



★ Area under the Graph gives the No. of Molecules

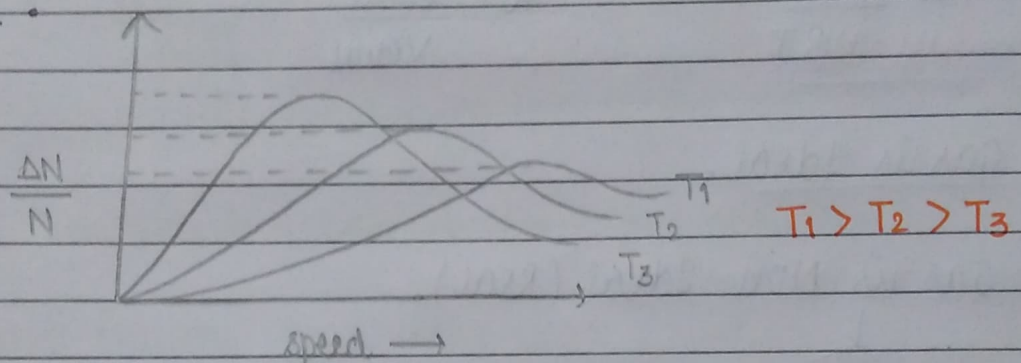
Good Write

DATE: ___/___/____
PAGE: _____

* On Increasing Temp., Area under the Graph remain Constant

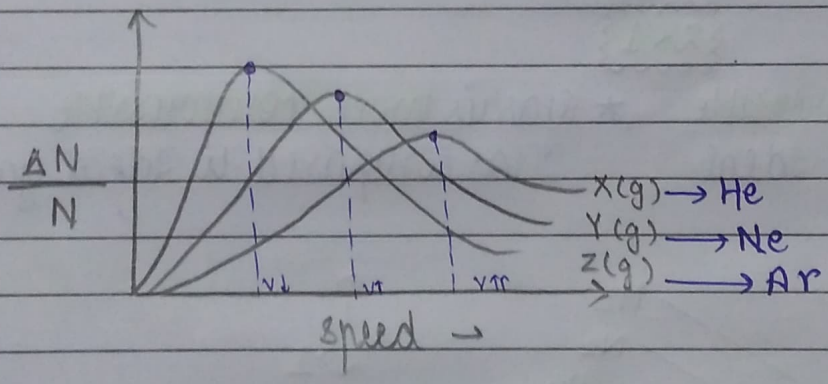
* On Increasing Temp. No. of Particles having Lower speed Decreases & No. of Particles Having Highest Speed Increases.

Ques^{n} :



$T_1 > T_2 > T_3$

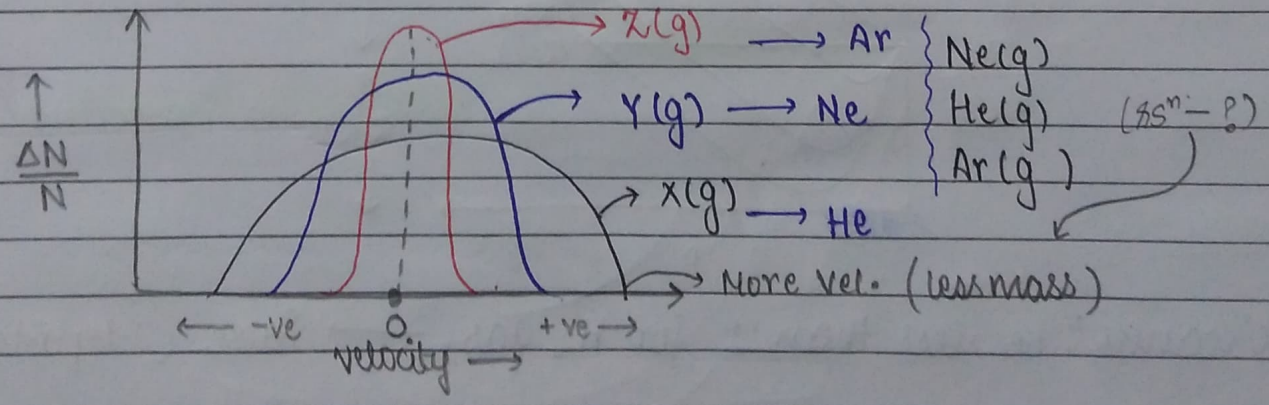
Ques^{n} : @ constt T & n



$v \propto \sqrt{\frac{T}{M}}$

@ T = constt

$* \; v \propto \frac{1}{\sqrt{M}}$



VAN DER WAAL EQ^{n}

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

Good Write

DATE: 6/12/22
PAGE:

1-3/20

Van der waal's eqn

- **Compressibility factor →** (Z)

$$Z = \frac{pV}{nRT} \qquad Z = \frac{V_{real}}{V_{ideal}}$$

★ If $Z = 1$, Gas is Ideal.

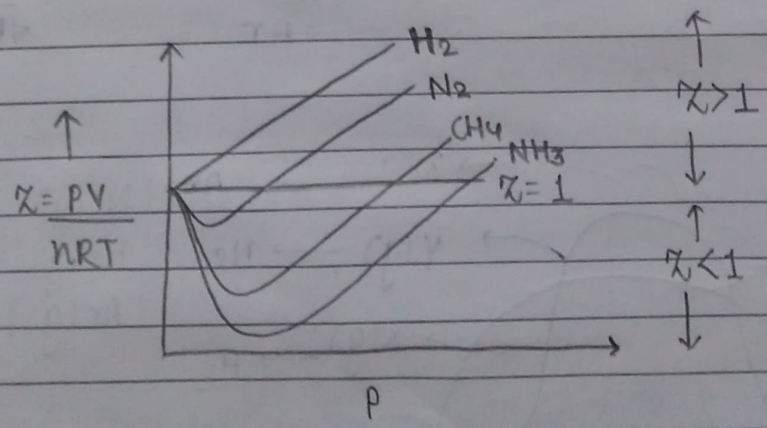
★ If $Z \neq 1$, Gas is Non-Ideal (Real).

$Z > 1$

★ Gas is less compressible as compared to Ideal Gas

$Z < 1$

★ Gas is more compressible as compared to Ideal gas



★ 'Z' cannot be less than 1 for H_2 gas. ⟶ False (T-dependent)

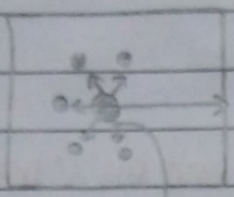
NOTE: ★ $Z > 1 \longrightarrow P\uparrow$ ⇒ Gas is less compressible
$V_{ideal} < V_{real}$

★ $Z < 1 \longrightarrow P\downarrow$ ⇒ Gas is more compressible
$V_{ideal} > V_{real}$

Good Write

DATE : __/__/____
PAGE : _____

Pressure correction



P = 5atm "Pideal > 5atm"

intermolecular forces

* Ideal Pressure for a real gas = $\left(P + \frac{an^2}{V^2}\right)$

(When there is No Intermolecular force of Attraction)

* Ideal volume for a real gas = $(V - nb)$

∴ Ideal eqⁿ for a real gas :

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

* a & b are called : Vander waal's constts.

Units of a & b :

$\frac{an^2}{V^2}$ = atm

$nb = L$

$b = L\text{-}mol^{-1}$

∴ 'a' = atm $L^2 mol^{-2}$

↓ litre

↓ lit.

significance of 'a' and 'b' :-

✓ 'a' measures the Extent of Intermolecular Forces of Attraction

a ↑ ∝ Molar mass, Surface Area, Polarity ↑

* He < Ar < Kr
(a ↑ses)

* Same type of gases = INERT GAS

Good Write

DATE : ___/___/____
PAGE : _____

✓ 'b' is called excluded volume or co-volume.

$b = 4 \times$ Vol. of a molecule

$$b = 4 \times \frac{4}{3}\pi r^3$$

★ 'b' depend on 'r' only

Critical constants

(1) CRITICAL TEMP. (T_c)

~~Temp. Above which gas cc~~

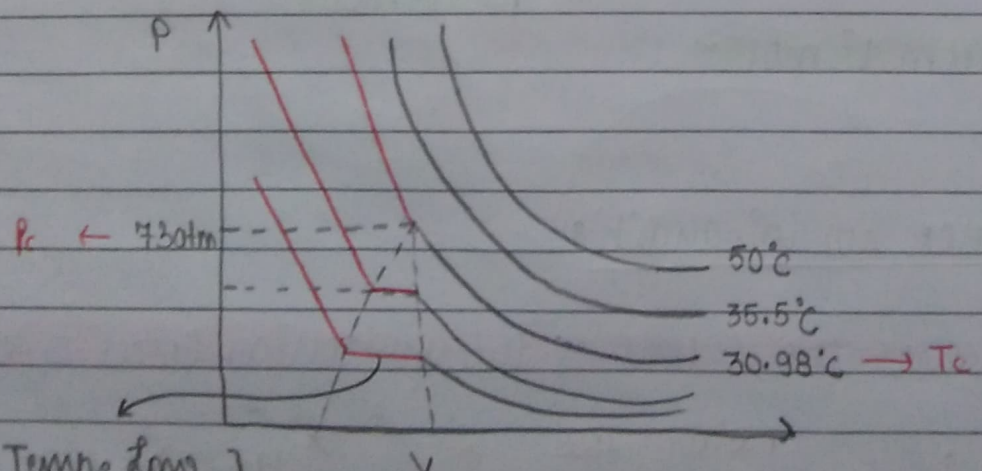
Max. Temp. @ which a gas can be converted into liquid by applying Pressure is called T_c

$$T_c = \frac{8a}{27Rb}$$

★ ease of liquification $\propto T_c$

(2) CRITICAL PRESSURE (P_c)

Min 'P' req^d at T_c to liquify gas



[Temp. ↓ ⇒ K.E. less ⇒ V ↓ wildly] (Graph for CO_2 gas)

Good Write

DATE : __/__/____
PAGE : _____

- **Critical Pressure (Pc)**

It is the min. Pressure that must be applied on a gas to just convert it into liquid.

$$P_c = \frac{a}{27b^2}$$

- **Critical Volume (Vc)**

Vol. of "one mole" of a gas at its critical Temp. & critical Pressure

$$V_c = 3b$$

Compressibility Factor at critical conditions (Z_c)

$$\star \quad Z_c = \frac{P_c V_c}{RT_c} \quad ; \; n = 1$$

$$= \frac{a}{27b^2} \times 3b \times \frac{1}{R} \times \frac{1}{8a} \times 27Rb$$

$$= 3/8$$

NOTE: $Z_c = 3/8$, constant for real gas

$\star$ Z_c for Ideal gas cannot be Defined.

ORDER OF VISCOSITY.

Glycerol > Ethylene glycol > Ethanol

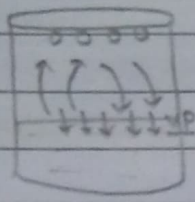
↓

has 3-OH (more Intermolecular force of Attraction)

DATE: ___/___/____
PAGE: _____

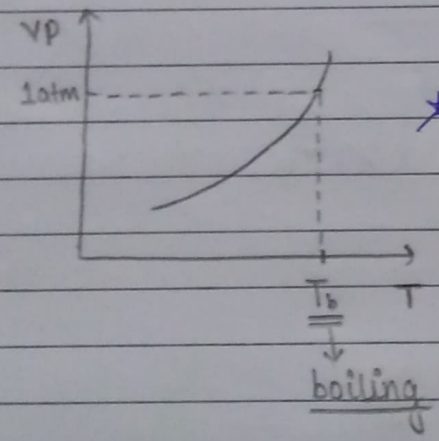
• VAPOUR PRESSURE:

Pressure exerted by vapours of liquid on the surface of the liquid when Rate of evaporation is equal to Rate of condensation is called vapour Pressure of liquid.



- ✓ can take place @ Any Temp.
- ✓ surface Phenomenon

* Vapour Pressure of liquid is Independent of the Amount of Liquid and its surface Area.
* Vapour Pressure of a liquid is constant @ constant Temp.
  i.e. depend on Temp.
* Effect of Temp. on vapour Pressure :-



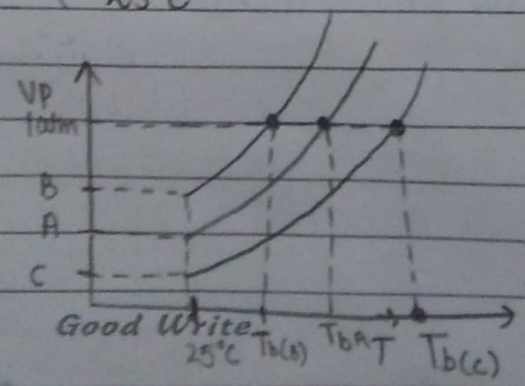
* Temp. @ which V.P. of Liquid becomes Atmospheric Pressure
  ↓
  Equal to

is called BOILING POINT OF A LIQUID.

NOTE: Boiling does not take place in a closed container.

Ques^n:

	A(ℓ)	B(ℓ)	C(ℓ)
V.P @ 25°C	220mmHg	260mmHg	200mmHg



Highest B.P. — C

C > A > B
(order of B.P.)

V.P ∝ 1/B.P.

DATE : __/__/____
PAGE : _____

Relation b/w vapour Pressure & Temp.

$$P = A\, e^{\frac{-\Delta H_v}{RT}}$$ ⇐ Calusius - Clapeyron eqⁿ

P → Vapour Pressure
A → Pre-exponential factor
ΔH_v → enthalpy of vaporisation
T → Absolute Temp.

Arrhenius eqⁿ

$$K = A \cdot e^{-Ea/RT}$$

K = rate constt
A = Pre-Exponential factor
Ea = Activation energy

Van't Hoff eqⁿ

$$K = A \cdot e^{-\Delta H_r/RT}$$

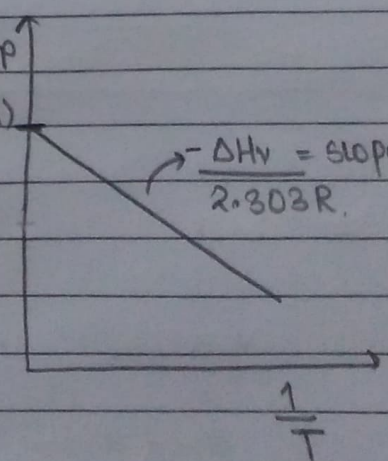
K = eqᵐ (→ equilibrium) constt
ΔH_r = enthalpy of rxⁿ

$$P = A \cdot e^{-\Delta H_v/RT}$$

$$\log_e P = \log_e A - \frac{\Delta H_v}{RT}$$

$$\log P = \log A - \frac{\Delta H_v}{2.303R} \times \frac{1}{T}$$

$$y = c - mx$$



Good Write

$$\log \frac{P_2}{P_1} = \frac{\Delta H_v}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Effect of Addition of a Non-Volatile solute →

↳ on Adding Non-volatile solute, Vapour Pressure of the liquid Decreases