Charle's Law

* for ideal Gas
* valid for V_{free} & Kelvin scale

Constant ⟶ P = constant, $\Delta P = 0$ → isobaric condition

n = constant, $\Delta n = 0$ → isomolar condition

M.Form:

$V \propto T$

$V = KT$ $\quad K = \frac{V}{T}$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ or $\frac{V_1}{V_2} = \frac{T_1}{T_2}$ or $V_1 T_1 = V_2 T_2$

For °C:

$$V_T = V_0 + \left(\frac{V_0}{273} \times T\right)$$

Constant "K":

$K = \frac{V}{T}$ $\quad PV = nRT$

$\frac{V}{T} = \frac{nR}{P}$

$K = \frac{nR}{P}$ → $K \propto n$

$K \propto R$

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

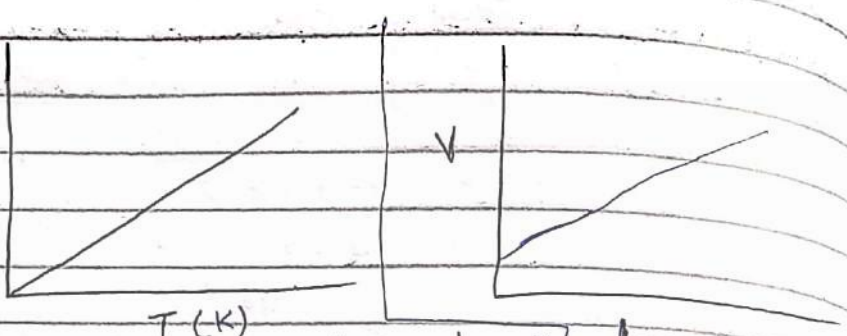
unit:

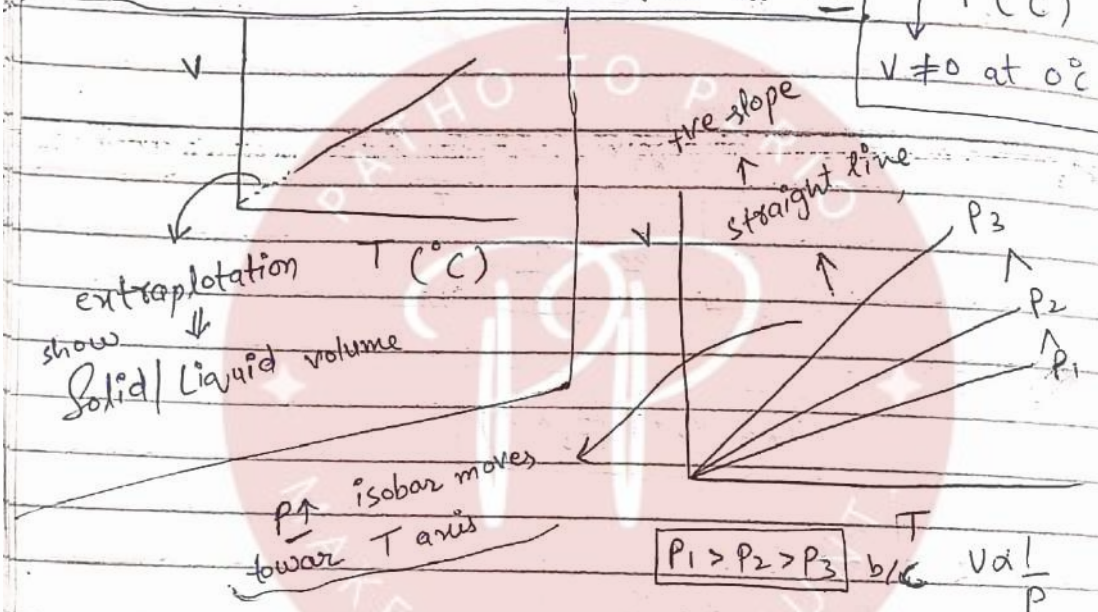
$K = \frac{dm^3}{K}$

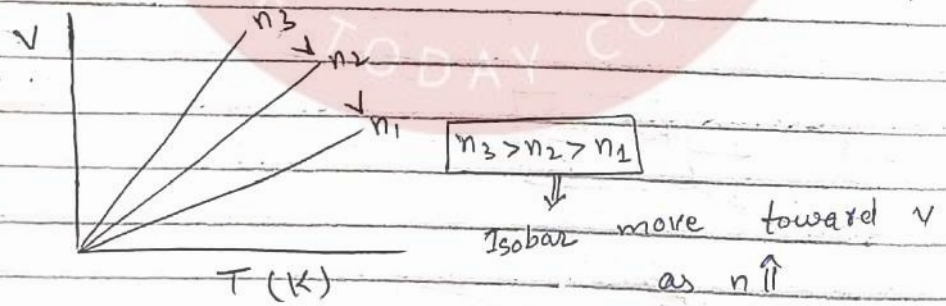
Isobar:

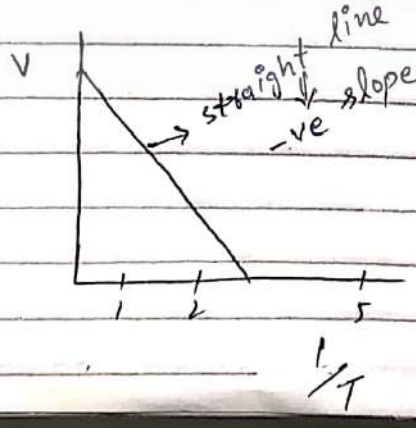
Graph b/w V & T

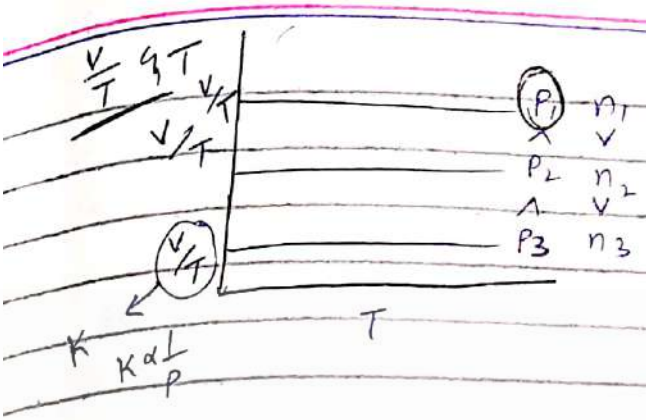
V–t Graph:











Q# The volume of a gas is V at 10°c . its volume will be double at
a) 20°c b) 40°c c) 273°c d) 293°c e) 40K

$T = 10°c = 283K \quad (V)$

$T = 566K \quad (2V)$

273

293°c

(volume will double at kelvin scale)

Q# The volume of a gas is V at 10K it will be double at:
a) 20K b) 40K c) 293°c d) 283°c

$T_1 = 10K \quad V$

$20K \quad 2V$

Q# The volume of a gas is V at 20°c . it will be double at (40°c)

increase but not double

~~293K~~ ~~V~~

Q# The volume of a gas is V at 10°c . How much temperature should be rised to make its volume double?

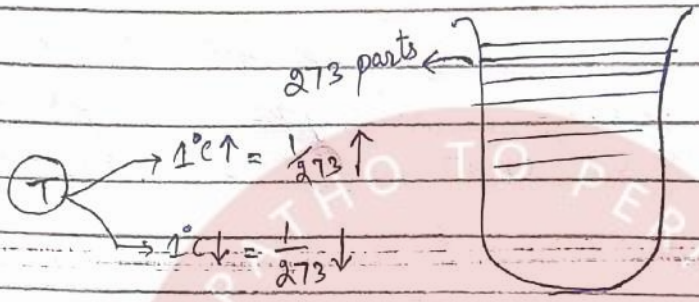
$T_1 = 10°c = 283K \quad V$

$566K \quad 2V$

$566 - 283 = 283K$

(#) Magnitude wise of Charle's Law

Volume of a given mass of a gas increase or decrease by $\frac{1}{273}$ of its original volume at $0^\circ C$.



Original Volume: $\rightarrow (V_0)$

Volume at $0^\circ C$ is called original volume.

Change in Volume:

$$\Delta V = \frac{1}{273} V_0 \times T$$

if $1T\uparrow$ $\Delta V = \frac{V_0}{273}$

if $2T\uparrow$ $\Delta V = \frac{2V_0}{273}$

if $3T\downarrow$ $\Delta V = -\frac{3V_0}{273}$

Total Volume at Any Temperature:

$$V_T = V_0 + \Delta V$$

V_0 = o. volume, ΔV = ch.

$$V_T = V_0 + \left(\frac{V_0}{273} \times T\right) \rightarrow (1)$$

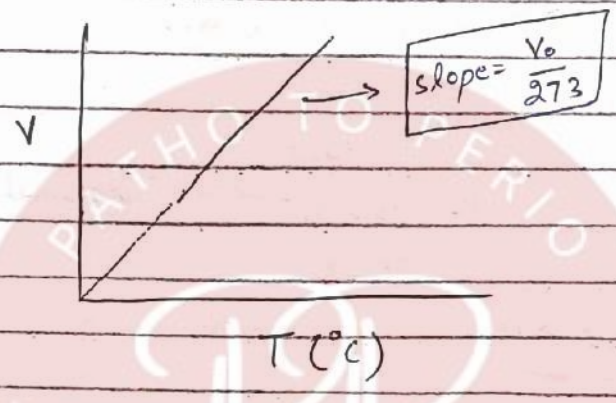
① → original volume & T in °c given.

Q# The volume of a gas at 0°c is 546ml (V_0) its volume at 2°c is:

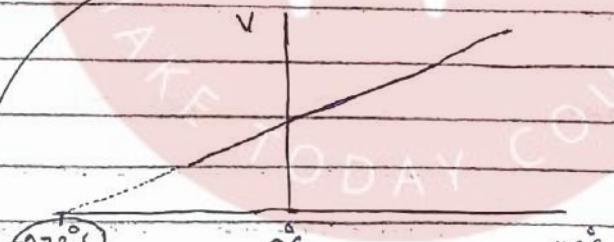
$$V_T = 546 + \left(\frac{546}{273} \times 2\right)$$

$$= 546 + 4 = \boxed{550ml}$$

Graph:



⊛ Absolute Zero



↓ T

gas volume not zero

* hypothetical Temperature at which volume of a gas is zero.

✓ T = 0K

✓ T = -273°C

✓ T = -459.67°F

* No gas exist & Liquid & Solid present.

✓ * K.E gas at A.zero = zero

✓ * K.E P.E at A.zero = zero

✓ * entropy & enthalpy of gas = zero

✓ * density of gas = zero

⊛ Avogadro's Law

Constant:

T = constant
P = constant → isothermal + isobaric

$\frac{V_1}{V_2} = \frac{n_1}{n_2}$

$V \propto n \Rightarrow V = Kn$ $\quad K = \frac{V}{n}$

$\frac{V_1}{n_1} = \frac{V_2}{n_2}$ $\quad V_1 n_2 = V_2 n_1$

Constant:

$\frac{V}{n} = K$

$PV = nRT \quad \frac{V}{n} = \frac{RT}{P} \quad K = \frac{RT}{P}$

$K \propto T$ $\quad V \propto R$ $\quad V \propto \frac{1}{P}$

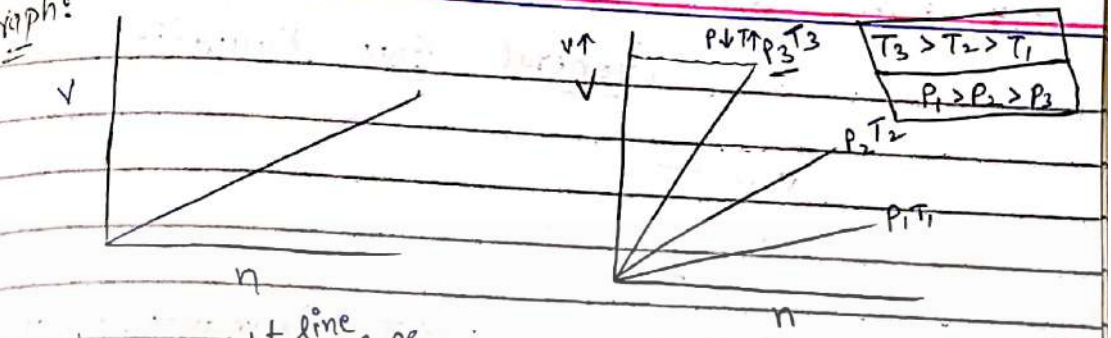
Unit:

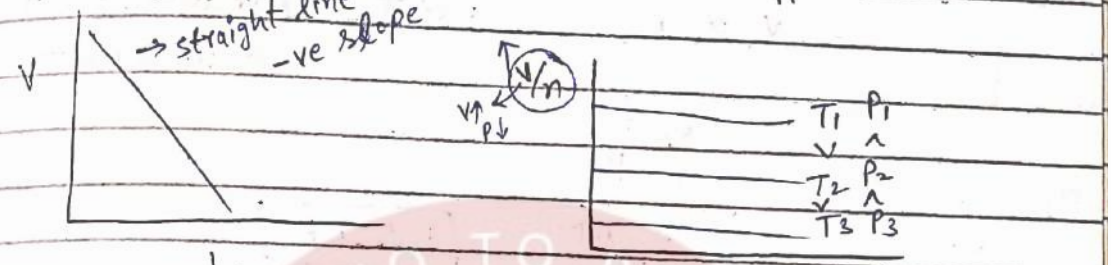
$K = \frac{dm^3}{mol} = \frac{1}{M} = \frac{1}{C}$

Molarity / con $= \frac{n}{V} = \frac{mol}{dm^3}$

isotherm isobar

Graph:





$V \propto$ No. molecules

$V \propto \frac{mass}{molar\ mass}$ $\quad V \propto mass$ (molar mass = const)

$V \propto \frac{1}{m \cdot mass}$ (mass = const)

$V = Kn \Rightarrow V = K \times \frac{mass}{m \cdot mass}$ $\quad mass = V \times M \times$

$V_1 : V_2 : V_3$
$n_1 : n_2 : n_3$

$m_1 : m_2 : m_3$
$V_1 M \cdot M_1 : V_2 M \cdot M_2 : V_3 M \cdot M_3$

Q# What is the mass ratio of $2 dm^3$ H_2, $0.5 dm^3$ CH_4 & $1 dm^3$ of O_2:

$H_2 : CH_4 : O_2$

$2 \times 2 : 0.5 \times 16 : 1 \times 32$

$4 : 8 : 32$

$1 : 2 : 8$

$1 : 1 : 84$

General Gas Equation

$V \propto T$

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

$V \propto n$ $\quad P \propto T$ (Amanton's Law, Gay Lusac's

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

$V = \frac{nRT}{P}$ $\quad \boxed{PV = nRT}$

$$\boxed{\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}}$$

Application

① Total $\underline{P}$ & $\underline{V}$:

$T \longrightarrow$ given

$$\boxed{P_T = (n_1 + n_2 + n_3)\frac{RT}{V_T}}$$

$$\boxed{V_T = (n_1 + n_2 + n_3)\frac{RT}{P_T}}$$

Q# what is total pressure of 2g H_2, 32g CH_4 & 8g He in 10 Litre flak at a temperature of 10K?

$$P_T = \frac{5 \times R \times 16}{16} \qquad \boxed{P_T = 5R}$$

ii) when T ⟶ not given

$$\boxed{P_T = \frac{P_1V_1 + P_2V_2}{V_T}} \qquad \boxed{V_T = \frac{P_1V_1 + P_2V_2}{P_T}}$$

Q# What is the total pressure in beaker when $2dm^3$ He at pressure of 1 atm is mixed with $0.5dm^3$ of O_2 at 0.5 atm pressure?

$$P_T = \frac{2 \times 1 + 0.5 \times 0.5}{2.5}$$

$$\boxed{P_T = \frac{2 + 0.025}{2.5}}$$

(2) Mass of gas:

$$\boxed{m = \frac{PVM}{RT}}$$

(4) Identification of gas:

$$\boxed{M.M = \frac{mRT}{PV}}$$

(5) density of a gas:

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

⑥ Concentration:

$$c = \frac{n}{V}$$

$$\boxed{c = \frac{P}{RT}}$$

⑦ Work done by a gas:

$$w = P\Delta V$$

$$PV = nRT$$

$$\boxed{w = \Delta nRT} \qquad \Delta n = n_p - n_R$$

$w \propto n$

⑧ Nature of R

R = energy of one mole of a gas at 1 K

$$R = \frac{PV}{nT} \qquad R = \frac{W}{nT}$$

$$\boxed{R = \frac{\text{energy}}{nT}}$$

R:

$$R = \frac{PV}{nT} \qquad n = 1$$

$$\boxed{R = \frac{PV}{T}}$$

Gas constant for one mole

not depend on P, V, T, n

independant of Gas (Nature)

* R depend on unit of measure.

(#) Boltsman (Kb) Constant:

$$K_b = \frac{R}{N_A}$$

$$PV = \frac{N}{N_A} RT \rightarrow K_b$$

$$PV = nK_bT$$

molecules

$N = 1$

$$K_b = \frac{PV}{NT}$$

gas constant (for one molecule)

Ideal gas	Real Gas
* No attractive & Repulsive forces	* forces present.
* $V_{free} \neq 0$	* $V_{free} \neq 0$ ($V_{molecule} \neq 0$)
* $V_{actual} = 0$	* $V_{actual} \neq 0$
* $V_{excluded} = 0$ (gas molecu moti → absent)	* $V_{excluded} \neq 0$
* $Z = 1$	* $Z >$ or < 1
* a & $b = 0$	* $a \neq 0$ $b \neq 0$
* cannot be liquified	* can be liquified
* No T_c & P_c	* having T_c & P_c

⊛ Compressibility / deviation factor:

(show extent deviation)

⇓

(ideal to Real)

$$Z = \frac{PV}{nRT}$$

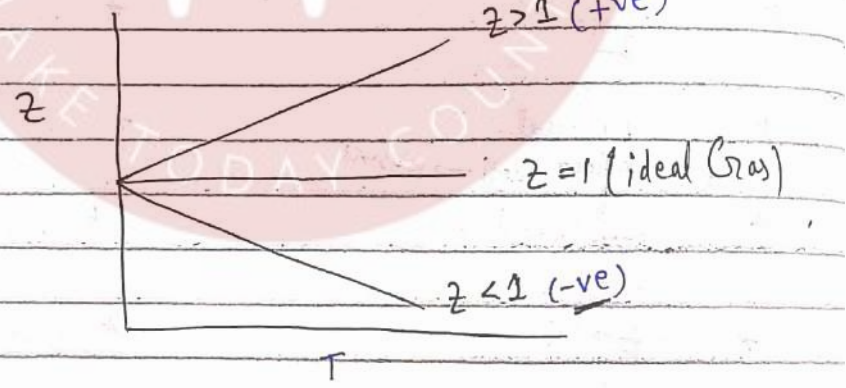
depend on condition.

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

* unit less
* always positive → b/c V can never be (-ve)
* For ideal gas → indepe of nature of gas

$$Z = 1$$

* For real → depend on nature.

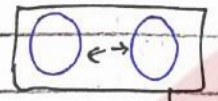
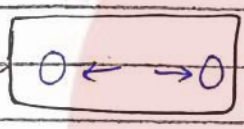
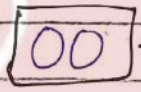


For ideal Gas:

* $PV = nRT$
* $V_{real} = V_{ideal}$
* $Z = 1$

Real gas:

* $PV \neq nRT$
* $V_{real} \neq V_{ideal}$

+ve	-ve
* 1st -ve then +ve	
+ve deviation	-ve deviation
	
V_{ideal}	V_{ideal}
After condition	
* 	* 
V_{real}	V_{real}
* $V_{real} > V_{ideal}$	* $V_{ideal} > V_{real}$
* $PV > nRT$	* $PV < nRT$
$V \uparrow\uparrow$	
* $Z > 1$	* $Z < 1$
* Repulsive forces	* attractive forces
* less compresible	* more compresible
* To become ideal	* To become ideal
⇓	⇓
low T & high-P	High T & low P
* H_2, He, Ne	* all other gases.
⇓	
+ve	

* Z near to 1 = more ideal

* Z lesser to 1 = more attractive forces.

* Z more than 1 = Repulsive forces.

Note:

-ve deviation ∝ IMF

-ve deviation ∝ H-bonding

-ve deviation ∝ M.mass

Q# W.O.F more attractive forces?

a) Z = 0.9 b) Z = 0.7

✓ (c) Z = 0.5 d) Z = 1

Q# w.o has smallest Z-value?

a) CH_4 (16) b) N_2 (28) c) O_2 (32) (d) ✓ CO_2 (44)

Factors on which dev^n depend

* Deviation ∝ P

* Deviation ∝ $\frac{1}{T}$

* Nature of gas.

* Deviation ∝ IMF

* Deviation ∝ a

* Deviation ∝ b

* Deviation $\propto T_c$ * Deviation $\propto P_c$

* Deviation $\propto$ ease of liquification

* Deviation $\propto \frac{1}{\text{ideal character}}$

Priority order:

① Deviation $\propto$ H-bonding

② Deviation $\propto$ NO-H-bonding

③ Deviation $\propto$ E.N of central atom

④ Deviation $\propto$ Molar mass.

⑤ Deviation $\propto$ cyclic > Linear > Branch
(↓ S.A ↑ more attraction)

⑥ Deviation $\propto \frac{1}{\text{Branching}}$

(50)

=> when difference in m.mass is very large.

then priority is given to m.mass but not H.B.

New Lec

Q# which one show max deviation?

(a) H_2O b) CH_4 c) NH_3 d) HF

$CH_3F < CH_3Cl < CH_3Br < CH_3I$

$NH_3 < Br_2 < I_2$

Note:

if m.mass range = 50 then consider H.B

* $HF < SO_3$

* $F_2 < Cl_2 < Br_2 < I_2$

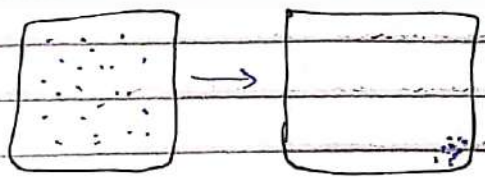
$H_2 > He$ → deviation. He → most ideal gas

Van der waal Equation

ideal gas → $PV = nRT$

for real gas

Volume:



$V_{vessel} = V_{free} - V_{actual}$

$V_{vessel} = V_{free} - nb$

So

$V_{actual} = 4b$ → $b = 4$ actual V

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

$b = \frac{16}{3}\pi r^3$

* Co-volume
* effective volume.

where gas molecule motion is negligible

$V = nb$

$b = V/n$

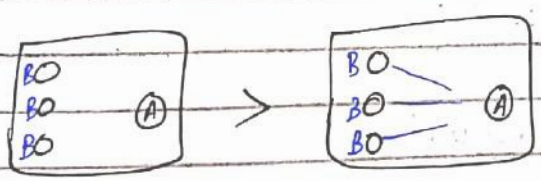
unit:

$b = \frac{dm^3}{mol} = \frac{l}{M} = \frac{l}{C}$

(#) b depend on:

- B∝ molecular size
- B∝ IMF
- b∝ H·B
- b∝ NO# H·B
- b ∝ Molar mass
- b ∝ Tc/Pc

(#) Pressure:



ideal Real

$P_{observed} = P_{ideal} - P'$

P' = decrease in pressure due to attraction.

$P_{ideal} = P_{observed} + P'$

$P' \propto \frac{n}{V}^{A} \cdot \frac{n}{V}^{B}$ $\quad P' \propto \frac{n^2}{V^2}$ $\quad P = \frac{an^2}{V^2}$

a ⟶ attraction.

$P'_{decrease} \propto a$

unit:

$P = \frac{an^2}{V^2}$ $\quad a = \frac{PV^2}{n^2}$

attraction or ($P_{decrease}$) ⟵ $a \propto c^2$

$a = \frac{atm \cdot dm^6}{mol^2}$

$a = \frac{Nm^{-2} \cdot m^6}{mol^2}$

$a = \frac{N m^4}{mol^2}$

depend of "a":

$a \propto IMF$ $\quad a \propto H \cdot B$

$a \propto b$ $\quad a \propto m \cdot mass$ $\quad a \propto P_c / T_c$

$a \propto$ deviation

Total equation

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

① $a = 0$ / $b \neq 0$ $\quad n = 1$

$$(P)(V - b) = RT$$

$PV - Pb = RT$ → $PV = RT + Pb$

$Z = \frac{PV}{RT}$ → $Z = \frac{RT + Pb}{RT}$ → $Z = 1 + \frac{Pb}{RT}$

② $a \neq 0$ & $b = 0$:

$n = 1$

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

$PV + \frac{an^2}{V} = RT$ → $PV = RT - \frac{an^2}{V}$

$Z = \frac{RT - \frac{an^2}{V}}{RT}$ → $Z = 1 - \frac{an^2}{RTV^2}$

MCQs:

The vanderwaal equation merges into ideal gas equation when:

$a = 0$, $b = 0$

⑧ Graham's Law of diffusion

→ applied on ideal gas

Constant:

✓ * Pressure constant (isobaric)

✓ * temp constant (isothermal)

M. Form:

$$r \propto \frac{P}{\sqrt{T M_{\text{mass}}}}$$

$$\gamma = \frac{AP}{\sqrt{TM}}$$

$$\gamma \propto \frac{1}{\sqrt{M}} \qquad \gamma \propto \frac{1}{\sqrt{d}}$$

$$\gamma = \frac{K}{\sqrt{M}}$$

$$\frac{\gamma_1}{\gamma_2} = \sqrt{\frac{M_2}{M_1}} \qquad \frac{\gamma_1}{\gamma_2} = \sqrt{\frac{d_2}{d_1}}$$

In term of ~~velocity~~ distance:

$$\text{Rate} = \frac{d}{t}$$

$$\frac{d_1/t_1}{d_2/t_2} = \sqrt{\frac{M_2}{M_1}} \qquad \frac{d_1 t_2}{d_2 t_1} = \sqrt{\frac{M_2}{M_1}}$$

$$\frac{d_1}{d_2} = \sqrt{\frac{M_2}{M_1}} \quad (t = \text{Same})$$

Q# ~~How much~~ He ~~distance~~ covered 8 Km distance. How much distance is covered by CH_4 in same time.

$$\frac{d_{He}}{d_{CH_4}} = \sqrt{\frac{16}{4}} = \sqrt{4}$$

CH_4

$$\frac{8}{d} = 2 \qquad d = \frac{8}{2} \qquad d = 4 \text{ Km}$$

(#) In term of time:

$$\frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}}$$

Q# CH_4 takes 4 days to diffuse how much time is taken by He to cover same distance.

Sol:

$$\frac{t_{CH_4}}{t_{He}} = \sqrt{\frac{16}{4}} \Rightarrow \frac{4}{t_{He}} = 2$$

$t_{He} = 2$ days

* In term of Volume:

$$\text{rate} = \frac{\text{Volume transfer}}{\text{time}}$$

Volume $\leftarrow \frac{V_1/t_1}{V_2/t_2} = \sqrt{\frac{M_2}{M_1}}$ $\quad \frac{V_1 t_2}{V_2 t_1} = \sqrt{\frac{M_2}{M_1}}$ $\quad \frac{V_1}{V_2} = \sqrt{\frac{M_2}{M_1}}$

* In term of Mole:

$$\text{rate} = \frac{\text{moles transfer}}{\text{time}}$$

$\frac{n_1/t_1}{n_2/t_2} = \sqrt{\frac{M_2}{M_1}}$ $\quad \frac{n_1 t_2}{n_2 t_1} = \sqrt{\frac{M_2}{M_1}}$ $\quad \frac{n_1}{n_2} = \sqrt{\frac{M_2}{M_1}}$

* In term of pressure:

$$\frac{\gamma_1}{\gamma_2} = \frac{P_1}{P_2}\sqrt{\frac{M_2}{M_1}}$$

Q#: What is the ratio of rates of ~~4 atm~~ He when diffuses at 4 atm by CH_4 diffuse at 8 atm.

$$\frac{\gamma_{He}}{\gamma_{CH_4}} = \frac{4}{8}\sqrt{\frac{16}{4}} \Rightarrow \frac{1}{2} \times 2 = \boxed{1:1}$$

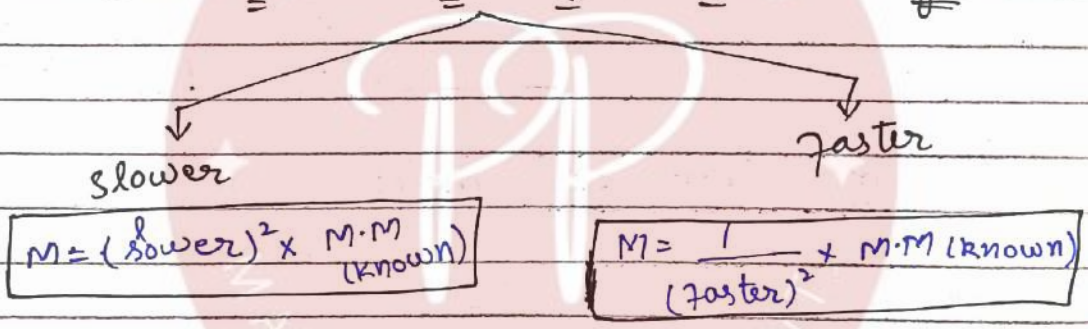
(*) In terms of Temperature:

$$\boxed{\frac{\gamma_1}{\gamma_2} = \sqrt{\frac{M_2}{M_1} \times \frac{T_2}{T_1}}}$$

Combine

$$\boxed{\frac{\gamma_1}{\gamma_2} = \frac{P_1}{P_2}\sqrt{\frac{M_2}{M_1} \times \frac{T_2}{T_1}}}$$

(*) Molar mass of unknown gas



$$\boxed{M = (\text{slower})^2 \times M \cdot M \text{ (known)}}$$

$$\boxed{M = \frac{1}{(\text{faster})^2} \times M \cdot M \text{ (known)}}$$

Q# He diffuses 4 times faster than an unknown gas, the gas is:

$$M \cdot M = \left(\frac{1}{4}\right)^2 \times 2 \quad \frac{2}{16} = (8) \text{ or } (32)$$

$(5)^2 \times 2$

$25 \times 2 = (50)$ $\frac{1}{(5)^2} \times 2$ $\frac{1}{25} \times 2$ $\frac{2}{25}$

$$\frac{\gamma_{H_2}}{\gamma_x} = \sqrt{\quad} \qquad \frac{\gamma_{He}}{4x} = \sqrt{\frac{1}{4}}$$

$$\frac{1}{4x} = \frac{1}{2}$$

Dalton's Law

* For ideal gas
* For Mixture of gas
* For Non-reacting gases.

MCQs Dalton's Law valid for:

(a) H_2 & He (b) H_2 & N_2 (c) H_2 & Cl_2

Mathematici:

$P \propto$ no. moles $\quad P = Kn$

$K = \frac{P}{n}$ $\quad \frac{P_1}{n_1} = \frac{P_2}{n_2}$

Constant:

$PV = nRT$

$\frac{P}{n} = \frac{RT}{V} \quad K = \frac{RT}{V}$

* Temperature & K
* volume

$K \propto R$ $\quad K \propto T$ $\quad K \propto \frac{1}{V}$

$P \propto n$ $\quad P \propto$ mass $\times (M \cdot M)$

Q# Max pressure is exerted by

$2g\,H_2 < 4g\,H_2 < 8g\,H_2$

$P \propto \frac{1}{M \cdot M}$ (m = same)

New Lec

Partial pressure

Individual pressure of a gas.

$$P_A = X_A \, P_t$$

mole fraction

$$P_A = \frac{n_A}{n_t} \times P_t$$

↳ Moles of gas / Moles of mixture

$P \propto n$ so

$$P_A = \frac{V_A}{V_t} \times P_t$$

Q# How much pressure is exerted by 4g H_2 & 8g of He in the mixture? Find P.P of (H)?

$P_t = 2$ atm

$$P_H = \frac{2}{4} \times P_t \quad \frac{\cancel{2}}{\cancel{4}} \times 2$$

$$P_H = 1 \text{ atm}$$

if P_t = not given → consider (1 atm)

Q# A mixture contain 5 dm^3 H_2 & 3 dm^3 O_2 at pressure of 0.5 atm. Find P.P of O_2?

3/ $P_{O_2} = \frac{3}{8} \times 0.5 \quad \frac{1.5}{8} \quad \frac{\cancel{15}}{\cancel{80}} \quad 6.3$

Fraction of total pressure:

$$P_A = X_A \times P_t$$

$$\frac{P_A}{P_t} = X_A$$

$$\frac{P_A}{P_t} = \frac{n_a}{n_t} = \frac{V_a}{V_t}$$

Q# The fraction of moles of H_2 in 4 moles total pressure at total pressure of 2 atm. 4 dm^3 of O_2

$$\frac{P_{O_2}}{P_t} = \frac{4}{6} = \frac{2}{3}$$

Total pressure

$$P_t = P_A + P_B + P_C$$

In case of Temp & Volume:

$$PV = nRT$$

$$P = \frac{nRT}{V} \qquad P = n\left(\frac{RT}{V}\right)$$

$$P_t = (n_1 + n_2 + n_3)\frac{RT}{V}$$

Ratio

$$P_A : P_B : P_C$$

$$X_A \times P_t \qquad X_B \times P_t \qquad X_C P_C$$

$$\frac{n_a}{n_t} + P_t \qquad \frac{n_B}{n_t} \times P_t \qquad \frac{n_c}{n_t} \times P_t$$

Q# What is the ratio of partial pressure of 4g H_2, 8g He & 32g CH_4 at total pressure of 2 atm?

H_2 : He : CH_4

$\frac{2}{6} \times 2 : \frac{2}{6} \times 2 : \frac{2}{6} \times 2$

$\frac{4}{6} : \frac{4}{6} : \frac{4}{6}$ $\quad \boxed{\frac{2}{3} : \frac{2}{3} : \frac{2}{3}}$

(#) Liquification of Gas

Conversion of gas into Liquid.

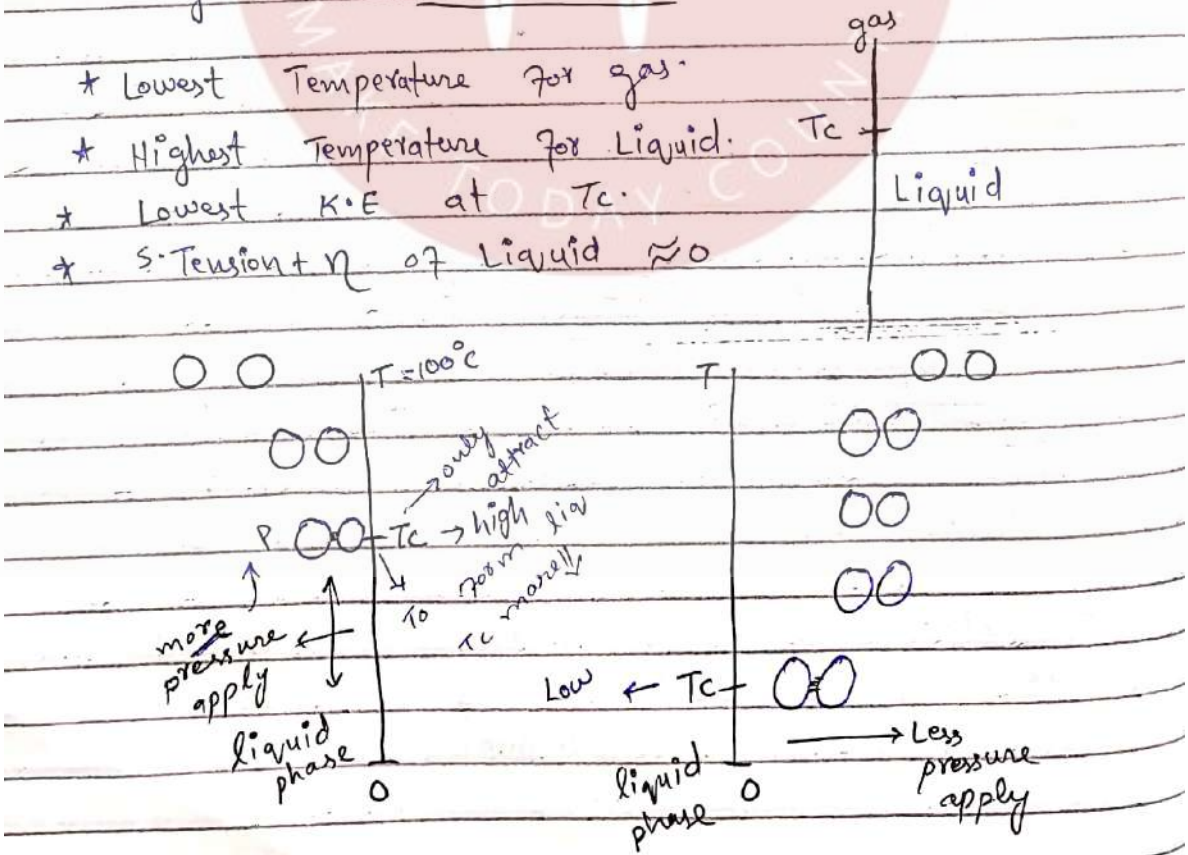
Principle:

* Low Temperature (1)
* High Pressure (2)

Critical Temperature:

* Temperature at which gases start attraction.

* Lowest Temperature for gas.
* Highest Temperature for Liquid.
* Lowest K.E at Tc.
* S.Tension + η of Liquid ≈ 0



$T_c \propto a$ $T_c \propto b$ $T_c \propto$ attraction

$T_c \propto$ deviation $T_c \propto IMF$ $T_c \propto H \cdot B$

$T_c \propto M \cdot$mass

Critical pressure

pressure applied at T_c stage called P_c. $T_c \propto P_c$

Critical Volume

Volume (at T_c is called V_c

depend on (Nature of gas)

Gas ⟶ Complete liquid

$T_c > T$ $P > P_c$

Methods: * Lind's

~~Laurd's~~ Method

* Faraday's Method * Cluad's method

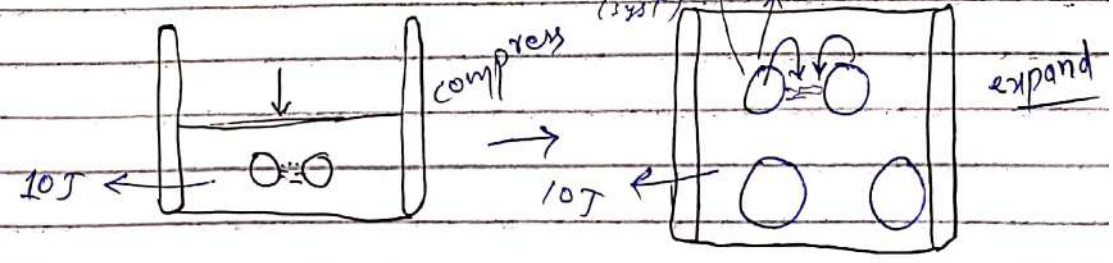
Lind's Method

* Joule thomson effect.
* Throwting effect.

use its own energy to break bond

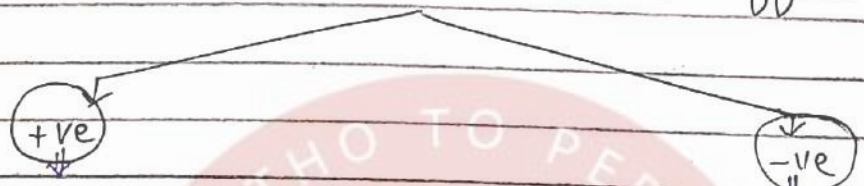
this energy ↓

not 10J (system)



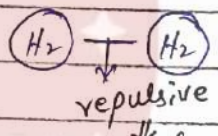
* Based on Compression & Expansion.
* Sudden process.
* Gas internal energy decrease
* Gas Temperature fall
* Adiabatic process (No change heat)
* Isoenthalpic process.

Joule Thomson effect



* gas → cools
* gas → -ve deviation
* internal energy of gas → decrease
* All gas

* gas → hot
* gas → +ve deviation



repulsive force
↓
repel → energy ↑

* internal E gas → increase
* H_2, He, Ne due to repulsive forces

Velocity of Gases

① Most probible velocity:

⇓

* The velocity that is possessed by max no. gas molecules called most probible velocity.

A^2	A^2
A^3	B^2
B^5	B^2

* May be highest or Lowest

* $V_{mp} = \sqrt{\frac{2RT}{M_{molar\ mass}}}$ $\left(V_{mp} \propto \sqrt{T}\right)$ $\left(V_{mp} \propto \frac{1}{\sqrt{M}}\right)$

② Average Velocity:

* For different gases.

$V_{avg} = \frac{V_1 + V_2 + V_3}{No.}$

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

$V_{avg} \propto \sqrt{T}$

$V_{avg} \propto \frac{1}{\sqrt{M}}$

③ Root Mean Square Velocity:

⇓

A = 2m/s	C = 5
B = 3m/s	B = 5
A = 5	B = 10
A = 4	C = 10

* For same gases (single)

$V_{RMS} = \sqrt{\frac{V_1^2 + V_2^2 + V_3^2 \cdots}{N}}$

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

$V_{RMS}^2 = \frac{V_1^2 + V_2^2 + V_3^2}{N}$

$V_{avg} : V_{RMS} : V_{mp}$

$\sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{3RT}{M}} : \sqrt{\frac{2RT}{M}}$

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

$\sqrt{2.54} : \sqrt{3} : \sqrt{2}$

$V_{RMS} > V_{avg} > V_{mp}$

Plasma

- unique state
- ⊕
- Irving Langmuire
- 1928
- in

* most abundant state of matter
* as mixture
* 1st state of matter
* shapeless

Formation:

Solid → (heat of fusion) → liquid (ionization / fusion) → gas (vaporization) → plasma (ionization)

Features:

Neutral atom + cation + free es → Neutral (Macroscopically)

charge (Microscopically)

↓

indivally

* electrical conductive.
* Magnetic properties.
* electrical " ".

Plasma

Natural
* Temperature → very high
* K.E → high
* T > 20,000°C
* Less reactive

Artificial
* Low Temperature.
* K.E → Low
* Reactive
* Disintegration.

Plasma Properties

* 99% universe made of plasma
* Neutral
* Respond to both $\vec{E}$ & $\vec{B}$
* Conduct electricity