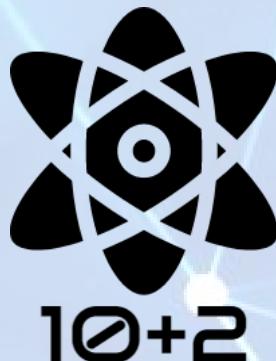


10+2 PCM NOTES

BY

JOYOSHISH SAHA

(PDF version handwritten notes of Maths, Physics and Chemistry
for 10+2 competitive exams like JEE Main, WBJEE, NEST, IISER
Entrance Exam, CUCET, AIPMT, JIPMER, EAMCET etc.)



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With best wishes from Joyoshish Saha

Gaseous State.

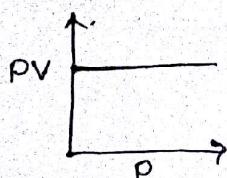
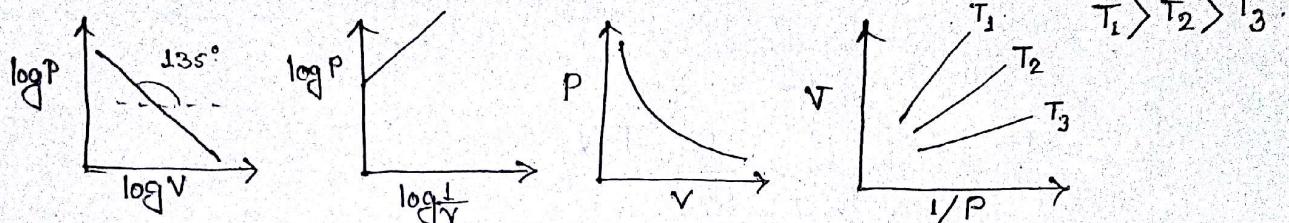
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- * Gaseous pressure measurement - manometer.
- Autorohermic pressure measurement - barometer.
- * 1 atm = 760 mmHg or torr = $1.01 \times 10^5 \text{ N/m}^2$ or Pascal.
- * STP \Rightarrow 1 atm, 298 K
- * Relative Density \rightarrow Density of gas relative to H₂ gas density.
- * Triple Point of water \rightarrow 0.0098°C & 4.58 mmHg.
- * Boyle's Law \rightarrow PV = constant (at constant T).

Differential form:

$$\left(\frac{dP}{dV} \right)_T = -\frac{k}{V^2}$$

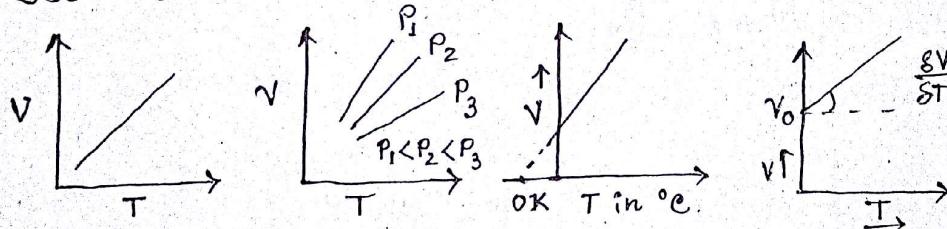
- * Isotherms -



* Charles Law: V \propto T (at constant pressure).

$dT = \text{constant}$ (m , $d \rightarrow$ density).
Not applicable for liquids.

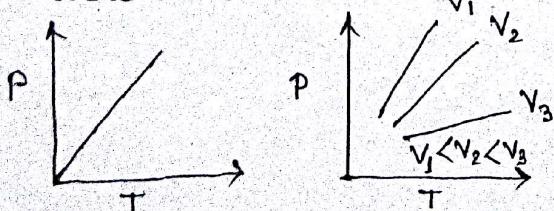
- * Isobars -



- * At absolute zero (-273.15°C) pressure, kinetic energy, heat content of gas is zero.

- * Gay Lussac's Law - P \propto T (at constant volume).

isochors -



- * Avogadro's Law:

(high temp. & low pressure)

V \propto n (cons. temp & pres., n \rightarrow No. of moles).

- * Molar Volume. At STP, 1 mole gas occupies 22.4 L

$$* N_A = 6.022 \times 10^{23}. * PV = nRT = \frac{w}{M} RT \Rightarrow P = \frac{w}{MV} RT = CRT$$

$$* R = 0.0821 \text{ L atm/mol K} = 8.314 \text{ J/mol K} = 8.314 \times 10^{-3} \text{ erg/mol K} = 2 \text{ cal/mol K}$$

Joyoshish Saha

* K (Boltzmann cons.) \rightarrow gas constant for a single molecule.
 $J = R/N_0 = 1.38 \times 10^{-23} \text{ J/deg abs/molecule}$
 $= 1.38 \times 10^{-16} \text{ erg/deg abs/molecule}$

* Dalton's Law of Partial Pressure. $P_{\text{mix}} = P_1 + P_2 + \dots$

$$P_x = \left(\frac{\text{No. of moles of } x}{\text{Total moles}} \right) \times P_{\text{mix}} \rightarrow \text{mole fraction } (x_i). \quad \begin{matrix} \text{Non-reacting} \\ \text{gases} \\ V \text{ cm litre.} \end{matrix}$$

$$P_{\text{mix}} = (n_1 + n_2 + \dots) \frac{RT}{V} = \left(\frac{m_1}{M_1} + \frac{m_2}{M_2} + \dots \right) \frac{RT}{V}$$

* Gas collected over water. $- P_{\text{moist}} = P_{\text{dry}} + P_{\text{vapour pressure of water}}$

Aqueous tension = Partial pressure of water vapour for moist gas.

* Vapour Pressure & Temperature

* Graham's Law of diffusion-

$$\text{rod } \frac{1}{\sqrt{d}} \text{ or } \frac{1}{\sqrt{M}} \text{ (at low pressure, cons. } P \propto T), \quad \frac{n_1}{n_2} = \frac{P_1}{P_2} \sqrt{\frac{M_2}{M_1}} = \frac{P_1}{P_2} \sqrt{\frac{d_2}{d_1}}.$$

$$\frac{V_1 t_2}{V_2 t_1} = \sqrt{\frac{M_2}{M_1}}. = \frac{V_1 t_2}{V_2 t_1} = \frac{d_1 t_2}{d_2 t_1} \quad [d \rightarrow \text{distance travelled for a particular gas}].$$

* KE of absolute temps.

$$PV = \frac{1}{3} mn u_{\text{rms}}^2 \quad K_F \text{ arg} = \frac{3}{2} KT$$

$$* u_{\text{arg}} = \sqrt{\frac{8RT}{TCM}} = \sqrt{\frac{8k}{TC} d} \quad u_{\text{rms}} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3k}{d}} \quad u_{\text{mp}} = \sqrt{\frac{2RT}{M}} = \sqrt{\frac{2k}{d}}. \quad \begin{matrix} \Delta n \\ N \end{matrix}$$

$$u_{\text{mp}} : u_{\text{arg}} : u_{\text{rms}} = 1 : 1.128 : 1.224. \quad u_{\text{arg}} = u_{\text{rms}} \times 0.9213.$$

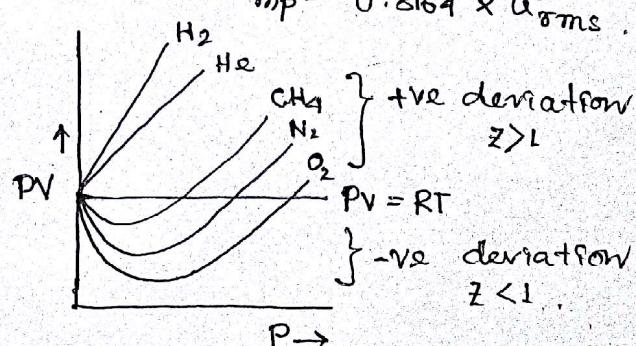
* Deviation from real gas.

Z = compressibility factor

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

$Z < 1$, gas more compressible

$Z > 1$, gas less compressible.



for $H_2, He \quad Z > 1$, as $\frac{a}{V^2} = 0, PV > RT$

at very low pressure, $\frac{a}{V^2}, b$ neglected $\Rightarrow PV \approx RT$.

at low pressure $\Rightarrow Z < 1$.

at high pressure $\Rightarrow Z > 1$.

With increase in temp. gases show decrease in deviation from ideal behaviour.

Gaseous State

C

R

* Van Der Waals Equn-

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

* at high pressure,

$$\frac{n^2 a}{V^2} \rightarrow 0 \Rightarrow PV - Pb = RT \\ \Rightarrow PV = RT + Pb \quad [\text{1 mole}].$$

* at low pressure,

$$nb \rightarrow 0, PV + \frac{a}{V} = RT$$

$$\Rightarrow PV = RT - \frac{a}{V}$$

* b shows gas molecules are incompressible.

$$b = 4N V_m = 4N \left(\frac{4}{3} \pi r^3\right). \\ (0.001 \leq b \leq 0.1)$$

* Inversion Temperature. at which gas shows neither heating or cooling effects in Joule-Thomson adiabatic expansion.

$$T_i = \frac{2a}{Rb}.$$

Below T_i , cooling

Above T_i , heating.

* Critical Temp (T_c)

$$T_c = \frac{8a}{27Rb} \quad \text{above}$$

which gas can't be liquefied with high pressure.

* Critical Volume (V_c)

$$V_c = 3b. \quad \text{Volume at } T_c, P_c$$

Volume Correction:

$$V_{\text{real}} = V - nb \xrightarrow{\substack{\text{Co-volume/} \\ \text{Excluded} \\ \text{Volume.}}}$$

Pressure Correction:

$$P_{\text{real}} = P + P'$$

$$P' \propto \frac{1}{V^2} \Rightarrow P' = \frac{n^2 a}{V^2}$$

* Unit of $a = L^2 mol^{-2}$ atm.

Unit of $b = L mol^{-1}$

* ' a ' gives magnitude of attraction force between two gas molecules.

Liquefaction $\propto a$.

$$(0.01 \leq a \leq 0.1).$$

* Boyle's Temp. (T_b) — above which real gas behaves like ideal. $T_b = a/Rb$.

Easily liquefiable gas has high T_b

* Mean Free Path: (λ)

$$\lambda \propto \frac{T}{P}. \quad \lambda = \frac{1}{\sqrt{2} \pi R T^2 n}$$

\rightarrow collision diameter.

$n \rightarrow$ no. of molecules / volume.

* Collision frequency: (Z)

(no. of collision / cc per second).

$$\frac{U_{\text{rms}}}{\lambda} = \sqrt{2} U_{\text{rms}} \pi T^2 R n$$

$$Z \propto P^2 (\text{cont}) \quad Z \propto T^{3/2} (\text{cont } P) \quad Z \propto T^{1/2} (\text{cont } P)$$

* Critical Pressure (P_c): $P_c = \frac{a}{27b^2}$ minimum pressure to liquefy any gas at T_c .

* Relation: $P_c V_c = \frac{3}{8} R T_c$.

* Liquefaction -

Liquefaction \propto intermolecular forces.

$$* PV = \frac{1}{2} M u_{rms}^2$$

$$V = \frac{M}{3P} u_{rms}^2$$

$$P = \frac{M}{3V} u_{rms}^2$$

* $b = 4 \times V_c$. ($V \rightarrow$ actual volume). Co-volume.

* Beckmann Thermometer: measurement of small difference in temp., like depression in freezing point.

$$* C_p - C_v = \frac{R}{M}$$

$$C_p - R_v = R.$$

$$g^l = \frac{C_p}{C_v}.$$

* Barometric Distribution Law: Relation between the pressure & height of the gas from the ground: $P = P_0 e^{-\frac{Mgh}{RT}}$
 ↓
 pressure at ground
 $M \rightarrow$ molecular weight.

$$d = d_0 e^{-\frac{Mgh}{RT}}$$

$$n = n_0 e^{-\frac{Mgh}{RT}}$$

logarithmic form:

$$2.303 \log \left(\frac{P}{P_0} \right) = - \frac{Mgh}{RT}$$

(all are in cgs).

* Loschmidt Number: 2.7678×10^{19}

No. of molecules present in 1 cc of gas at STP.

* Gas constant is work done per degree per mole.

* Increase in temp $\Rightarrow V_{mp}$ increases

* H₂ & He show heating effect on

adiabatic expansion (Joule-Thomson effect) because of their low T_i .

$$* V_{\text{escape}} = \sqrt{2gR}$$

* Law of corresponding

$$\text{state: } \left(P_r + \frac{3}{V_r^2} \right) (3V_r - 1) = 8T_r$$

* Amagat's Law of Partial Volume:

$$V = V_1 + V_2 + V_3 + \dots$$

* Collision frequency:

Total no. of molecules colliding per cc per second = $Z =$

No. of collisions experienced by molecules per cc per second =

$$n = \frac{TCV^2 N^2}{\sqrt{2}} \quad | \quad \tau = \tau_{\text{avg}}$$

$T =$ molecular diameter.
 $N =$ no. of molecules/cc.

* Mean free path:

avg distance travelled by a molecule between two successive collisions / second

$$\lambda = \frac{\tau}{\sqrt{2}TCV^2 N} = \frac{1}{\sqrt{2}TCV^2 N}$$

$$\lambda = \frac{KT}{\sqrt{2}TCV^2 p} \quad \left[N = \frac{P}{kT} \right]$$



* Viscosity of Gases: Internal resistance that one part of a fluid offers to the flow of another part of the fluid.
(For gases, we assume planes of fluid to be at a distance of mean free path (λ))

$$\eta = \frac{S}{16\pi^2} \left(\frac{\pi k T}{m} \right)^{1/2} \quad \left\{ \text{where } S \rightarrow \text{diameter } d \text{ and mass } m \text{ of the molecule} \right\}$$

$\frac{1}{\eta} \rightarrow$ fluidity. | unit \rightarrow poise (dyne cm⁻².s). (CGS)
Pascal second (SI)

Viscosity increases with increase of temperature.

* Molar heat capacity (of Ideal gas):

$$C_p - C_v = R \approx 2 \text{ cal.}$$

$$C_p \text{ (calories)} \quad C_v \text{ (m cal)} \quad \gamma$$

monoatomic	5	3	1.67
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diatomic	7	5	1.40
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triatomic	8	6	1.33
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* Adsorption of gases on solid:

(van der waals force or valence forces).

x/m of gas is adsorbed in mg solid,

$$\frac{x}{m} \propto p \text{ at low } p.$$

$$\frac{x}{m} \propto p^0 \text{ at high } p.$$

$$\frac{x}{m} = K p^n$$

$$\frac{x}{m} = K C^n$$

(pressure concentration). Freundlich Adsorption Isotherm

$$\Rightarrow \log \frac{x}{m} = n \log p + \log K$$

