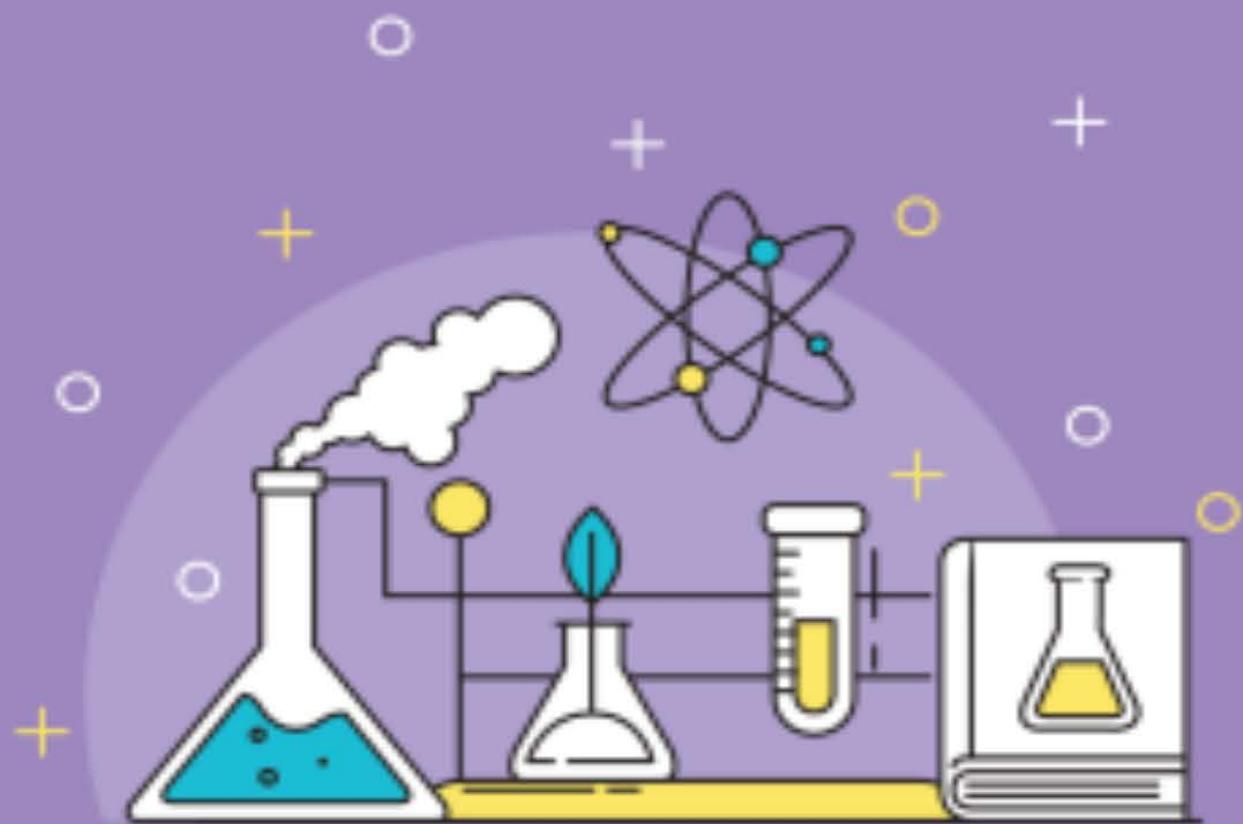


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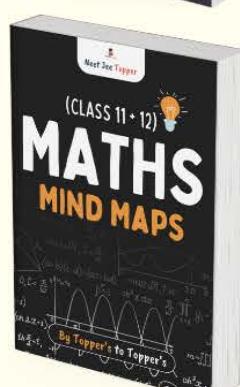
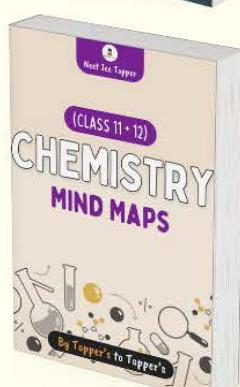
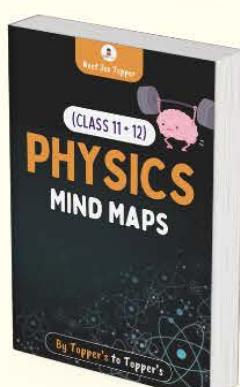
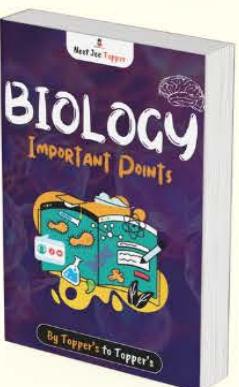
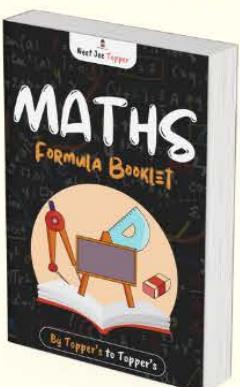
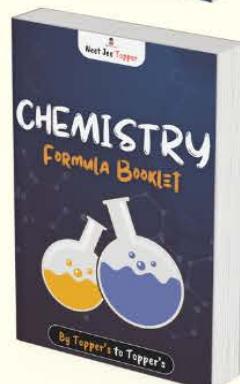
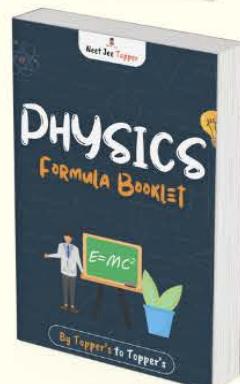
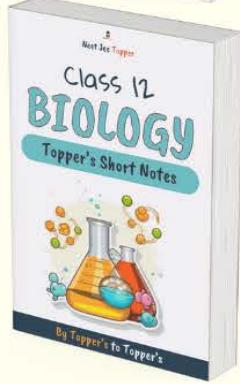
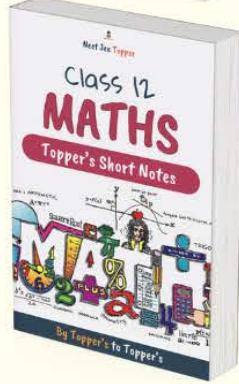
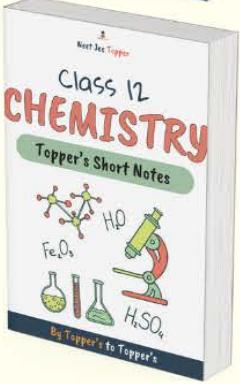
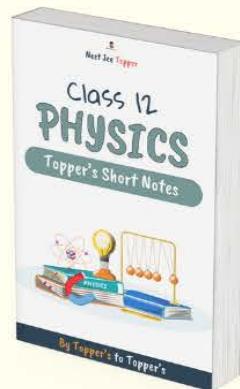
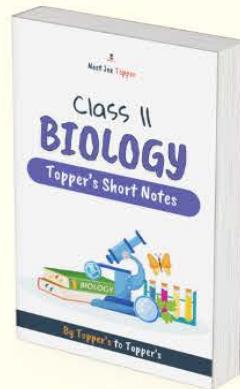
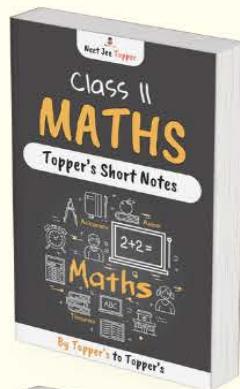
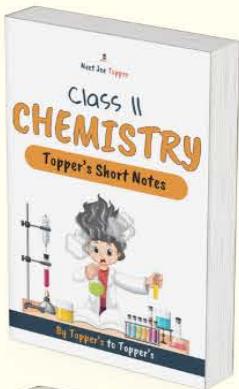
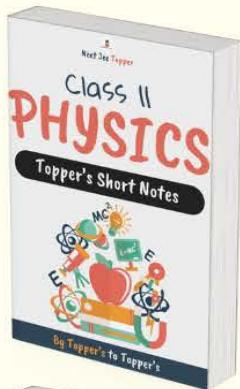
PHYSICAL CHEMISTRY

Formula Booklet



AirJeeNeet

Topper's Notes



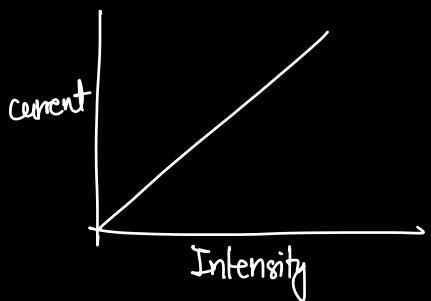
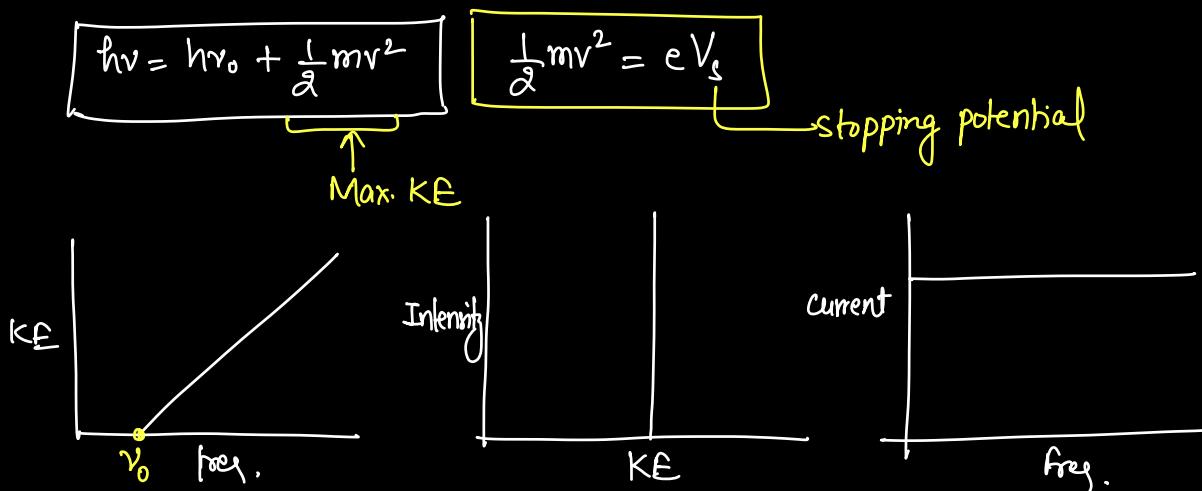
What You will Get:

- Class 11 + 12 (Air 1,16,32) Handwritten Notes**
- DPP's + PYQ's According to Your Exam!**
- Sample Papers + Mock Tests**
- Formula Booklets and High Quality Mind Maps**
- Mentorship Support***

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1. Atomic Structure

- distance of closest approach , $R = \frac{4kZe^2}{m_\alpha v_\alpha^2}$ rel. of approaching α -particle
- Photoelectric effect



- Quantum theory , $E = h\nu = \frac{hc}{\lambda}$ only for E.M. waves.
- De Broglie's equation , $\lambda = \frac{h}{mv}$ — applicable for matter waves
- Bohr's model

$$mv\tau = \frac{n\hbar}{2\pi} \quad \text{Quantisation of angular momentum}$$

$$E_n = -13.6 \frac{Z^2}{n^2} \text{ eV/atom}$$

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

$$r_n = \frac{n^2 a_0}{Z}$$

$a_0 = 0.529 \text{ \AA} \quad (\text{Bohr's radius})$

$\therefore r \propto \frac{n^2}{Z}, \text{ vel.} \propto \frac{Z}{n}$

for Hydrogen

$$\text{freq.} = \frac{1}{\text{Time}}$$

$$\text{vel.} = \frac{\text{dist}}{\text{Time}} \Rightarrow \text{time} = \frac{r}{v} = \frac{n^2/Z}{Z/n}$$

$$\text{freq.} \propto \frac{Z^2}{n^2}$$

$$\therefore \text{time} \propto \frac{n^3}{Z^2}$$

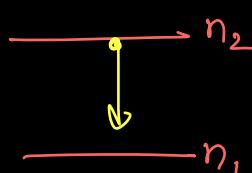
- * When a charged particle (q) is accelerated by V potential
Gain in KE = Work done

$$\frac{1}{2}mv^2 = qV$$

* For spectral lines

$$\frac{1}{\lambda} = RZ^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

↓ ↓
lower higher



Lyman, $n \rightarrow 1$ - UV
Balmer, $n \rightarrow 2$ - visible
Paschen, $n \rightarrow 3$
Brackett, $n \rightarrow 4$
P-fund, $n \rightarrow 5$

IR

$$R = 109678 \text{ cm}^{-1} \quad (\text{Rydberg's const})$$

- * $n \rightarrow 1$ No. of spectral lines = $\frac{n(n-1)}{2}$

$$\Delta x \cdot \Delta p \geq \frac{\hbar}{4\pi}$$

$$\Delta E \cdot \Delta t \geq \frac{\hbar}{4\pi}$$

Quantum Numbers

- Orbital angular momentum, $L = \sqrt{l(l+1)} \frac{\hbar}{2\pi}$
- spin moment , $\sqrt{n(n+2)} \frac{\hbar}{2\pi}$
- Max. orbitals in a subshell = $2l+1$
- Max e^- = $2(2l+1)$

Mole Concept

$$\text{specific gravity} = \frac{\text{density of substance}}{\text{density of water at } 4^\circ\text{C}}$$

$$V.D = \frac{\text{Mol. wt}}{2}$$

$$\text{Mole} = \frac{\text{Given wt}}{\text{At or Mol.wt}} = \frac{\text{Given vol. of gas}}{\text{Molar vol. of gas}} = \frac{\text{No. of particles}}{N_A}$$

$$\text{Molarity} = \frac{\text{no. of moles of solute}}{\text{vol. of solution (L)}}$$

$$\text{molality} = \frac{\text{moles of solute}}{\text{wt of solvent (kg)}}$$

→ Temp. independent

$$\text{Mole fraction} = \frac{\text{moles of solute}}{\text{Total moles}}$$

$$\% \text{ by mass or w/w \%} = \frac{\text{wt of solute (gm)}}{\text{wt of solution (gm)}} \times 100$$

$$\% \text{ by vol. or v/v \%} = \frac{\text{vol. of solute (ml)}}{\text{vol. of solution (ml)}} \times 100$$

$$\begin{aligned} \text{ppm} &= \frac{\text{solute particle}}{\text{Total part}} \times 10^6 \\ &= \frac{\text{solute mass}}{\text{Total mass}} \times 10^6 \\ &= \frac{\text{solute vol}}{\text{Total vol}} \times 10^6 \end{aligned}$$

$$\% \text{ w/v} = \frac{\text{wt of solute}}{\text{vol. of solution}} \times 100$$

* Molarity = moles of solute in 1000 ml | wt of 1000 ml = 1000d

$$m = \frac{M \times 1000}{1000d - MW}$$

$$\text{Eq. wt} = \frac{\text{At or Mol. wt}}{n\text{-factor}}$$

n-factor for elements = valency

for salt = cationic or anionic charge

for acids = basicity (H⁺ it can give per molecule)

for bases = acidity (H⁺ gain)

$$\text{Normality} = n\text{-factor} \times \text{Molarity}$$

$$\text{No. of Eq} = n\text{-factor} \times \text{no. of moles}$$

* Dilution → amt. of solute is conserved

moles before dilution = moles after dilution

$$M_1 V_1 = M_2 V_2$$

$$\% \text{ of any component} = \frac{\text{wt of component}}{\text{Mol. wt}} \times 100$$

$$\text{Hardness of water in ppm} = \frac{\text{mass of CaCO}_3}{\text{Total mass of water}} \times 10^6$$

* Vol. strength of H_2O_2

$$\text{Normality of } H_2O_2 (N) = \frac{\text{Vol. strength of } H_2O_2}{5.6}$$

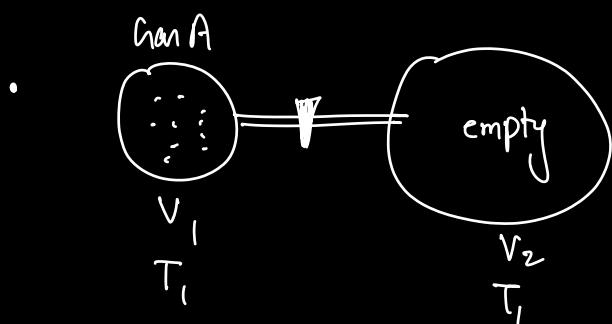
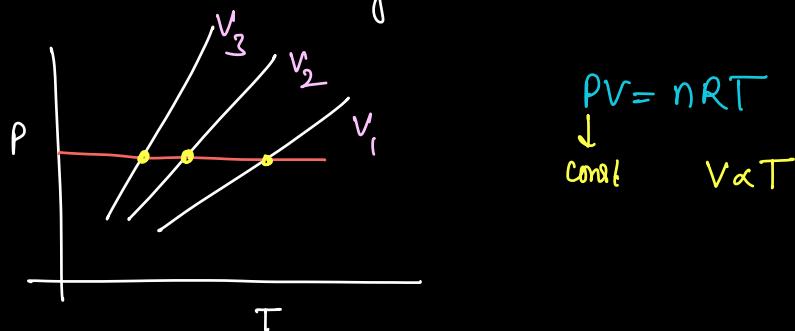
$$\text{Molarity of } H_2O_2 (M) = \frac{\text{Vol. strength of } H_2O_2}{11.2}$$

Gaseous State

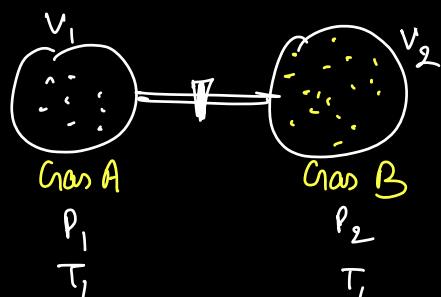
- $PV = nRT$
- $P = \text{const} \rightarrow \text{Charles's law}, V \propto T$
- $T = \text{const} \rightarrow \text{Boyle's law}, P \propto \frac{1}{V}$
- same $P, T \rightarrow \text{Avogadro's law}, V \propto n$
- $V = \text{const} \rightarrow \text{Gay Lussac's law}, P \propto T$

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

$$V_1 > V_2 > V_3$$

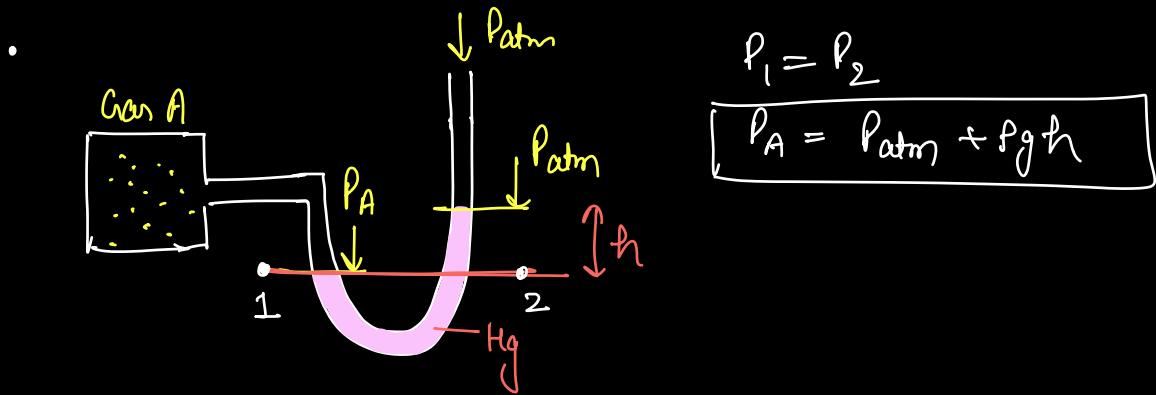


only vol. is \uparrow and $T = \text{const}$
 $\therefore P \propto \frac{1}{V}$ or $P_1V_1 = P_2V_2$



when valve is opened
moles of Gas one conserved

$$\frac{P_1V_1}{RT_1} + \frac{P_2V_2}{RT_1} = \frac{P(V_1 + V_2)}{RT_1}$$



- Dalton's law:

$$\boxed{A + B + C}$$

$$\boxed{P_A V = n_A R T}$$

$$\boxed{P_{\text{Total}} = P_A + P_B + P_C}$$

$$\therefore P_A = P_{\text{Total}} \cdot X_A$$

- Graham's Law

$$\text{Rate of effusion} \propto \frac{P_A}{\sqrt{T M}} \quad \begin{array}{l} \text{Press. of gas} \\ \text{area of cross-section of hole} \\ \rightarrow \text{Mol. wt. of gas} \\ \text{Temp.} \end{array}$$

$$\text{Rate}_A = \frac{\text{vol. of gas escaped}}{\text{Time taken}} = \frac{\text{mass escaped}}{\text{Time taken}} = \frac{\text{dist travelled}}{\text{Time taken}}$$

* KTG

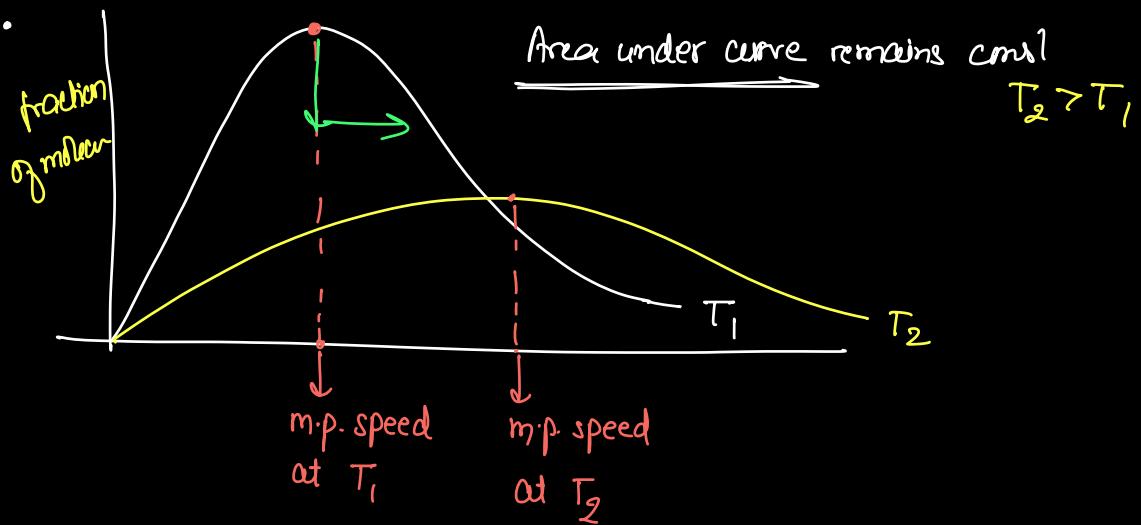
$$\frac{1}{2} m v^2 \propto \text{abs. temp}$$

$$\boxed{V^2 \propto T}$$

$$V \propto \sqrt{T}$$

$$\bullet \boxed{U_{\text{mp}} : U_{\text{avg}} : U_{\text{rms}} = \sqrt{\frac{2RT}{M}} : \sqrt{\frac{8RT}{NM}} : \sqrt{\frac{3RT}{M}}} \\ | : 1.128 : 1.224$$

$$\bullet \text{Avg KE per mole} = \frac{3}{2} RT, \quad \text{Avg KE per particle} = \frac{3}{2} kT$$



- $P_{\text{id}} \cdot V_{\text{id}} = nRT$

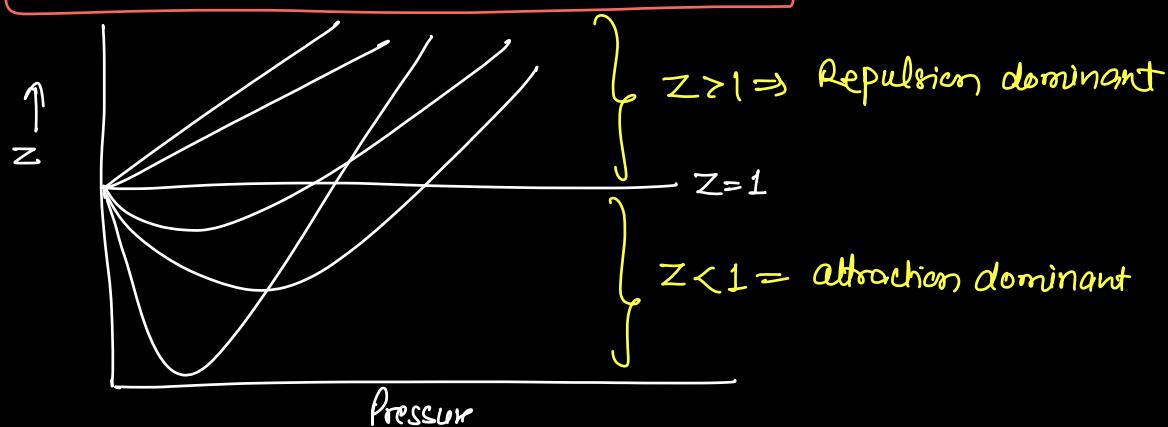
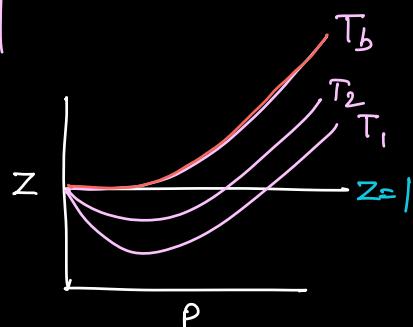
$$\left(P_{\text{real}} + \frac{n^2 a}{V^2} \right) (V_{\text{real}} - nb) = nRT$$

$\underbrace{P_{\text{id}}}_{\text{P}_{\text{id}}} \quad \underbrace{V_{\text{id}}}_{\text{V}_{\text{id}}} = nRT$

— Van der Waals Equation

- $Z = \text{compressibility factor} = \frac{V_{\text{Real}}}{V_{\text{ideal}}} = \frac{P_{\text{id}} \cdot V_{\text{Real}}}{RT}$

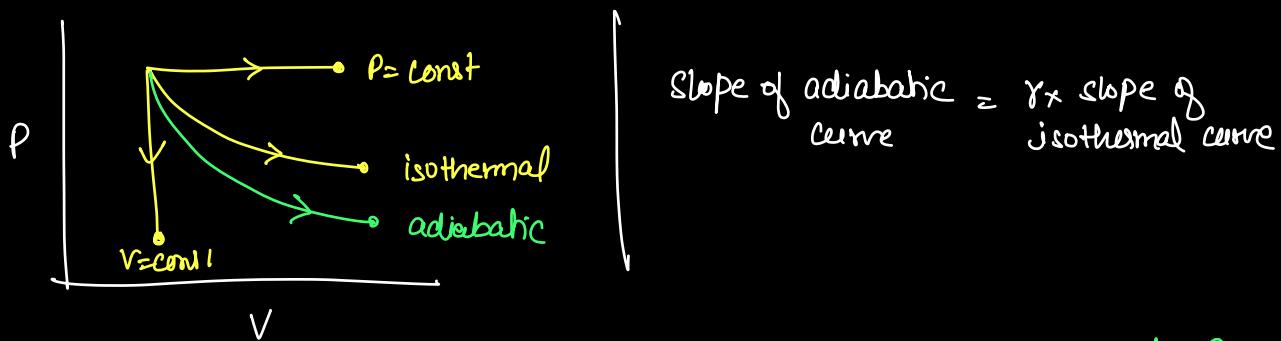
- $T_B = \frac{a}{Rb} = \text{Boyle's Temp.}$, $T_i = \frac{2a}{Rb}$
 $T_C = \frac{8a}{27Rb}$, $P_C = \frac{a}{27b^2}$, $V_C = 3b$



Thermodynamics

→ applications
→ limitations

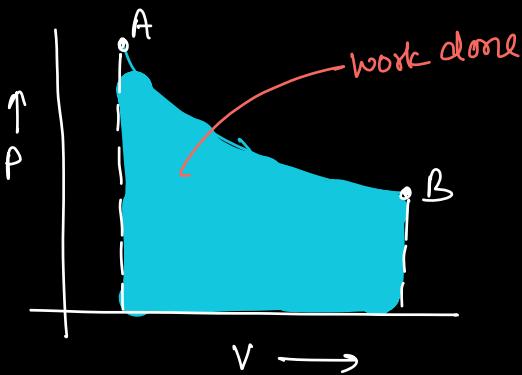
- Isothermal process, $T = \text{const}$, $dT = 0$, $\Delta T = 0$
- Isobaric " , $P = \text{const}$, $dP = 0$, $\Delta P = 0$
- Isochoric " , $V = \text{const}$, $dV = 0$, $\Delta V = 0$
- Adiabatic " , $q = 0$ (Entropy is const in rev. adiabatic process)



- FLOT : $\rightarrow dU = dq + dw$ → Not applicable for phase change
- $$\boxed{\Delta U = nC_V \Delta T}$$
- $$\boxed{\Delta H = nC_P \Delta T}$$
- $$; C_P - C_V = R$$
- $$; \left(\frac{\partial U}{\partial V} \right)_T = \left(\frac{\partial U}{\partial P} \right)_T = 0$$
- I.E. of ideal gas depends only on temp.

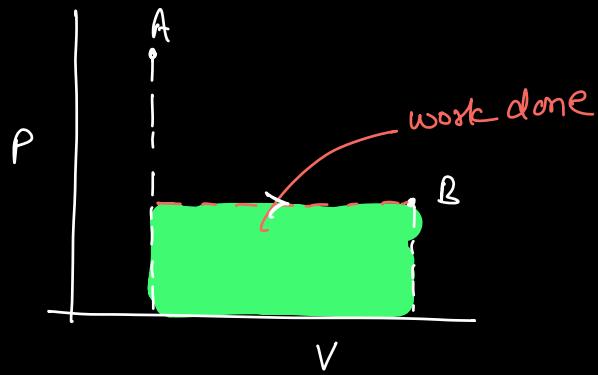
$$\boxed{W_{\text{Rev Iso}} = -2.303 nRT \log \frac{V_2}{V_1} = -2.303 nRT \log \frac{P_1}{P_2}}$$

$$\boxed{W_{\text{IRR.Iso}} = -P \Delta V}$$



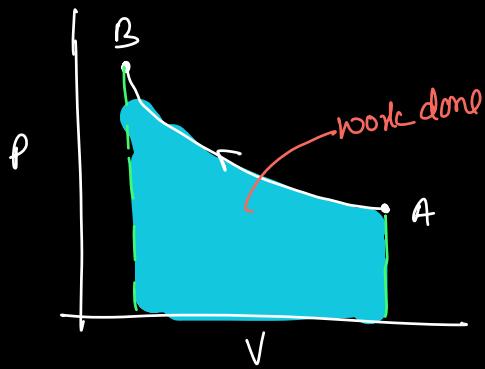
Rev. isothermal expansion

$$W_{\text{rev. exp.}} = -ve$$

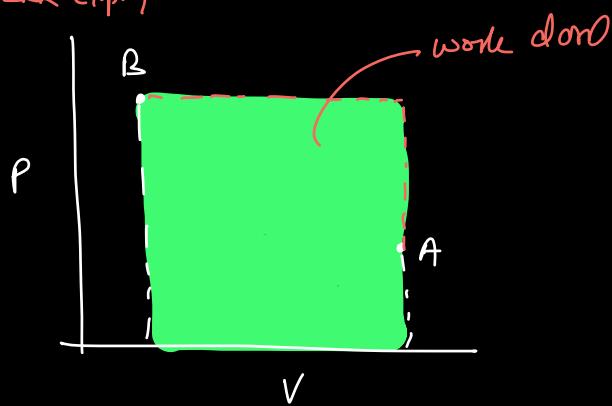


IRR. Iso. Expansion

$$|W_{\text{Rev. exp.}}| > |W_{\text{IRR. exp.}}|$$



Rev. iso compression



IRR. iso compression

$$W_{\text{IRR. comp.}} > W_{\text{Rev. comp.}}$$

- $W_{\text{(isochoric)}} = -P_{\text{ext}} \Delta V = 0$

$$W_{\text{(Isobaric)}} = -P_{\text{ext}} \Delta V$$

- Adiabatic Process

(a) Rev. adiabatic

$$PV^r = \text{const}$$

$$TV^{r-1} = \text{const}$$

$$T^r P^{1-r} = \text{const}$$

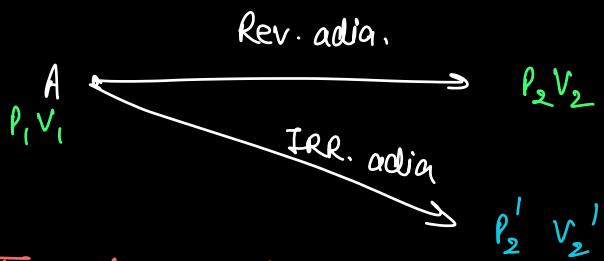
(b) IRR. adiabatic

- $W = \Delta U = n C_v \Delta T$

$$= \frac{n R (T_2 - T_1)}{r-1}$$

$$= \frac{P_2 V_2 - P_1 V_1}{r-1}$$

$$\begin{aligned} W &= \Delta U = nC_V \Delta T \\ &= \frac{nR(T_2 - T_1)}{\gamma - 1} \\ &= \frac{P_2 V_2 - P_1 V_1}{\gamma - 1} \end{aligned}$$



* $T_{\text{final}} (\text{Rev. adia}) < T_{\text{final}} (\text{IRR. adia})$

* Enthalpy \Rightarrow heat exchange at const pressure

$$\begin{aligned} \Delta H &= \Delta U + \Delta(PV) = \Delta U + P\Delta V + V\Delta P \\ &= \Delta U + \Delta n g RT \\ &= \Delta U + nR\Delta T \\ &= nC_p \Delta T \end{aligned}$$

ΔU = heat exchange at const volume

* $dS = \frac{dq_{\text{rev}}}{T}$: $\Delta S_{\text{vap}} = \frac{\Delta H_{\text{vap}}}{T_{\text{B.P.}}}$, $\Delta S_{\text{fusion}} = \frac{\Delta H_{\text{fusion}}}{T_{\text{F.P.}}}$

$$\boxed{\Delta S_{\text{sys}} = nC_V \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1}}$$

- For Isothermal : $\Delta S = nR \ln \frac{V_2}{V_1}$ or $nR \ln \frac{P_1}{P_2}$
- Adiabatic ; $\Delta S_{\text{sys}} = 0$; $\Delta S_{\text{sur}} = 0$ (Rev. adiabatic)
 $\Delta S_{\text{sys}} = 0$; $\Delta S_{\text{sur}} > 0$ (IRR. adiabatic)
- Isobaric : $\Delta S = nC_p \ln \frac{V_2}{V_1}$
- Isochoric : $\Delta S = nC_V \ln \left(\frac{P_2}{P_1} \right)$

$$G_i \equiv U + PV - TS = H - TS$$

$$\Delta G = \Delta G_i - T\Delta S - S\Delta T$$

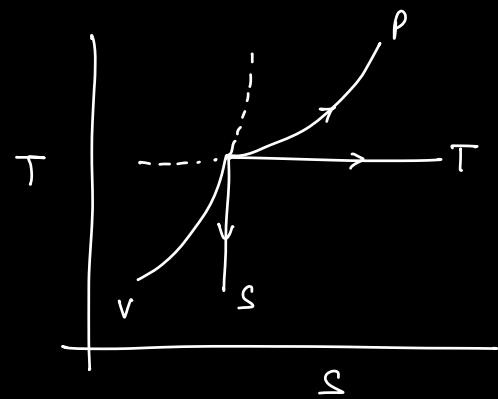
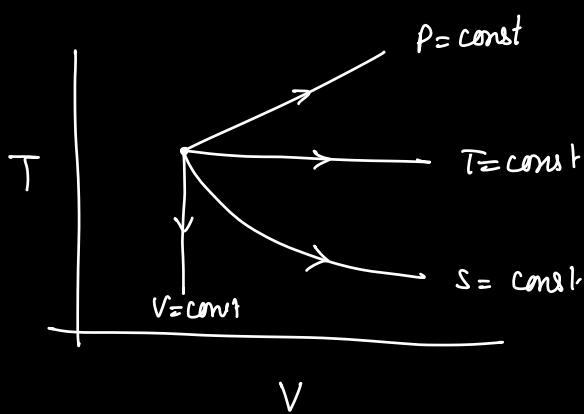
$$dG = VdP - SdT \quad \text{for a closed system}$$

$$\begin{cases} \rightarrow T = \text{const} \\ \rightarrow P = \text{const} \end{cases}, \quad dG = VdP \Rightarrow V = \left(\frac{\partial G}{\partial P}\right)_T$$

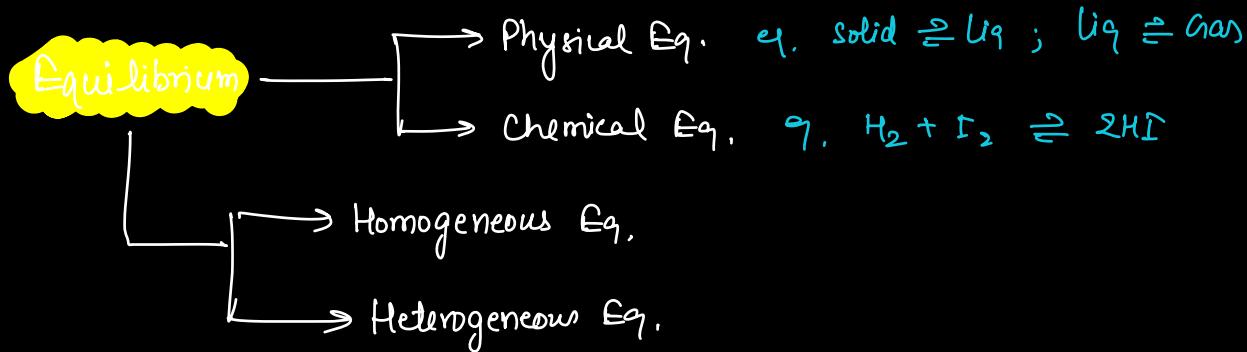
$$dG = -SdT \Rightarrow S = -\left(\frac{\partial G}{\partial T}\right)_P$$

$$\Delta G_{\text{sys}} = -T\Delta S_{\text{univ.}}$$

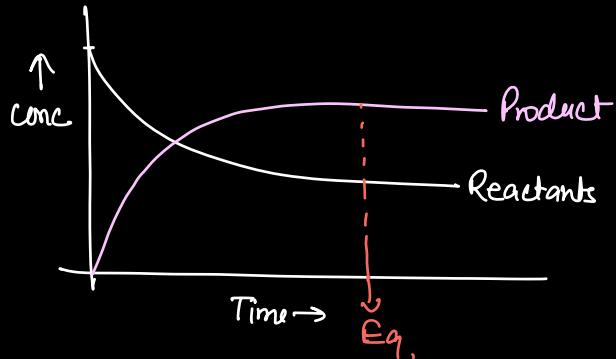
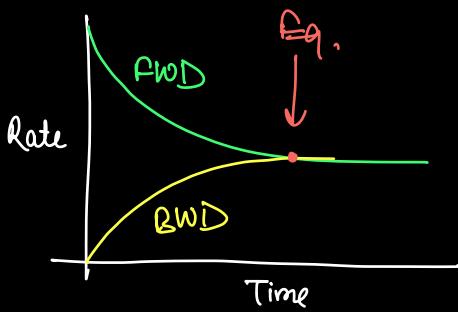
$$\Delta G = \Delta G_i + 2.303RT \log Q$$



Chemical Equilibrium



at Eq. $R_f = R_b$ and $Q = \frac{[C]^c [D]^d}{[A]^a [B]^b}$ $Q = K_{eq}$ at Eq.



- $\Delta G = \Delta G^\circ + 2.303 RT \log Q$

↓
zero
at Eq.

↓
 K_{eq} .

- $\therefore \Delta G^\circ = -2.303 RT \log K_{eq}$.

- $K_p = K_c (RT)^{\text{ong}}$

$K_p = K_c \cdot P^{\text{ong}}$

Total Pressure

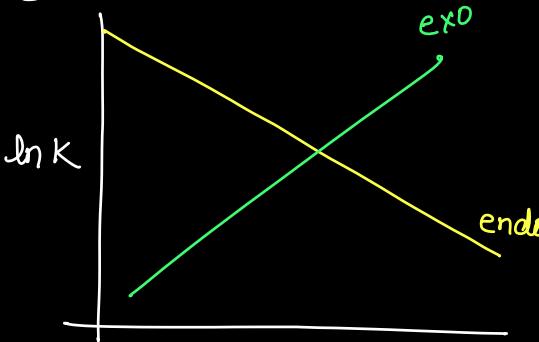
Run goes FWD Run goes BWD

$Q < K_{eq}$. $Q > K_{eq}$.

$\therefore Q = K_{eq}$.

- Magnitude of K_{eq} →
 - High ($> 10^3$) \Rightarrow [Product] \gg [Reactant]
 - Low ($< 10^{-3}$) \Rightarrow [Reactant] \gg [Product]

- Key.** → doesn't depend on conc. of reactants, products.
 presence or absence of catalyst
 pressure
 volume

depends on temp. only
- $$\ln\left(\frac{K_2}{k_1}\right) = \frac{\Delta H^\circ}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

- $$\ln K = \frac{-\Delta H^\circ}{RT} + \text{const}$$

$$y = mx + c$$

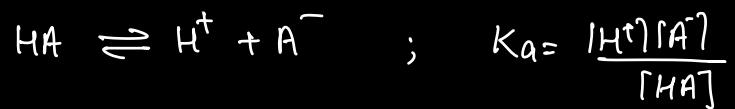
$\text{slope} = -\frac{\Delta H^\circ}{R}$
 when $\Delta H = +ve$; $-ve$ slope
 $\Delta H = -ve$; $+ve$ slope
- $$\frac{D}{d} = 1 + (n-1)\alpha$$

$D = \text{v.D. before dissociation}$
 $d = \text{v.D. after dissociation}$

$$A_n(g) \rightleftharpoons nA(g)$$

Ionic Equilibrium

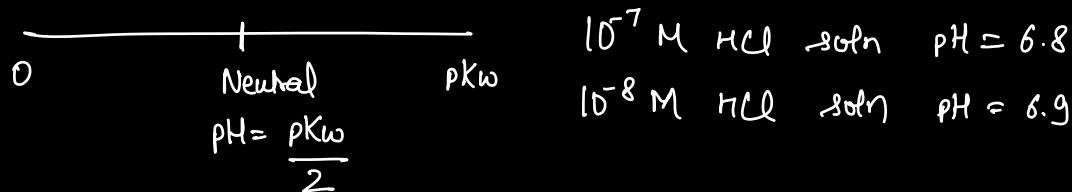
- Ostwald dilution law (only for weak electrolytes)



$$\alpha = \sqrt{\frac{K_a}{C}} \quad (\text{only if } \alpha < 0.1)$$

- $pH = -\log [H^+] \rightarrow 10^{-3} M \text{ HCl soln} \quad pH = 3$

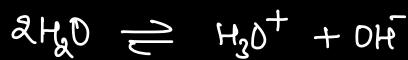
$$10^{-5} M \text{ HCl soln} \quad pH = 5$$



If $K_w = 10^{-14}$, $pK_w = 14 \Rightarrow \text{Neutral point} = 7$

$$K_w = 10^{-12}, \quad pK_w = 12 \Rightarrow \text{..} = 6$$

- Absolute dissociation const of water



$$K_a = K_b = \frac{[H^+][OH^-]}{[H_2O]} = \frac{10^{-7} \times 10^{-7}}{55.55} = 1.8 \times 10^{-14} \quad \text{at } 298K$$

$$K_w = \text{ionic product of water} = [H^+][OH^-] = 10^{-14} \quad \text{at } 298K$$

$$K_a \cdot K_b = K_w$$

$$pK_a + pK_b = pK_w = 14 \quad \text{at } 298K$$

- **pH calculation**

→ Mix. of 2 strong acids = $\frac{\text{Total mole } H^+}{\text{volume}} = \frac{N_1V_1 + N_2V_2}{V_1 + V_2} = \text{conc. of } H^+$

2 strong bases = $\frac{\text{Total mole } OH^-}{\text{volume}} = \frac{N_1V_1 + N_2V_2}{V_1 + V_2} = \text{conc. of } OH^-$

↳ Mix. of an acid + base (strong)

$$\text{if Eq. of acid } (N_1V_1) > \text{Eq. of base } (N_2V_2) \Rightarrow \frac{N_1V_1 - N_2V_2}{V_1 + V_2} = [H^+]$$

$$\text{Eq. of base } (N_2V_2) > \text{Eq. of acid } (N_1V_1)$$

$$\Leftrightarrow \frac{N_2V_2 - N_1V_1}{V_1 + V_2} = [OH^-]$$

↳ pH of a weak monoprotic acid (HA)

$$HA \rightleftharpoons H^+ + A^- ; K_a , \alpha = \sqrt{\frac{K_a}{C}}$$

$$[H^+] = C\alpha = \sqrt{K_a \cdot C} \Rightarrow \text{pH} = \frac{1}{2}(pK_a - \log C)$$

↳ pH of a soln. of polyprotic acid (H_2A)

$$\text{pH} = \frac{1}{2}(pK_{a_1} - \log C)$$

- Salt Hydrolysis \Rightarrow ions of strong species don't undergo hydrolysis

Salt of	Type of Hyd.	K_h	\bar{h}	pH
WA + SB	Anionic hyd.	$\frac{K_w}{K_a}$	$\sqrt{\frac{K_w}{K_a \cdot C}}$	$7 + \frac{pK_a}{2} + \frac{\log C}{2}$
SA + WB	Cationic hyd.	$\frac{K_w}{K_b}$	$\sqrt{\frac{K_w}{K_b \cdot C}}$	$7 - \frac{pK_b}{2} - \frac{\log C}{2}$
WA + WB	both	$\frac{K_w}{K_a \cdot K_b}$	$\sqrt{\frac{K_w}{K_a \cdot K_b}}$	$7 + \frac{pK_a}{2} - \frac{pK_b}{2}$
SA + SB	don't undergo hydrolysis			pH = 7

- Buffer solution → Resists change in pH

[acidic buffer wA + salt with sB
 Basic buffer wB + salt with sA

$$pH = pK_a + \log \frac{[salt]}{[acid]}$$

$$pOH = pK_b + \log \frac{[salt]}{[Base]}$$

- Indicators



$$pH = pK_{HIn} + \log \frac{[In^-]}{[HIn]}$$

- Titration with HCl

Phenolphthalein

NaOH 100% Rxn is indicated
 (SB)
 $NaOH + HCl \rightarrow NaCl + H_2O$

Methyl Orange

100% Rxn is indicated
 $NaOH + HCl \rightarrow NaCl + H_2O$

Na_2CO_3 50% rxn upto $NaHCO_3$
 (WB) stage is indicated
 $Na_2CO_3 + HCl \rightarrow NaHCO_3 + NaCl$

100% rxn is indicated
 $Na_2CO_3 + 2HCl \rightarrow H_2CO_3 + 2NaCl$

$NaHCO_3$ No Rxn indicated

100% rxn is indicated

- Isoelectric Point ⇒

$$pI = \frac{pK_a_1 + pK_a_2}{2}$$

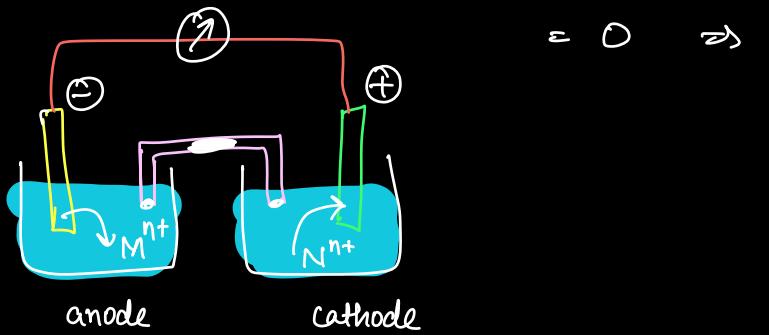
Electrochemistry

- anode half || cathode half

$$E_{\text{cell}} = E_{\text{RHS}} - E_{\text{LHS}} = +ve \Rightarrow \text{cell is spontaneous}$$

$$= -ve \Rightarrow " " \text{ non-spontaneous}$$

$$= 0 \Rightarrow \text{Equilibrium}$$



- $\boxed{\text{SRP value} \propto \text{Ox. Power}}$
 $\boxed{\text{SOP value} \propto \text{Red. Power}}$

- $\Delta G_i = -nFE_{\text{cell}}$

$$\Delta G_i = \Delta G_i^\circ + 2.303 RT \log Q$$

$$-nFE = -nFE^\circ + 2.303 RT \log Q$$

$$\boxed{E = E^\circ - \frac{2.303 RT}{nF} \log Q} \rightarrow \text{ensure you have balanced the given cell equation.}$$

\downarrow

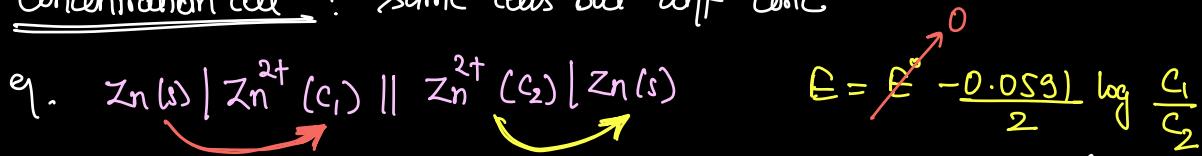
no. of e^- participating in balanced eqn.



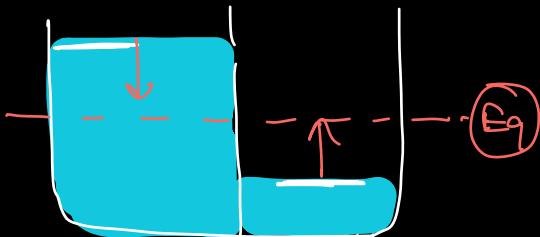
$$Q = \frac{[X^{2+}]}{[M^{2+}]}$$

$$\boxed{E_{\text{cell}}^\circ = \frac{0.0591}{n} \log K_{\text{eq}}}.$$

- Concentration cell: same cells but diff conc



$E_{cell} > 0$ if $c_2 > c_1$



$$E = \frac{0.0591}{2} \log \left(\frac{c_2}{c_1} \right)$$

- Metal-Metal insoluble salt electrode

$$E_{Cu^+|AgCl|Ag} = E^\circ_{Cu^+|AgCl|Ag} - 0.0591 \log [Cl^-]$$

$dG = VdP - SdT$

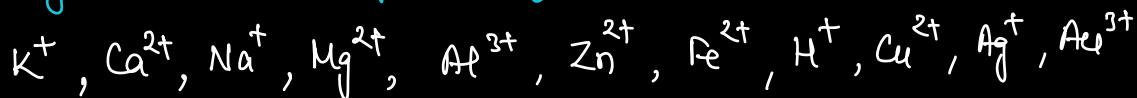
at const P, $dG = -SdT \Rightarrow S = -\left(\frac{\partial G}{\partial T}\right)_P$

$$\Delta S = - \left[\frac{d(AG)}{dT} \right]_P = \left[nF \left(\frac{dE_{cell}}{dT} \right) \right]_P$$

temp coefficient

- Electrolysis → Non-spontaneous

- higher SRP → deposited first



Increasing order of deposition

increasing SRP

- Faraday's law

- 1 Faraday deposits 1 Equivalent



$$W = Zit = \frac{Eit}{96500}$$

$$E = Eq. wt$$

i = current in Amp.

t = time in sec

- When cells are connected in series, same amt. of charge flows through them

$$\frac{Q}{J}$$

Eq. deposited are same in all connected cells.

- Conductance = $\frac{1}{\text{Resistance}}$

$$R = \rho \frac{l}{A} \quad , \quad \frac{1}{\rho} = \frac{l}{A} \cdot \frac{1}{R}$$

$K = \text{cell const.} \cdot \frac{1}{R}$

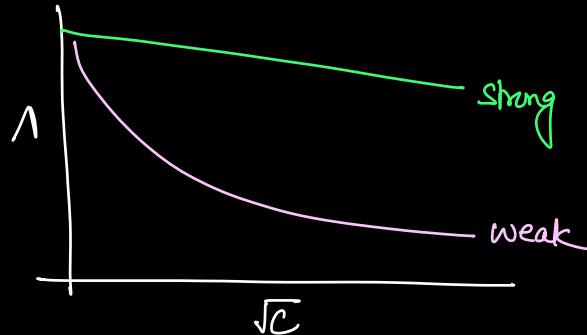
$K = \text{sp. conductance}$
 $K \downarrow \text{on dilution}$
 $\downarrow \text{S cm}^{-1} \text{ or } \text{Sm}^{-1}$

- $\Lambda_m = \frac{\kappa \times 1000}{\text{Molarity}}$; $\Lambda_{eq} = \frac{\kappa \times 1000}{\text{Normality}}$

- Kohlrausch's law

$$\Lambda_m = \Lambda_m^\infty - b\sqrt{C}$$

$\Lambda_m \uparrow \text{on dilution}$



- for an electrolyte

$$\Lambda_\infty = n_+ \Lambda_+^\infty + n_- \Lambda_-^\infty$$

e.g. $K_2SO_4 \Rightarrow \Lambda_m^\infty = 2\Lambda_m^\infty(K^+) + \Lambda_m^\infty(SO_4^{2-})$ (Molar conductivity)

$$\Lambda_{eq}^\infty = \Lambda_{eq}^\infty(K^+) + \Lambda_{eq}^\infty(SO_4^{2-})$$

- $\alpha = \frac{\Lambda_m^c}{\Lambda_m^\infty}$

Solutions & Colligative Properties

Homogeneous mix.

Solubility → Nature of solute & solvent

Temp.

Pressure (for gaseous solute)

Solubility ↑ with T ↑ if $\Delta H = +ve$
↓ with T ↑ if $\Delta H = -ve$

- Henry's law

$$P_{\text{gas}} = K_H \chi$$

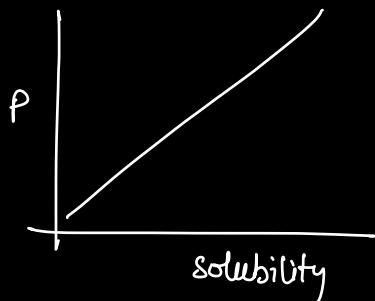
$$\chi = K'_H P$$

$$P \propto \chi$$

$$K_H \propto \frac{1}{\text{solubility}}$$

$$\text{solubility} \propto \frac{1}{\text{Temp.}}$$

Gases



- V.P. is independent of
 - amt. of substance
 - surface area
 - shape of vessel

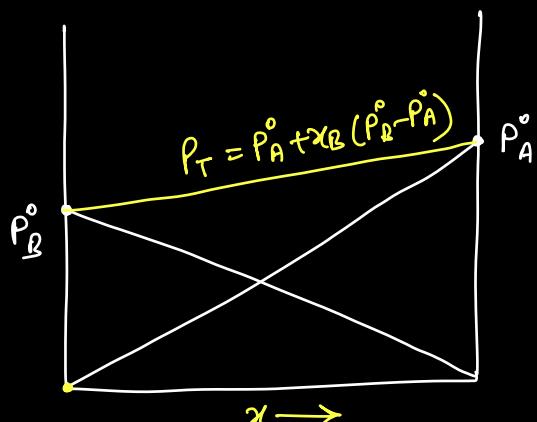
depends on
Temp. only

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

- Raoult's law → V.P. of solution

$$P_A = P_A^o \chi_A, \quad P_B = P_B^o \chi_B$$

$$P_{\text{total}} = P_A + P_B = P_A^o + \chi_B (P_B^o - P_A^o)$$



Solution \rightarrow obey Raoult's law \rightarrow ideal solutions

\rightarrow Do not obey \rightarrow Non-ideal \rightarrow +ve deviation

-ve deviation

Ideal soln

$$\Delta H_{\text{mix}} = 0, \Delta V_{\text{mix}} = 0$$

$$\Delta G_{\text{mix}} = -\text{ve}, \Delta S_{\text{mix}} = +\text{ve}$$

$\left. \begin{array}{c} A-A \\ A-B \\ B-B \end{array} \right\}$ equivalent attraction

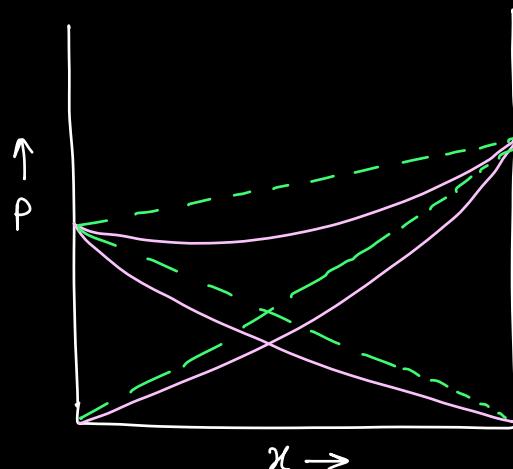
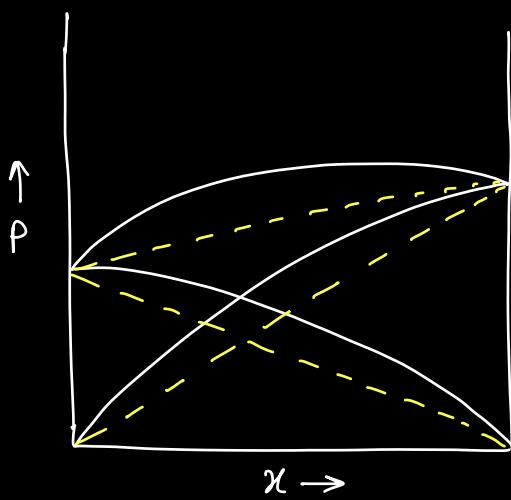
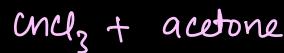
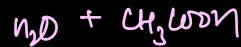
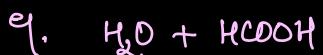
+ve deviation \rightarrow weaker attractive forces

- $\Delta H_{\text{mix}} = +\text{ve}$
- $\Delta V_{\text{mix}} = +\text{ve}$
- $\Delta S_{\text{mix}} = +\text{ve}$
- $\Delta G_{\text{mix}} = -\text{ve}$

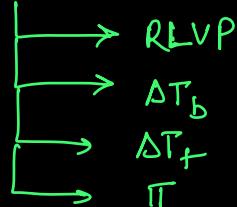


-ve deviation \rightarrow stronger attractive forces

- $\Delta H_{\text{mix}} = -\text{ve}$
- $\Delta V_{\text{mix}} = -\text{ve}$
- $\Delta S_{\text{mix}} = +\text{ve}$
- $\Delta G_{\text{mix}} = -\text{ve}$



- Colligative Prop. \rightarrow depend only on no. of particles



RLvP

- $$\frac{P^o - P_s}{P^o} = i X_{\text{solute}}$$

 $P^o = \text{Press. of solvent}$
 $P_s = \text{v.p. of solution}$
 - $$\frac{P^o - P_s}{P_s} = i \frac{n_{\text{solute}}}{n_{\text{solvent}}}$$
- Rearrange
to
get

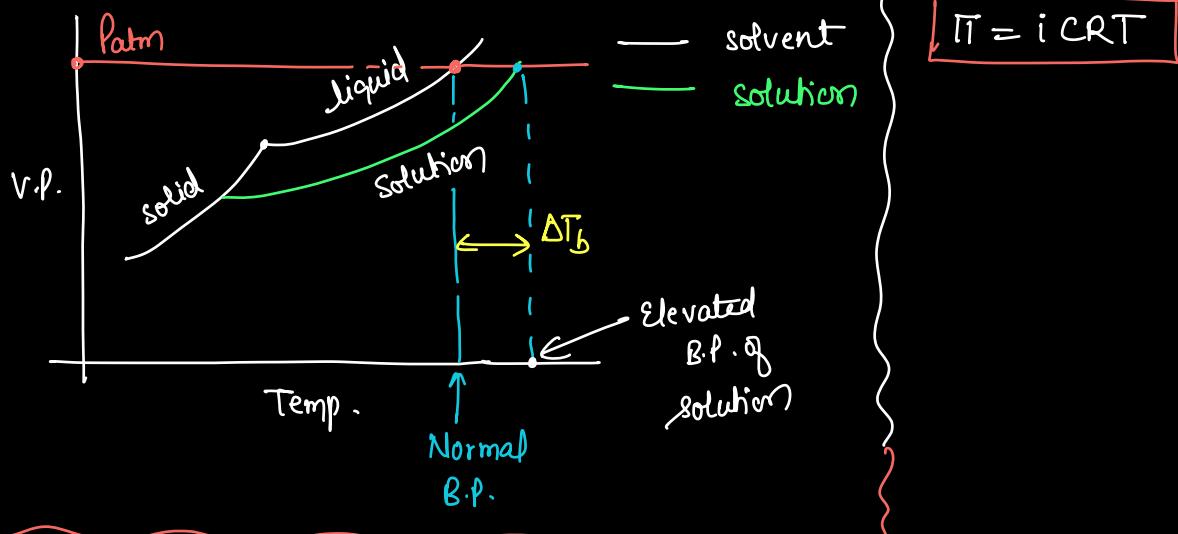
ΔT_b

$$\Delta T_b = i K_b \cdot m$$

molarity

K_b of solvent

$$K_b = \frac{RT_b^2 M_{\text{solvent}}}{1000 \Delta H_{\text{vap}}}$$



$$i = \frac{\text{exp. / observed / actual value of c.p.}}{\text{theoretical value of c.p.}} = \frac{\text{theoretical mass}}{\text{Exp. molar mass}}$$

$i > 1$ for dissociation

$i < 1$ for association

$$i = 1 + (n-1)\alpha$$

no. of particles generated by 1 particle.

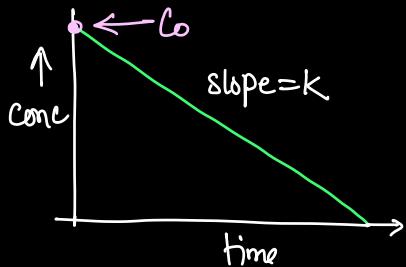
Chemical Kinetics

1. Zero order Rxn

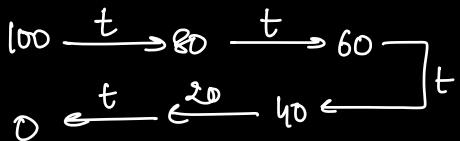
$$C_t = C_0 - kt \quad \text{linear drop}$$

$$t_{1/2} = \frac{C_0}{2k}$$

$$t_{100} = \frac{C_0}{k}$$



- Equal amt. drops in equal time intervals.



2. First Order Reaction

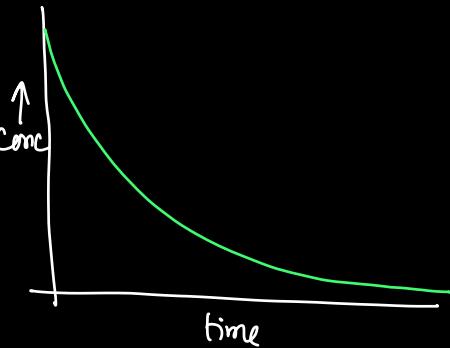
$$C_t = C_0 e^{-kt}$$

$$\ln\left(\frac{C_0}{C_t}\right) = kt$$

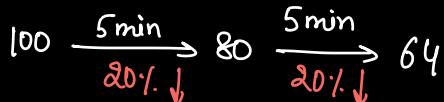
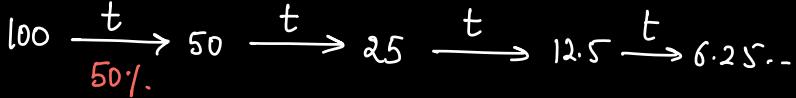
$$k = \frac{2.303}{t} \log \frac{C_0}{C_t}$$

$$t_{1/2} = \frac{0.693}{k}$$

$$t_{75\%} = 2.3 t_{1/2}$$



- Equal % drops in equal time intervals



$$t_{1/2} \propto (\text{conc.})^{1-n}$$

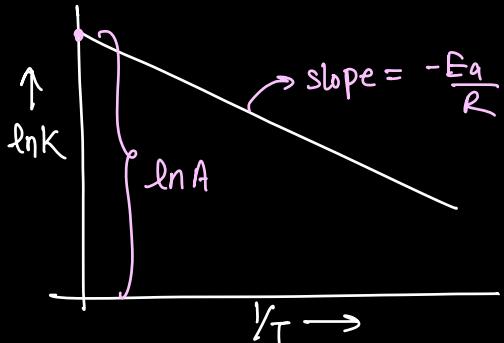
Arrhenius Equation

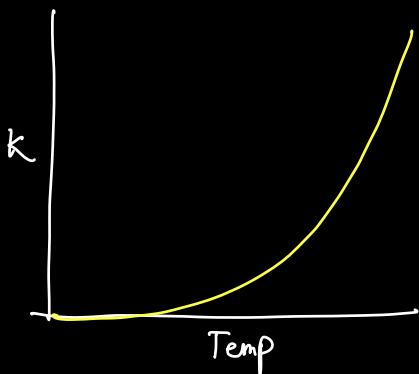
$$k = A e^{-E_a/RT}$$

$$\ln k = -\frac{E_a}{R} \cdot \frac{1}{T} + \ln A$$

$$y = mx + c$$

as $T \uparrow$, $k \uparrow$ ∴ Rate of Rxn ↑





$$\log\left(\frac{K_2}{K_1}\right) = \frac{E_a}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

Solid State

	a	Packing Eff.	Z	C.N.
• Simple Cubic	$a=2r$	52%	1	6 at dist. a
• BCC	$\sqrt{3}a=4r$	68%	2	8 at $\sqrt{3}a/2$
• FCC	$\sqrt{2}a=4r$	74%	4	12 at $a/\sqrt{2}$

- density of unit cell = $\frac{\text{Mass of unit cell}}{\text{vol. of unit cell}} = \frac{Z M}{N_A} \cdot \frac{1}{a^3}$ → vol. of unit cell
Mass of unit cell

<u>C.N.</u>	<u>LRR (r^+/r^-)</u>
3	0.155 - 0.225 (triangular)
4	0.225 - 0.414 (tetrahedral)
6	0.414 - 0.732 (Octahedral)
8	0.732 - 0.999 (Cubic)

- Size of voids: Cubic > Octahedral > tetrahedral > triangular

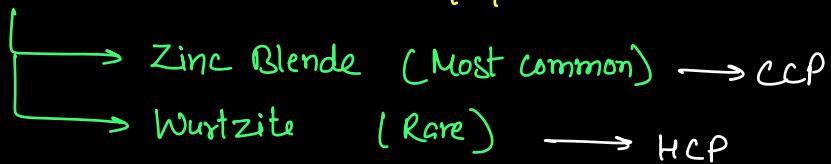
- Rock Salt Structure (NaCl) $\rightarrow \text{Na}^+$ = at every OHV
 $\text{C.N.} = 6:6$ Cl^- = at lattice sites (FCC)

4 formula units/unit cell

$$a = 2(r^+ + r^-)$$

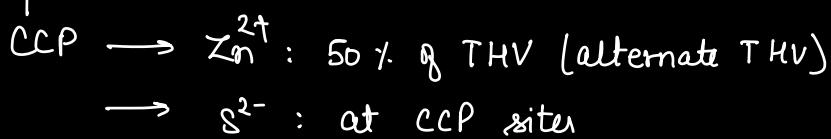
- CsCl structure $\rightarrow \text{C.N.}: 8:8 \rightarrow \text{Cs}^+$ = cubic void
 $\rightarrow \text{Cl}^-$ = cubic corners.
 1 formula unit/unit cell , $\sqrt{3}a = 2(r^+ + r^-)$

- ZnS Structure $\rightarrow \text{C.N.}: 4:4$



 Zinc Blende (Most common) $\rightarrow \text{CCP}$
 Wurtzite (Rare) $\rightarrow \text{HCP}$

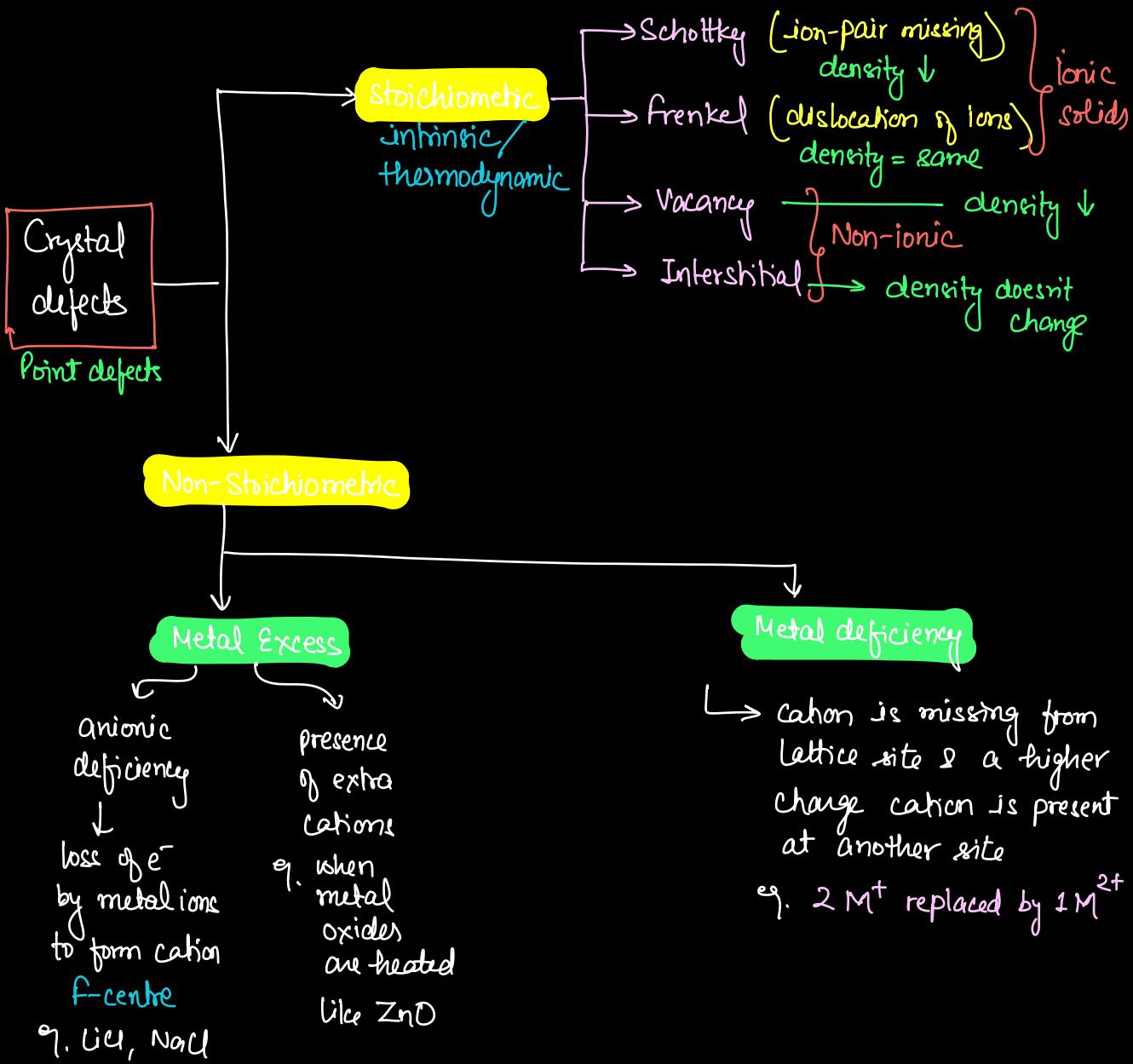
Zinc Blende



 $\text{CCP} \rightarrow \text{Zn}^{2+}$: 50% of THV (alternate THV)
 $\rightarrow \text{S}^{2-}$: at CCP sites

$$r^+ + r^- = \frac{1}{4} \cdot \sqrt{3}a$$

- * Diamond structure \rightarrow like ZnS
 $\boxed{Z=8}$ \rightarrow every location is occupied by C



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