



# Chemistry Formulas

## Physical Quantities and SI Units

Physical Quantity	Symbol	Name of Unit	Symbol of Unit
Length	$l$	metre	m
Mass	$m$	kilogram	kg
Time	$t$	seconds	s
Electric Current	$I$	Ampere	A
Temperature	$T$	Kelvin	K
Amount of Substance	$n$	mole	mol
Luminous intensity	$I_v$	candela	cd

## Prefixes in SI System

Multiple	Prefix	Symbol
$10^{-24}$	yocto	y
$10^{-21}$	zepto	z
$10^{-18}$	atto	a
$10^{-15}$	femto	f
$10^{-12}$	pico	p
$10^{-9}$	nano	n
$10^{-6}$	micro	$\mu$
$10^{-3}$	milli	m
$10^{-2}$	centi	c
$10^{-1}$	deci	d

Multiple	Prefix	Symbol
$10^{24}$	Yotta	Y
$10^{21}$	Zetta	Z
$10^{18}$	Exa	E
$10^{15}$	Peta	P
$10^{12}$	tera	T
$10^9$	giga	G
$10^6$	mega	M
$10^3$	kilo	k
$10^2$	Hecta	h
10	deca	da

## Mole Concept

- \* Mass of one atom =  $\frac{\text{Gram at. mass}}{6.022 \times 10^{23}}$
- \* Mass of one molecule =  $\frac{\text{Gram molecular mass}}{6.022 \times 10^{23}}$
- \* No. of moles of atoms =  $\frac{\text{mass}}{\text{At. mass}}$
- \* No of moles of atoms =  $\frac{\text{No of atoms}}{6.022 \times 10^{23}}$
- \* No of atoms =  $\text{no. of moles} \times 6.022 \times 10^{23}$
- \* No of atoms =  $\frac{\text{mass}}{\text{At. mass}} \times 6.022 \times 10^{23}$
- \* No of moles of molecules =  $\frac{\text{mass}}{\text{molecular mass}}$
- \* No of moles of molecules =  $\frac{\text{no. of molecules}}{6.022 \times 10^{23}}$

- \* No of moles of molecules =  $\frac{\text{Vol}^{\%} \text{ of gas at STP in cm}^3}{22400 \text{ cm}^3}$
- \* No of moles of molecules =  $\frac{\text{Vol}^{\%} \text{ of gas at STP in dm}^3}{22.4 \text{ dm}^3}$
- \*  $\text{Vol}^{\%} \text{ of gas at STP} = \frac{\text{mass in gram} \times \text{gram molar Vol}^{\%}}{\text{Gram mole. mass}}$
- \* No of molecules =  $\frac{\text{Vol}^{\%} \text{ at STP} \times 6.022 \times 10^{23}}{\text{Gram molar Volume}}$

- \* Mass percent =  $\frac{\text{mass of solute}}{\text{mass of solution}}$
- \* Mole fraction =  $\frac{\text{no of moles of compound}}{\text{total no of moles of solute + solvent}}$

$n_1 \rightarrow$  No of moles of solvent

$n_2 \rightarrow$  No of moles of solute

$x_1 \rightarrow$  Mole fraction of solvent

$x_2 \rightarrow$  Mole fraction of solute

$$* \quad x_1 = \frac{n_1}{n_1 + n_2} \quad x_2 = \frac{n_2}{n_1 + n_2}$$

$$* \quad \text{Molarity} = \frac{\text{mass in grams} / \text{dm}^3 \text{ of solution}}{\text{mol mass}}$$

$$* \quad \text{Molarity} = \frac{\text{no of moles of solute}}{\text{Vol}^{\%} \text{ of sol}^{\%} \text{ in dm}^3}$$

$$* \quad \text{Molarity} = \frac{\text{mass of solute}}{\text{mol. mass of solute} \times \text{Vol}^{\%} \text{ of sol in dm}^3}$$

$$* \quad \text{Molarity} = \frac{w}{M \times V(\text{dm}^3)} = \frac{w \times 1000}{M \times V(\text{ml})}$$

$$* \quad \text{Molarity} = \frac{\text{mass in grams} / \text{kg. solvent}}{\text{mol. mass}}$$

$$* \text{ Molality} = \frac{\text{No of moles of Solute}}{\text{Mass of solvent in kg}}$$

$$* \text{ Molality} = \frac{\text{mass Solute}}{\text{mol. mass of Solute} \times \text{mass of Solvent in kg}}$$

$$* \text{ Molality} = \frac{W_2}{M \times W_1}$$

$$* \text{ Molality} = \frac{W_2 \times 1000}{M \times W_1 \text{ (g)}}$$

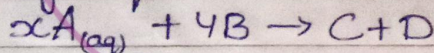
$$* \text{ Normality} = \frac{\text{mass in grms/dm}^3 \text{ Sol}^n}{\text{Equivalent mass}}$$

$$* \text{ Normality} = \frac{\text{mass of solute}}{\text{Equivalent mass of Solute} \times \text{Vol of Sol}^n \text{ in dm}^3}$$

$$* \text{ Normality} = \frac{W}{E \times V \text{ (l/dm}^3)}$$

$$* \text{ Normality} = \frac{W \times 1000}{E \times V \text{ (l/dm}^3)}$$

\* Molarity Equation



$$V_1 = \text{Vol of A}$$

$$V_2 = \text{Vol of B}$$

$m_1 \rightarrow$  Molarity of A

$m_2 \rightarrow$  Molarity of B

$$\frac{m_1 V_1}{x} = \frac{x}{x}$$

$$\frac{m_2 V_2}{4} = \frac{y}{4}$$

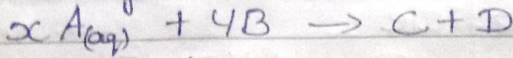
$$\frac{m_1 V_1}{x} = \frac{x}{x}$$

$$\frac{m_2 V_2}{4} = \frac{y}{4}$$

$$\frac{m_1 V_1}{x} = \frac{m_2 V_2}{4}$$

It is molarity of Equation

\* Normality Equation



$V_1 \rightarrow$  Vol. A

$V_2 \rightarrow$  Vol of B

$N_1 \rightarrow$  Normality of A

$N_2 \rightarrow$  Normality of B

$$N_1 V_1 = 1$$

$$N_2 V_2$$

$$N_1 V_1 = N_2 V_2$$

\* Relationship b/w Eq. mass & mole. mass

\* Equivalent mass =  $\frac{\text{Molecular mass}}{\text{Combining Capacity}}$

\* Eq. mass of acid =  $\frac{\text{molecular mass of acid}}{\text{Basicity}}$

\* Eq. mass of base =  $\frac{\text{molecular mass of base}}{\text{acidity}}$

\* Relationship b/w Normality and Molarity

\* Normality = Molarity  $\times$  'n' factor

\* n factor = acidity no / Basicity no / no of Valency of metal atoms

\* no of equivalent =  $\frac{\text{mass}}{\text{equivalent mass}}$

\* no of moles =  $\frac{\text{mass}}{\text{molecular mass}}$

\* molecular mass =  $2 \times$  Vapour density

\* Estimation of Closest distance of approach of  $\alpha$  particle

$$R = \frac{4KZe^2}{m_\alpha v_\alpha^2}$$

\* Radius of nucleus  $R = R_0(A)^{1/3}$  cm

\* Planck's Quantum Theory

$$E = h\nu = \frac{hc}{\lambda}$$

\* Photoelectric effect

$$h\nu = h\nu_0 + \frac{1}{2} m_e v^2$$

\* Bohr's model for hydrogen like atoms

$$* mvr = \frac{nh}{2\pi}$$

$$* E_n = -\frac{E_1}{n^2} Z^2 = 2.178 \times 10^{-18} \frac{Z^2}{n^2} \text{ J/atom}$$

$$* r_n = \frac{n^2}{Z} \times \frac{n^2}{4\pi^2 e^2 m}$$

$$* V = \frac{2\pi Ze^2}{nh}$$

\* De-Broglie Wavelength

$$\lambda = \frac{h}{mc} = \frac{h}{p}$$

\* Wavelength of emitted photon

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

\* Heisenberg's uncertainty principle

$$\Delta x \cdot \Delta p > \frac{h}{4\pi}$$

$$\Delta x \Delta v \geq \frac{h}{4\pi m}$$

\* Quantum Numbers

\* Principal quantum number

$$n = 1, 2, 3 \dots \infty$$

\* Orbital angular momentum =  $\frac{nh}{2\pi}$

\* Azimuthal quantum number

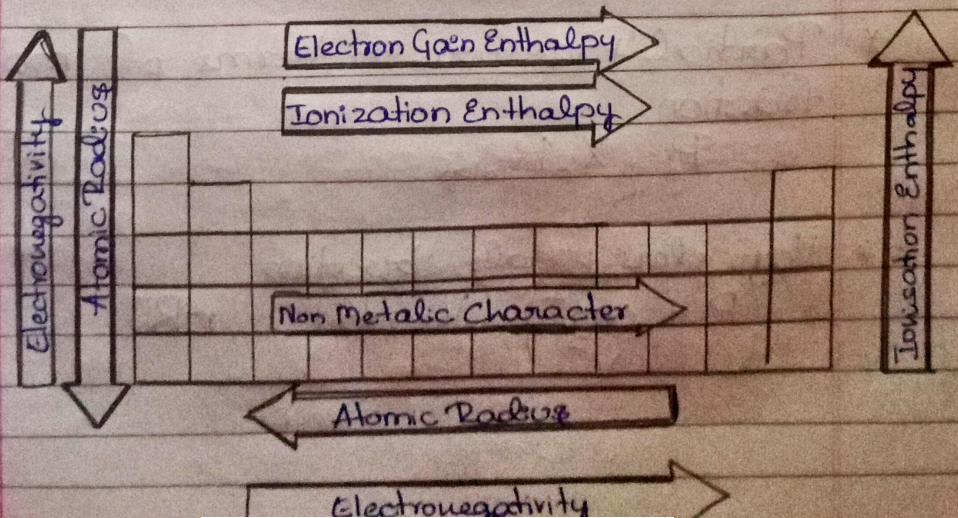
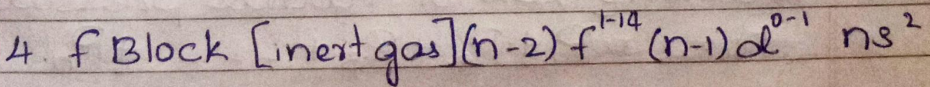
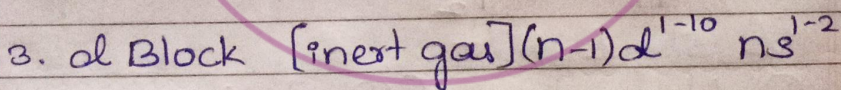
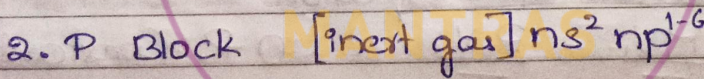
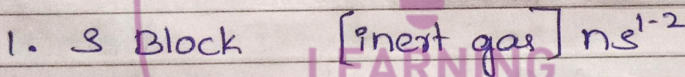
$$l = 0, 1, 2 \dots (n-1)$$

\* No of Orbitals in Subshell =  $2l + 1$

\* Orbital angular momentum

$$L = \frac{h}{2\pi} \sqrt{l(l+1)}$$

\* General Electronic Configuration



\* Boyle's Law

$$P_1 V_1 = P_2 V_2 \quad [T \text{ and } n \text{ Constant}]$$

\* Charles's Law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad [P \text{ and } n \text{ Constant}]$$

\* Avagadro's Law

$$V = kn \quad [P \text{ and } T \text{ Constant}]$$

\* Ideal Gas Equation

$$PV = nRT$$

$$M = \frac{dRT}{P}$$

\* Combined Gas Equation

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad [n, R \text{ Constant}]$$

\* Dalton's Law of Partial pressure

$$P_{\text{Total}} = P_1 + P_2 + P_3 + \dots + P_n$$

\* Partial Pressure in terms of mole fraction

$$P_i = X_i P_{\text{Total}}$$

\* Van der Waals Equation

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



\* Compressibility factor  $Z$

$$Z = \frac{PV}{RT} \quad [\text{for 1 mole of gas}]$$

$$Z = \frac{nPV}{RT} \quad [\text{for } n \text{ mole of gas}]$$

\*  $W = F \times dx$

$W =$  Workdone

$F =$  force

$dx =$  distance moved

\*  $W = P_{\text{ext}} \Delta V$

$$\Delta V = V_2 - V_1$$

\*  $dW = P dV$

\*  $W = \int_{V_1}^{V_2} P_{\text{ext}} dV$

\* Workdone by the system = -ve

Workdone on the system = +ve

\*  $Q = \Delta E + W$  first law of thermodynamics

$$q = dE + W$$

\* Heat absorbed by a system = +ve

Heat given out by a system = -ve

\*  $H = E + PV$

\*  $\Delta H = \Delta E + P \Delta V$

\*  $C_v = \left[ \frac{\partial E}{\partial T} \right]_v$

$C_v =$  Heat capacity at const Vol<sup>y</sup>

$\partial E =$  Change in internal Energy  
 $\partial T =$  Change in Temp<sup>y</sup>

$$* C_p - C_v = R$$

R = Gas Constant  
C<sub>p</sub> & C<sub>v</sub> = heat capacity at const P & Vol

$$* \frac{C_p}{C_v} = \gamma$$

\* Exothermic reaction  $\Delta H = -ve$   
Endothermic reaction  $\Delta H = +ve$

$$* \text{Heat of Combustion} = Z \times \theta \times \frac{M}{m} \text{ (Cal)}$$

M = molar weight

m = weight of substance

$\theta$  = raise in temperature

Z = heat capacity

\* Enthalpy of reaction

$$\Delta H = \sum \Delta_f H^\circ (\text{Products}) - \sum \Delta_f H^\circ (\text{Reactants})$$

$$\Delta_{\text{sub}} H^\circ = \Delta_{\text{fus}} H^\circ + \Delta_{\text{vap}} H^\circ$$

\* Heat Capacity  $\Delta$

$$C = \frac{q}{\Delta T}$$

specific heat capacity  $C_s = \frac{q}{m \Delta T}$

molar heat capacity

$$C_m = \frac{q}{m \Delta T}$$

\* Energy Changes

$$\Delta U = q_v$$

$q_v \Rightarrow$  Heat exchange at Const Vol<sup>y</sup>

$$\Delta H = q_p$$

$q_p \Rightarrow$  Heat exchange at Const P<sup>y</sup>

\* Enthalpy

$$H = U + pV$$

\* Reaction b/w  $\Delta H$  and  $\Delta U$

$$\Delta H = \Delta U + P\Delta V$$

$$\Delta H = \Delta U + \Delta n_g RT$$

\*  $C_p - C_v = R$

$$\Delta S = \frac{q_{rev}}{T}$$

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

$$\Delta G^\circ = -RT \log_e K$$

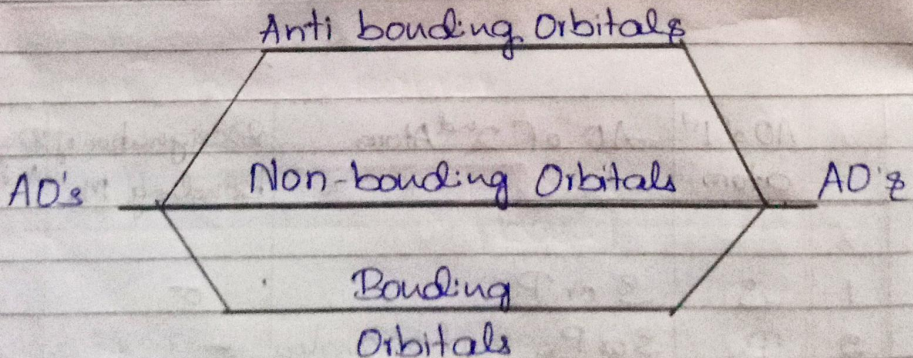
Atomicity	$\gamma$	$C_p$	$C_v$
Monoatomic	5/3	5R/2	3R/2
Diatomic	7/5	7R/2	5R/2
Triatomic non linear	4/3	4R	3R

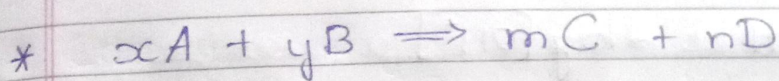
AO of 1 <sup>st</sup> atom	AO of 2 <sup>nd</sup> Atom	Designation of bonding $M_o$	Designation of Antibonding $M_o$
1 s	s or $P_x$	$\sigma$	$\sigma^*$
2 $P_x$	s or $P_x$ end on overlap	$\sigma$	$\sigma^*$
3 $P_y$	$P_y$ Side overlap	$\pi$	$\pi P_y^*$
4 $P_z$	$P_z$ Side overlap	$\pi$	$\pi P_z^*$

## \* VSEPR Theory

	No. of Bond Pairs	No. of Lone Pairs	Formula	Molecular shape	Hybridization	Bond Angle
1	2	0	$AB_2$	Linear	$sp$	$180^\circ$
	3	0	$AB_3$	Plane Triangle	$sp^2$	$120^\circ$
	4	0	$AB_4$	Tetrahedron	$sp^3$	$109^\circ 28'$
	3	1	$AB_3E$	Trigonal Pyramid	$sp^3$	$107^\circ$ $102^\circ$
	2	2	$AB_2E_2$	Angular V-shaped	$sp^3$	$104^\circ$ $102^\circ$
	5	0	$AB_5$	Trigonal Bipyramid	$sp^3d$	$120^\circ$ $90^\circ$
	2	3	$AB_2E_3$ $A_3E_3$	Linear	$sp^3d$	$180^\circ$
	6	0	$AB_6$	Octahedral	$sp^3d^2$	$90^\circ$

## \* Molecular Orbital theory





$$K_c = \frac{[C]^m [D]^n}{[A]^x [B]^y} \quad K_c = \text{Equilibrium Const. in terms of Concentration}$$

$$K_p = \frac{P_C^m P_D^n}{P_A^x P_B^y} \quad K_p = \text{Equilibrium Constant in terms of partial p\%}$$

\* Relation b/w  $K_p$  and  $K_c$

$$K_p = K_c (RT)^{\Delta n}$$

Case 1  $\Delta n > 0 \Rightarrow K_p > K_c$

Case 2  $\Delta n < 0 \Rightarrow K_p < K_c$

Case 3  $\Delta n = 0 \Rightarrow K_c = K_p$

\* Equilibrium Constant

$$K_c = \frac{\text{Rate Const. of forward react.}}{\text{Rate Const. of backward react.}} = \frac{K_f}{K_b}$$

$$* \quad K_a = \frac{C\alpha^2}{(1-\alpha)} \quad (\alpha \text{ Value in denominator is neglected})$$

$$K_a = C\alpha^2$$

$$* \quad \alpha = \sqrt{\frac{K_a}{C}}$$

$$* \quad K_b = \frac{C\alpha^2}{(1-\alpha)}$$

$$* \quad \alpha = \sqrt{\frac{K_b}{C}}$$

$$* \text{pOH} = -\log [\text{OH}^-]$$

$$* \text{pOH} = \log \frac{1}{[\text{OH}^-]}$$

$$* \text{pK} = -\log K$$

\* 'N' of mixture of two strong acids or two strong bases

$$N_{\text{mix}} = \frac{N_1 V_1 + N_2 V_2}{V_1 + V_2}$$

\* Henderson eq

① for Acidic buffer

$$\text{pH} = \text{pK}_a + \log \frac{[\text{salt}]}{[\text{acid}]}$$

② for Basic buffer

$$\text{pOH} = \text{pK}_b + \log \frac{[\text{salt}]}{[\text{base}]}$$

\* pH of basic buffer

$$\text{pH} = \text{pK}_a - \log \frac{[\text{salt}]}{[\text{base}]}$$

## \* Classification of Crystal into 7 System

Crystal System	Unit Cell dimensions and Angles
Cubic	$a = b = c$ $\alpha = \beta = \gamma = 90^\circ$
Orthorhombic	$a \neq b \neq c$ $\alpha = \beta = \gamma = 90^\circ$
Tetragonal	$a = b \neq c$ $\alpha = \beta = \gamma = 90^\circ$
Monoclinic	$a \neq b \neq c$ $\alpha = \gamma = 90^\circ \neq \beta$
Rhombohedral	$a = b = c$ $\alpha = \beta = \gamma \neq 90^\circ$
Triclinic	$a \neq b \neq c$ $\alpha \neq \beta \neq \gamma \neq 90^\circ$
Hexagonal	$a = b \neq c$ $\alpha = \beta = 90^\circ \neq \gamma = 120^\circ$

## \* Analysis of Cubical System

Property	sc	BCC	FCC
1 Atomic radius	$\frac{a}{2}$	$\frac{\sqrt{3}a}{4}$	$\frac{a}{2\sqrt{2}}$
2 No of atom/unit Cell	1	2	4
3 Coordination No.	6	8	12
4 Packing efficiency	52%	68%	74%
5 No Voids			4
a) Octahedral	-	-	8
b) Tetrahedral	-	-	

## \* Neighbourhood of a particle

**NEET**  
**MANTRA**

1. Simple Cubic Structure

$$\text{Distance} = a$$

$$\text{No of neighbours} = 6$$

2. BCC

$$\text{Distance} = 2r = \frac{a\sqrt{3}}{2}$$

$$\text{No of neighbours} = 8$$

3. FCC

$$\text{Distance} = \frac{a}{\sqrt{2}}$$

$$\text{No of neighbours} = \frac{3 \times 8}{2} = 12$$

## \* Density of lattice

$$d = \frac{Zm}{a^3 N_A}$$

$N_A = \text{Avagadro No.}$

$m = \text{At. mass}$

## \* Ionic Crystals

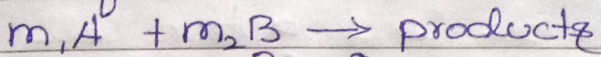
C.No	Limiting radius ratio
3	0.155 - 0.225 [Triangular]
4	0.225 - 0.414 [Tetrahedral]
6	0.414 - 0.732 [Octahedral]
8	0.732 - 0.999 [Cubic]



\* Rate / Velocity of Chemical reaction

$$\text{Rate} = \frac{\Delta C}{\Delta t} = \frac{\text{mol/lit}}{\text{Sec}}$$

\* Order of Reaction



$$R \propto [A]^p [B]^q$$

\* Zero Order reaction

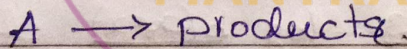
$$\text{Rate} = k [\text{Conc.}]^0$$

$$\text{Rate} = k = \frac{C_0 - C_t}{t}$$

$$C_t = C_0 - kt$$

$$t_{1/2} \propto C_0$$

\* First Order Reaction



$$t = \frac{2.303}{k} \log \frac{a}{a-x}$$

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

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

$$t_{\text{avg}} = \frac{1}{k} = 1.44 t_{1/2}$$

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

\* Second Order reaction

Type 1	Type 2
$A + A \rightarrow \text{products}$	$A + B \rightarrow \text{products}$
$a$	$a \quad b$
$(a-x)(a-x)$	$(a-x)(b-x)$
$\therefore \frac{dx}{dt} = k(a-x)^2$	$\frac{dx}{dt} = k(a-x)(b-x)$
$\frac{1}{(a-x)} - \frac{1}{a} = kt$	$k = \frac{2.303}{t(a-b)} \log \frac{b(a-x)}{a(b-x)}$

\* Pseudo first Order reaction

For  $A + B \rightarrow \text{Products}$

Rate  $= k[A][B]$

$$k = \frac{2.303}{t(a-b)} \log \frac{b(a-x)}{a(b-x)}$$

If  $b \gg a$

$$k = \frac{2.303}{bt} \log \frac{a}{a-x}$$

$$kb = \frac{2.303}{t} \log \frac{a}{a-x}$$

$$k' = \frac{2.303}{t} \log \frac{a}{a-x}$$

$k'$  is pseudo first Order reaction.

\* For Any Electrode  
Oxidation potential = - Reduction potential.

\*  $E_{cell} = \text{RP of Cathode} - \text{R.P of anode}$

\*  $E_{cell} = \text{RP of Cathode} + \text{O.P of Anode}$

\* Gibbs free Energy Change

$$\Delta G = -nFE_{cell}$$

$$\Delta G^{\circ} = -nFE_{cell}^{\circ}$$

\* Nernst Equation

$$\Rightarrow \Delta G = \Delta G^{\circ} + RT \ln a$$

$$\Delta G^{\circ} = -RT \ln K_{eq}$$

$$E_{cell} = E_{cell}^{\circ} - \frac{RT}{nF} \ln a$$

$$E_{cell} = E_{cell}^{\circ} = \frac{2.303RT}{nF} \log a$$

$$E_{cell} = E_{cell}^{\circ} - \frac{0.0591}{n} \log a \quad (\text{At } 298\text{K})$$

At Chemical equilibrium

$$\Delta G = 0$$

$$E_{cell} = 0$$

\*  $\log K_{eq} = \frac{nE_{cell}^{\circ}}{0.0591}$

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

\* Electrolyte Concentration Cell

$$E = \frac{0.0591}{2} \log \left[ \frac{C_2}{C_1} \right]$$

\* Electrode Concentration Cell

$$E = \frac{0.0591}{2} \log \left[ \frac{P_1}{P_2} \right]$$

Calculation of different Thermodynamic

\*  $\Delta G = -nFE_{cell}$

\*  $S = - \left[ \frac{dG}{dT} \right]_p$

\*  $\Delta S = - \left[ \frac{d\Delta G}{dT} \right]_p = nF \frac{d[E_{cell}]}{dt}$

\*  $\Delta H = nF \left[ T \left( \frac{\partial E}{\partial T} \right)_p - E \right]$

\*  $\Delta C_p$  of Cell reaction

$$C_p = \frac{dH}{dT}$$

$$\Delta C_p = \frac{d}{dT} (\Delta H)$$

$$\Delta C_p = nFT \frac{d^2 E_{cell}}{dT^2}$$

## Faraday's Law of Electrolysis

\* First law

$$W = Zq \quad W = Z$$

\* Second law

$$W \propto E \quad \frac{W}{E} = \text{Constant}$$

$$\frac{W}{E} = \frac{i \times t \times \text{current efficiency factor}}{96500}$$

\* Current Efficiency =  $\frac{\text{actual mass deposited}}{\text{Theoretical mass deposited}} \times 100$

\* Conductance

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

\* Specific conductance or Conductivity

$$K = \frac{1}{\rho}$$

\* Equivalent Conductance

$$\lambda_e = \frac{K \times 1000}{\text{Normality}}$$

\* Molar conductance

$$\lambda_m = \frac{K \times 1000}{\text{Molarity}}$$

Specific conductance = conductance  $\times \frac{l}{a}$

\* Kohlrausch law

① Strong electrolyte

$$\lambda_m^0 = \lambda_m^{\infty} - b\sqrt{C}$$

② Weak electrolyte

$$\lambda_m = n_+ \lambda_+^0 + n_- \lambda_-^0$$

\* To Calculate degree of dissociation of a weak electrolyte

$$\alpha = \frac{\lambda_m}{\lambda_m^0} \quad ; \quad K_{eq} = \frac{C\alpha^2}{1-\alpha}$$

\* Ionic mobility

$$u = \frac{V}{(V/l)}$$

V = Speed of

V/l - potential gradient.