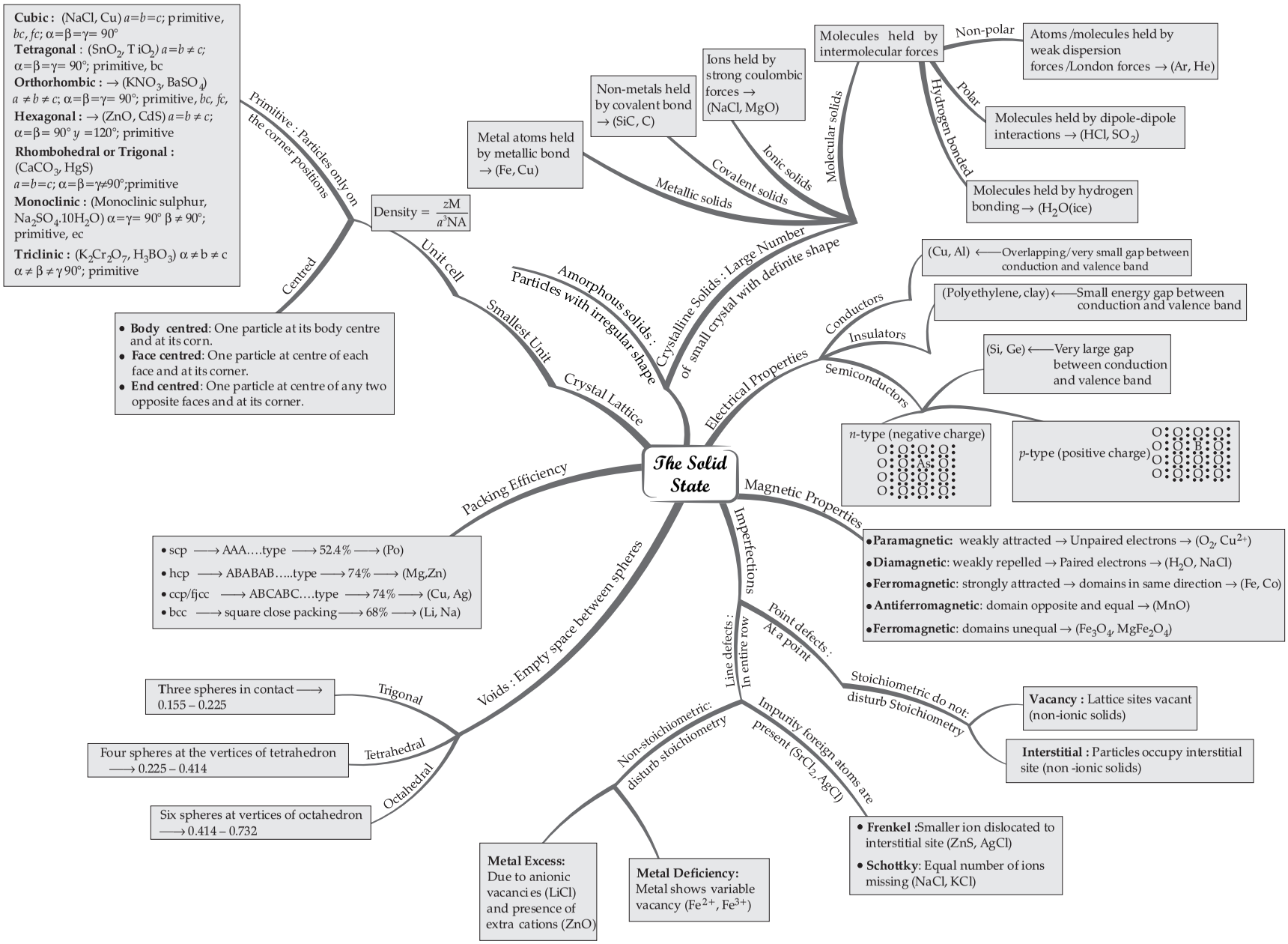
# MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 1



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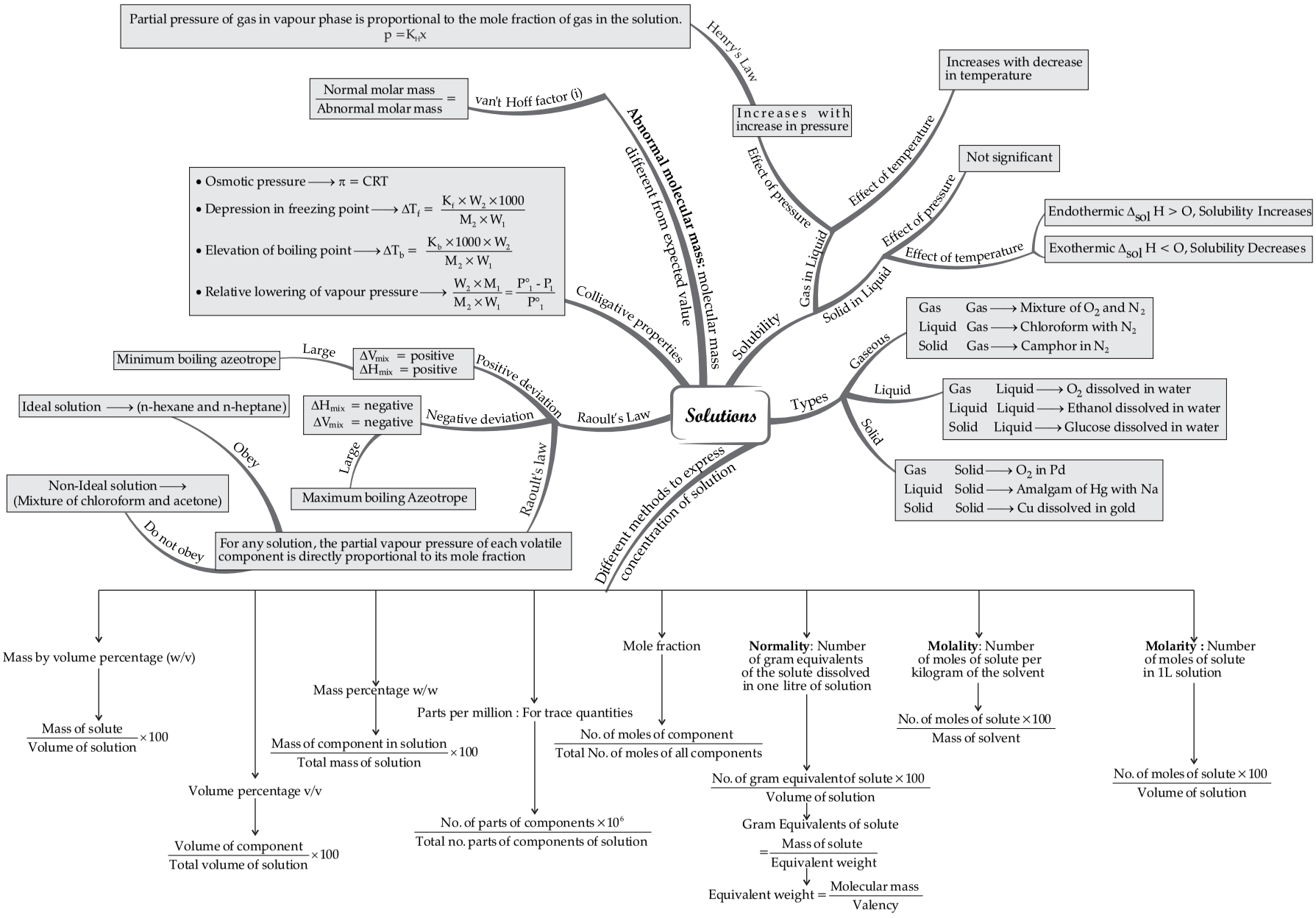
## CHAPTER - 2



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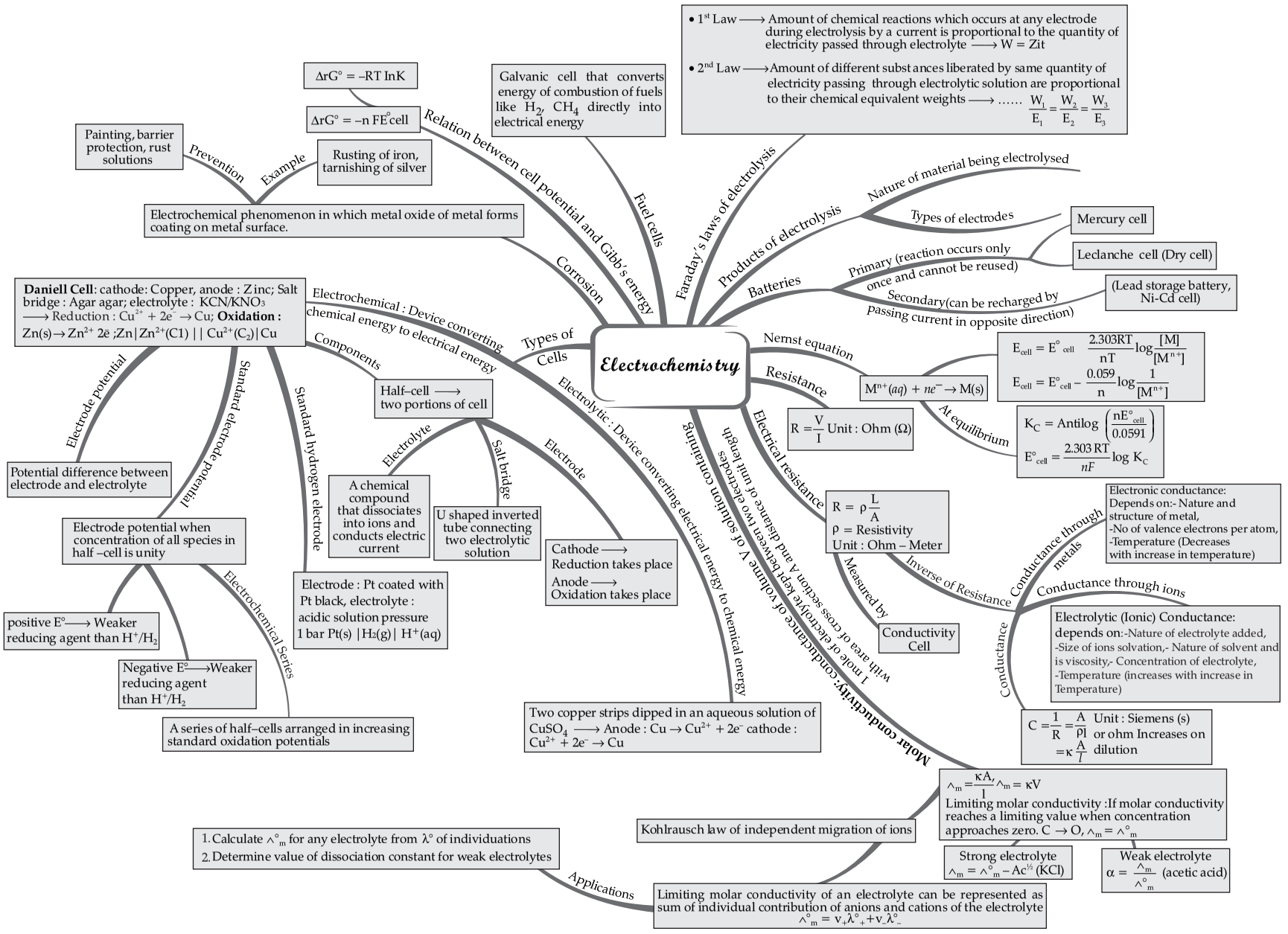
## CHAPTER - 3



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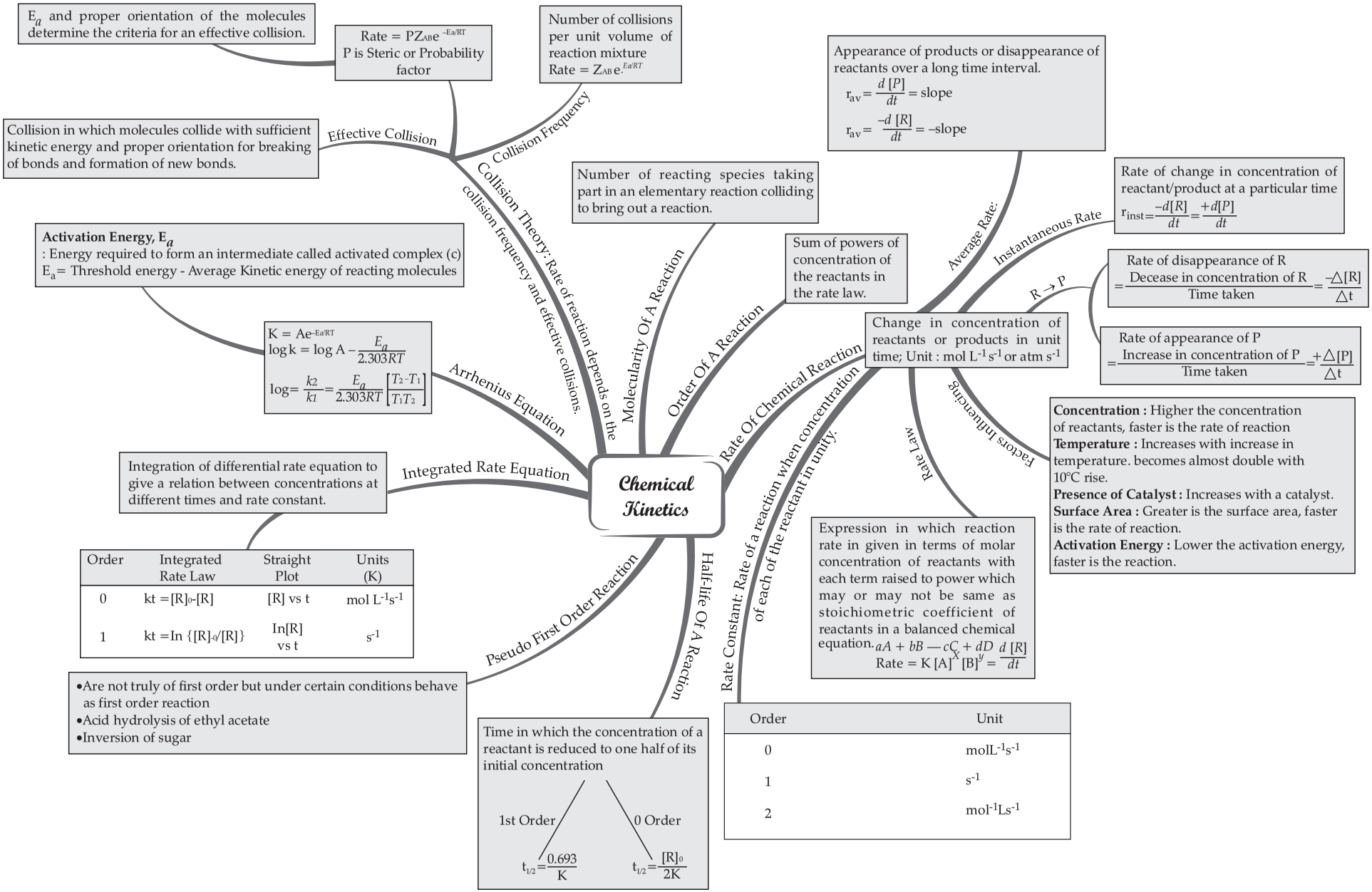
CHAPTER - 4



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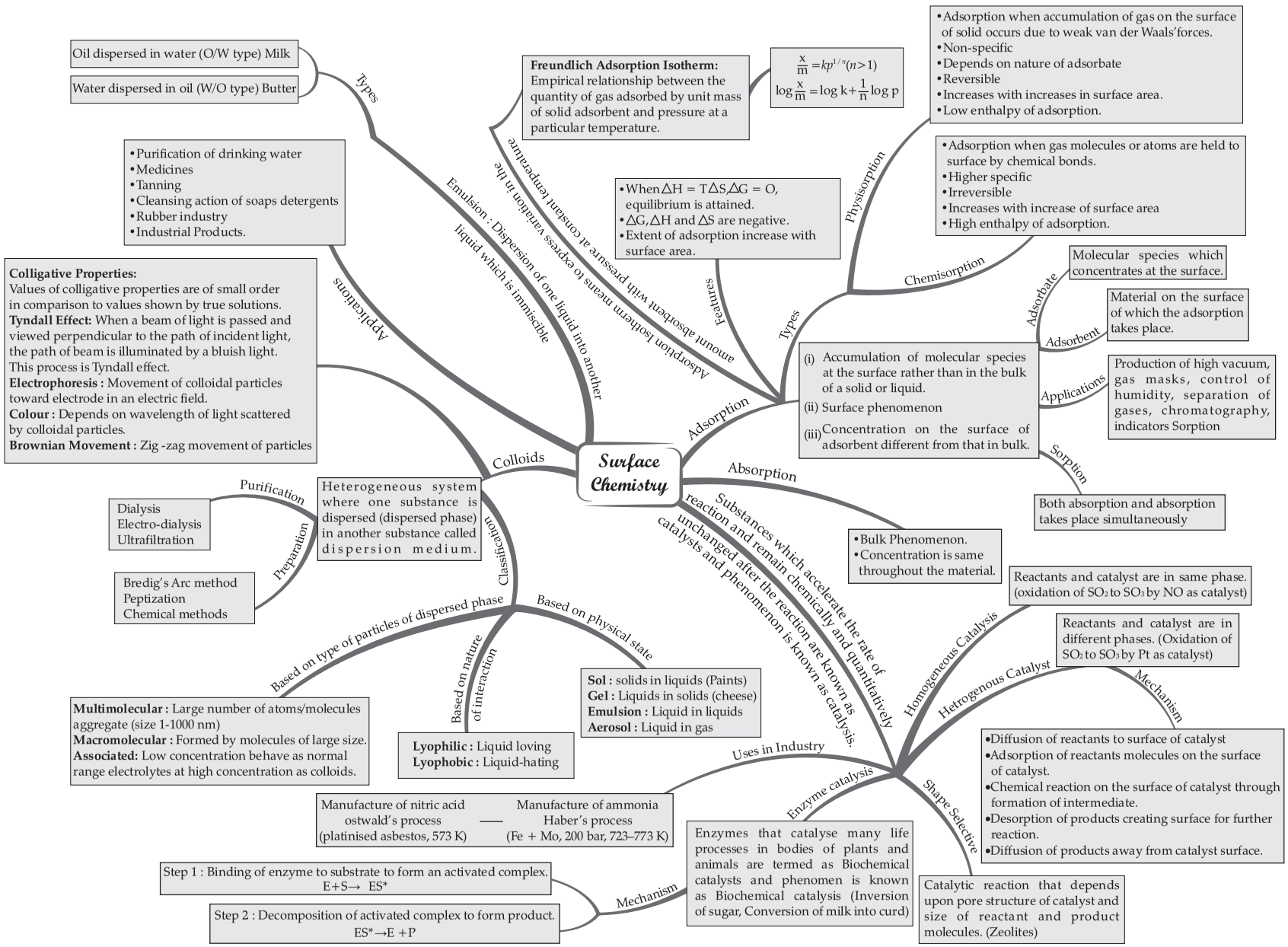
CHAPTER - 5



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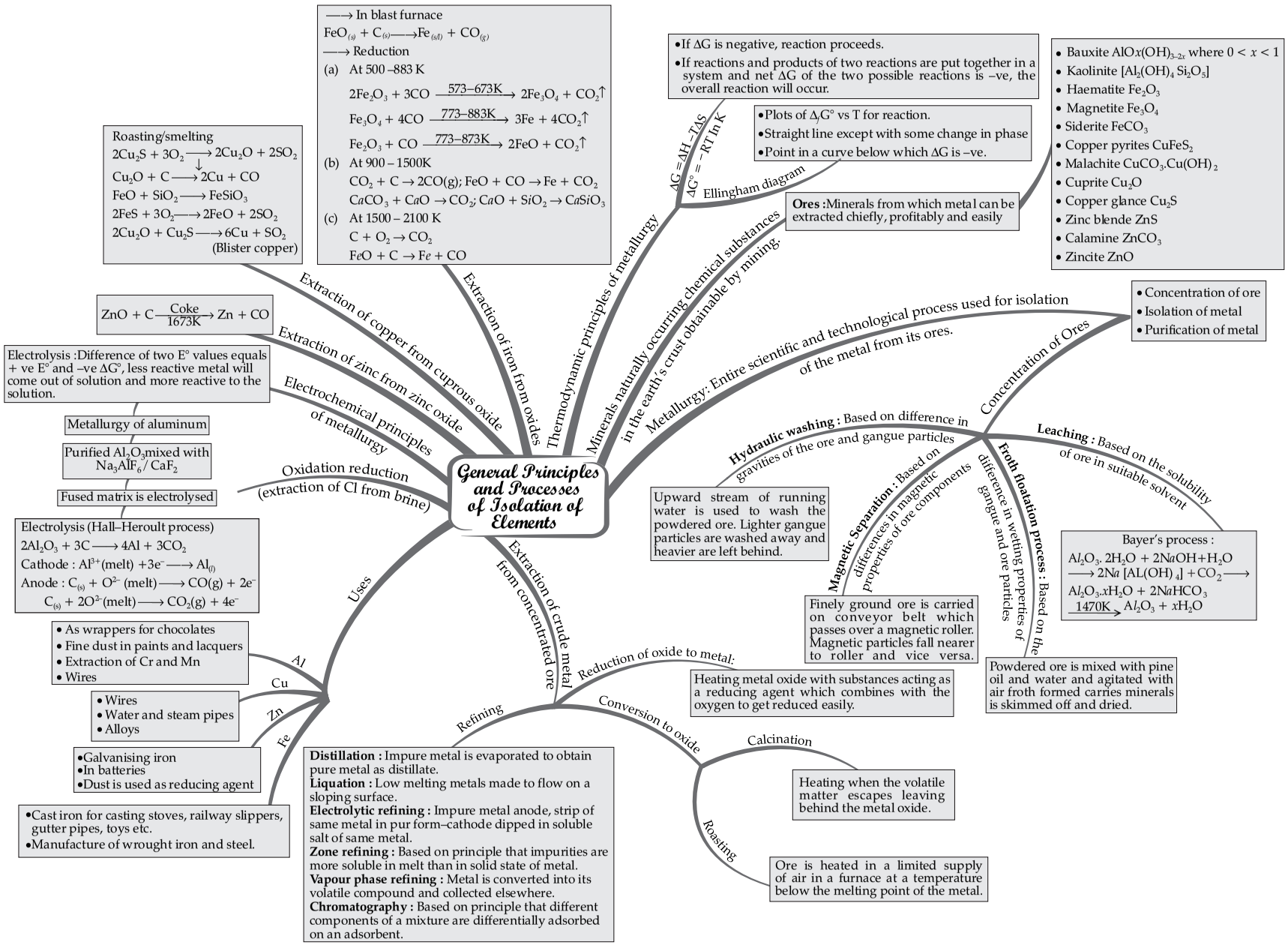
CHAPTER - 6



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CHAPTER - 7

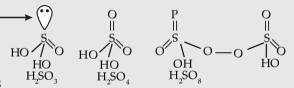
## The p- Block Elements

### Group 18 Elements

- **Occurrence :** All except radon occur in atmosphere
- **Electronic configuration :** $ns^2 np^6$ except He
- **IE :** High
- **Atomic radii :** Increases down group
- **Electron gain enthalpy :** Largely positive
- **Physical properties :** Monoatmic, colourless, odorless and tasteless. Sparingly soluble in water.
- **M.P. and B.P. :** Low
- **Chemical properties :** Least reactive xenonefluorine compound : $XeF_2$, $XeF_4$ and $XeF_6$.
- **Xenone oxygen compounds :** $XeO_3$, $XeOF_2$, $XeOF_4$

### Group 16 Elements

- Electronic configuration : $ns^2np^4$
- Atomic and ionic radii : Increase down the group
- IE : Decreases down the group
- Electron Gain enthalpy : O hass less–ve than S.
- Electro-negativity : Decreases with increase in atomic number
- Physical properties : O and S are non metals, Se and Te metalloids whereas Po is a metal. All exhibit allotropy
- M.P. and B.P. : Increases down the group
- Chemical properties : variable
  - ✓ Reactivity with hydrogen : stable hydrides
  - ✓ Reactivity with halogens : $F^- > Cl^- > Br^- > I^-$
- Oxoacids of S :




- Dioxygen ($O_2$) :

Preparation : $2KClO_3 \xrightarrow[MnO_2]{\Delta} 2KCl + 3O_2$

Properties : Colourless and odourless gas

$2Ca + O_2 \longrightarrow 2CaO$; $4Al + 3O_2 \longrightarrow 2AlO_3$

$2SO_2 + O_2 \xrightarrow{V_2O_5} 2SO_3$; $4HCl + O_2 \xrightarrow{CuCl} 2Cl + 2H_2O$

### Group 17 Elements

- Occurrence : F and Cl are fairly abundant while Br and I less so
- Electronic configuration : $ns^2np^5$
- Atomic Ionic radii : Smallest in periods but increases from F to I
- IE : Decreases down the group
- Electron gain enthalpy : Less –ve down the group
- Electro-negativity : High, decreases down the group
- Physical properties : F and Cl are gases, Br is liquid and I solid
- M.P. and B.P. : Increases with atomic number
- Chemical properties : Chlorine

**All exhibit –** 1 oxidation state Cl, Br and I exhibit + 1, + 3, + 5 and + 7.O.N
**Reactivity towards hydrogen :** H – F > H – Cl > H – Br > H – I
**Reactivity towards oxygen :** F form $OF_2$ (stable) and $O_2F_2$
**Reactivity towards metals :** MF > MCl > MBr > MI
**Reactivity towards other halogens :** Forms $XX'$, $XX'_3$, $XX'_5$ and $XX'_7$.

**Preparation :** $MnO_2 + 4HCl \longrightarrow MnCl_2 + Cl_2 + 2H_2O$

**Deacon's process :** $4HCl + O_2 \xrightarrow[CuCl_2]{} 2Cl_2 + 2H_2O$

**Properties :** Greenish yellow gas with pungent and suffocating odour. Heavier than air

$2Al + 3Cl_2 \longrightarrow 2AlCl_3$

$H_2 + Cl_2 \longrightarrow 2HCl$

$H_2S + Cl_2 \longrightarrow 2HCl + S$

$8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$

$2NaOH + Cl_2 \longrightarrow NaCl + NaOCl + H_2O$ (cold and dilute)

$2Ca(OH)_2 + 2Cl_2 \longrightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O$

$CH_4 + Cl_2 \xrightarrow{uv} CH_3Cl + HCl$

$C_2H_4 + Cl_2 \xrightarrow{RT} C_2H_4Cl_2$

$2FeSO_4 + H_2SO_4 + Cl_2 \longrightarrow Fe_2(SO_4)_3 + 2HCl$

$SO_2 + 2H_2O + Cl_2 \longrightarrow H_2SO_4 + 2HCl$

$Cl_2 + H_2O \longrightarrow 2HCl + 0$

Inter-halogen compounds: $XX'$ – $sp^3$(linear), $XX'_3 sp^3d$ (T–shaped), $XX'_5 sp^3d^2$ (square pyramidal), $XX'_7 sp^3d^3$ (Pentagonal bipyramidal)

### Group 15 Elements

- Electronic configuration : $ns^2np^3$
- Elements : $_7N$, $_{15}P$, $_{33}As$, $_{51}Sb$, $_{83}Bi$
- Atomic and Ionic radii : Increase in size down the group.
- Ionization enthalpy : Decreases down the group due to gradual increase in atomic size.
- Electro-negativity : Decreases down the group with increasing atomic size.
- Physical properties : Polyatomic, metallic character increases down the group. N and P are non-metals, As and Sb metalloids and Bi metal. B.P increases top to bottom and M.P. increases upto As and then decreases upto Bi. Except Ni all show allotropy
- Chemical properties : Common O.N : –3, +3 and +5. Nitrogen shows anomalous behaviour.

**Ammonia Preparation**

$NH_4CO\,NH_2 + 2H_2O \longrightarrow (NH_4)_2CO_3 \rightleftharpoons 2NH_3 + H_2O + CO_2$

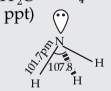
$N_2 + 3H_2 \rightleftharpoons 2NH_3$ $\Delta_f H° = -46.1$ kJ mol$^{-1}$

Properties :
Colourless with pungent odour, soluble in water

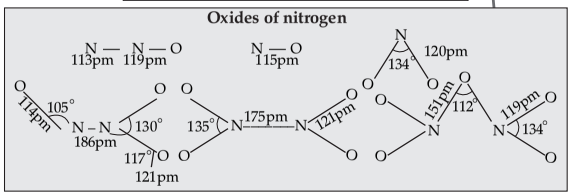
$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

$ZnSO_4 + 2NH_4OH \longrightarrow Zn(OH)_2 + (NH_4)SO_4$ (white ppt)

$FeCl_3 + NH_4OH \longrightarrow Fe_2O_3.xH_2O + NH_4Cl$ (Brown ppt)




**Oxides of nitrogen**




**Oxides of nitrogen**

**Dinitrogen preparation**

- **In laboratory :** $NH_4Cl + NaNO_2 \longrightarrow N_2 + 2H_2O + NaCl$
- **Thermal decomposition :** $(NH_4)_2Cr_2O_7 \xrightarrow{Heat} N_2 + 4H_2O + Cr_2O_3$

$Ba(N_3)_2 \longrightarrow Ba + 3N_2$

- **Properties :** Colourless, odourless, tasteless and non-toxic gas

$6Li + N_2 \xrightarrow{\Delta} 2Li_3N$

$3Mg + N_2 \xrightarrow{\Delta} Mg_3N_2$

$N_2 + 3H_2 \xrightarrow{773K} 2NH_3$ $\Delta_f H° = 46.1$ KJ mol$^{-1}$

$N_2 + O_2 \xrightarrow{\Delta} 2NO$

# MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 8

## The d– And f– Block Elements

### d– Block transition elements groups 3–12

- Position : Between s–and p–blocks
- Electronic configuration : $(n-1)d^{1-10}ns^{1-2}$
- Physical properties : Show typical metallic properties, melting and boiling point are high; High enthalpies of atomization
- Decrease in radius with increasing atomic number. Lanthanoid contraction is due to imperfect shielding of one $e^-$ by another in same set of orbitals.
- Ionisation enthalpies : Increases from left to right
- Oxidation states : Variable ;higher ON stable
- Trends in $M^{2+}/M$ E° : E° for Mn, Ni and Zn are more negative than expected.
- Trends in $M^{3+}/M^{2+}$ E° : variable
- Chemical reactivity and E° values : Variable; $Ti^{2+}$, $V^{2+}$ and $Cr^{2+}$ are strong reducing agents.
- Magnetic properties : Diamagnetism and paramagnetism. Magnetic moment increases with increasing atomic number.
- Formation of coloured ions : Form coloured compounds due to d – d transitions
- Formation of complex compounds : Form a large number of complex compounds
- Catalytic properties : Due to variable oxidation states and ability to form complexes.
- Forms interstitial compounds : Non - stoichiometric and are neither ionic nor covalent.
- Alloy formation : Due to similar atomic sizes.

### Uses

- Helps in production of iron and steels.
- TiO in pigment industry
- $MnO_2$ in dry battery cells.
- As catalysts in industry.
- Ni complexes useful in the polymerization of alkynes and other organic compounds such as benzene.
- Ag Br in photographic industry.

### Oxides and oxoanions of metals

- Potassium dichromate $K_2Cr_2O_7$

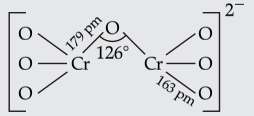
  Preparation : $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$

  $2Na_2CrO_4 + 2H^+ \rightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$

  $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$

  Properties : $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

  Oxidises iodides to iodine, $H_2S$ to S, $SO_3^{2-}$ to $SO_4^{2-}$, $NO_2^-$ to $NO_3^-$




- Potassium permanganate $KMnO_4$

  Preparation : $2MnO_2 + 4KOH + O_2 \rightarrow 2KMnO_4 + 2H_2O$

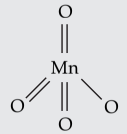
  $3\,MnO_4^{2-} + 4H^+ \rightarrow 2\,MnO_4^- + MnO_2 + 2H_2O^+$

  $2Mn^{2+} + 5S_2O_3 + 8H_2O \rightarrow 2\,MnO_4^- + 10\,SO_4^{2-} + 16H^+$

  Properties : Intense colour, weak temperature dependent paramagnetism

  $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

  Oxidizes $I^-$ to $I_2$, $Fe^{2+}$ to $Fe^{3+}$, $C_2O_4^{2-}$ to $CO_2$, $S^{2-}$ to S, $SO_3^{2-}$ to $SO_4^{2-}$, $NO_2^-$ to $NO_3^-$




### f– Block Transition Elements

#### Lanthanoid contraction is progressive decrease in atomic/ionic radii from $La^{3+}$ to $Lu^{3+}$

#### Actinoids

- Electronic : configuration $[Rn]5f^{1-14}\,6d^{0-2}7s^2$
- Ionic sizes : Gradual decrease along the series
- Oxidation states : Most common is +3. They show ON of +4, +5, +6 and +7.
- **General characteristics :**
  - –Silvery in appearance
  - –Display variety of structures
  - –Highly reactive metals
  - –Irregularities in metallic radii, greater than in Lanthanoids.
  - –Magnetic properties more complex than lanthanoids.

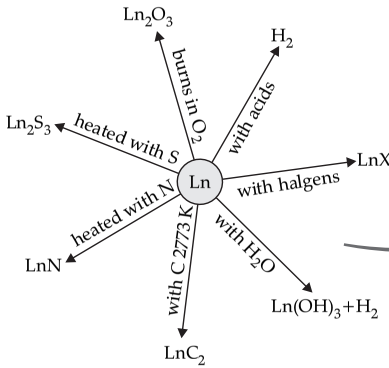
#### Lanthanoids

- Electronic configuration $4f^{1-14}\,5d^{0-1}\,6s^2$
- Atomic and ionic sizes

  Decreases from La to Lu
- Oxidation states

  Most common is +3. Some elements exhibit +2 and +4.
- General characteristics
  - •Silvery while soft metals and tarnish rapidly in air.
  - •Hardness increases with increasing atomic number.
  - •Metallic structure and good conductors of heat and electricity.
  - •Variable density
  - •Trivalent Lanthanoid ions are coloured.
- Ionisation Enthalpies : Low third ionisation enthalpies
- Good reducing agents.

#### Chemical Properties



# MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 9

## Coordination Compounds

### Terms

- **Coordination entity :** A central metal atom/ion bonded to fixed number of ions or molecules. $[Ni(CO)_4]$
- **Central atom/ion :** Atom/ion to which a fixed number of ions/groups are bound in a definite geometrical arrangement.
- **Ligands :** Ions or molecules bound to central atom/ion types : Unidentate – single donor, Didentate –two donors Polydentate – several donors, Chelating – Di-or polydentate which forms more than one coordinate bonds. Ambidentate : Can ligate through two different atoms.
- **Coordination number :** No. of ligand donor atoms to which metal is directly bonded
- **Coordination sphere :** Central atom/ion and the ligands attached to it and enclosed in square bracket.
- **Coordination polyhedron :** spatial arrangement of ligand atoms with central atom/ion.
- **Oxidation number :** Charge of central atom if all ligands are removed along with e– pairs shared with central atom.
- **Homoleptic complex :** Metal is bound to one type of donor groups. $[Co(NH_3)_6]_{3+}$
- **Heteroleptic complex :** Metal is bound to more than one type of donor groups

Compounds in which a central metal atom or ion is linked to a fixed number of ions or molecules through coordinate bonds.

Stability : expressed by equilibrium constant $B_n = k_1 \times k_2 \times k_3 \times \ldots\ldots k_n$

Double salt : Dissociate completely into simple ions when dissolved in water. (Mohr's salt $FeSO_4.(NH_4)_2SO_4.6H_2O$

Complex compound : Do not dissociate into simple ions when dissolved in water. ($K_4[Fe(CN)_6$)

Naming of mononuclear

- Cation is named first.
- Naming of ligands in alphabetical order.
- Anionic ligands end in–o, neutral and cationic are same
- Prefixes mono, di, tri etc. are used.
- Followed by roman numeral in parentheses.

Formulas of mononuclear

- Central atom is listed first
- Ligands in alphabetical order.
- Formula is enclosed in square bracket.
- Polyatomic ligands in parenthesis.
- No space between ligand and metal.
- Charge is indicated outside brackets.
- Charge of cation(s) balanced by charge of anion(s)

### Bonding

Valance bond theory

Metal atom/ion under the influence of ligands can use its (n–1)d, ns, np or ns, np, nd orbitals for hybridisation; $sp^3$(Tetrahedral), $dsp^2$(square) planar, $sp^3d$ (Trigonal pyramidal), $sp^3d^2$ and $d^2sp^3$ (Octahedral); Magnetic moment $= \sqrt{n(n+2)}$ BM

In metal carbonyls

Metal–carbon bond possess both σ and π character

Crystal field theory

Ligands are point charges and there is electrostatic force of attraction between ligands and metal atom/ion. Degeneracy of d orbitals is lighted causing splitting of d orbitals. $\Delta_0$ depends upon the field produced by the ligand and charge on metal ion.

### Colour

Caused by d-d transition; the colour is complementary to wavelength absorbed

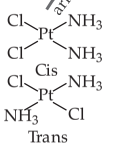
### Isomerism

**Structural**: different bonds

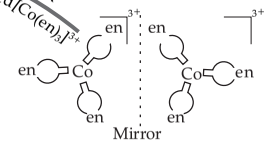
- $[CO(NO_2)(NH_3)_5]Cl$ / $[CO(ONO)(NH_3)_5]Cl$ — Linkage occurs in ambidentate ligand
- $[CO(NH_3)_6][Cr(CN)_6]$ / $[Cr(NH_3)_6][CO(CN)_6]$ — Coordination interchange of ligands between catonic and anionic entities of different metal ions
- $[Co(NH_3)_5SO_4]Br$ / $[CO(NH_3)_5Br]SO_4$ — Ionisation counter ion is a potential ligand and can displace a ligand
- $[Cr(H_2O)_6]Cl_3$ / $[Cr(H_2O)_5Cl]Cl_2.H_2O$ — Solvate differ in number of water molecules attached to metal atom/ion.

Stereoisomerism : different spatial arrangements

Geometrical : Different arrangement Ligand




Optical: images which cannot be superimposed $[Co(en)_3]^{3+}$




### Werner's Theory: Postulates

- In coordination compounds metals show primary and secondary linkages (valances)
- Primary valences are ionisable and are satisfied by negative ions.
- Secondary valences are non-ionisable and are satisfied by neutral molecules or negative ions.
- Ions/groups bound by secondary linkages to metal have characteristic spatial arrangements corresponding to different coordination numbers.

### Uses

- In qualitative and quantitative chemical analysis.
- Estimation of hardness of water.
- In extraction metals.
- In purification of metals.
- In biological systems.
- As catalysts for industrial processes.
- In black and white photography.
- In medicinal chemistry.

# MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 10

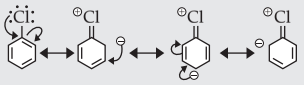
## Haloalkanes and Haloarenes

### Polyhalogen compounds

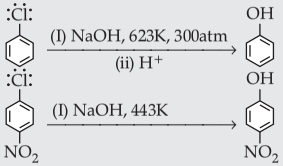
- Chloroform
  - Iodoform
    - Antiseptic
  - Carbon tetrachloride
    - Manufacture of refrigerants and propellants.
    - Cleaning fluid
  - Freons
    - For aerosol propellants, refrigeration and air conditioning purposes
  - D.D.T.
    - As insecticide
  - Dichloromethane
    - Paint remover
    - Propellant in aerosols
    - Metal cleaning and finishing solvent.
- Solvent for fats, alkaloids, I etc.
- Production of Freon

### Haloarenes

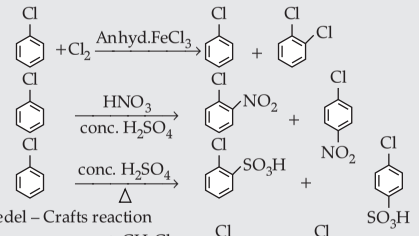
- Reactions :
- (a) Nucleophilic substitution
  - (i) Resonance effect



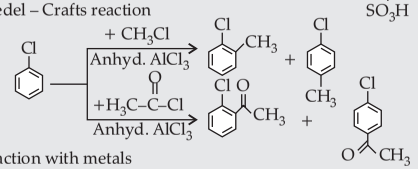
  - (ii) Hybridization of C – X bond in : Haloalkane –$sp^3$; Haloarence –$sp^2$
  - (iii) Phenyl cation unstabilised by resonance




- (b) Electrophilic substitution

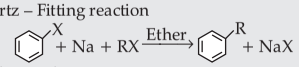



Friedel – Crafts reaction

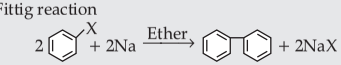



- (c) Reaction with metals

Wurtz – Fitting reaction




Fittig reaction




### Racemisation $S_N1$

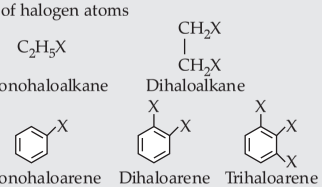
- Chiral : Objects which are non-superimposable
- Achiral : objects which are superimposable

### $S_N2$ Stereochemical inversion

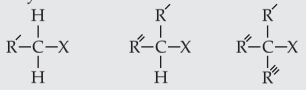
- (a) Dextro (+/d)
- (b) laevo (–/l)

### Classification

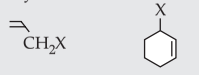
- No. of halogen atoms




- Compounds containing $sp^3$ C–X bond
  - (a) Alkyl halides

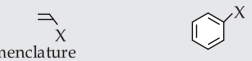


  - (b) Allylic halides




  - (c) Benzylic halides


- Compounds containing $sp^2$ C–X bond
  - (a) Vinylic halides
  - (b) Aryl halides



- Nomenclature

Common name : alkyl group followed by halides. Dihalogen derivatives, prefixes o–, m–, p– are used.

IUPAC name : numerals are used

- Nature of C –X bond

: Carbon –halogen bond is polarized



### Haloalkanes

- Preparation
  - From alcohol :

$R–OH + HCl \xrightarrow{ZnCl_2} R–Cl + H_2O$

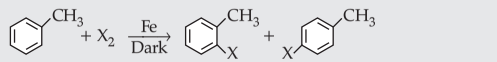
$3R–OH + PX_3 \longrightarrow 3R–X + H_3PO_3$

$ROH + PCl_5 \longrightarrow R–Cl + POCl_3 + HCl$

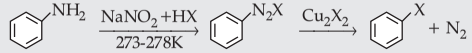
  - From hydrocarbons :
    - (a) By free radical halogenations

$CH_3CH_2CH_2CH_3 \xrightarrow{Cl_2/UV} CH_3CH_2CH_2CH_2Cl + CH_3CH_2CHClCH_3$

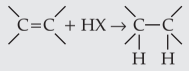
    - (b) By electrophilic substitution

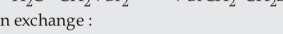



    - (c) Sand meyer's reaction




    - (d) From alkenes




  - Halogen exchange :

$R–X + NaI \rightarrow R–I + NaX$

- Properties
  - Physical : Colourless, volatile, sweet smell.

Lower members are gases at room temperature while higher are solids.

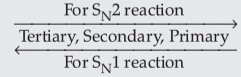
B.P : RI > R Br > RCl > RF.

M.P : Para isomers have high m.p. than ortho and meta – isomers.

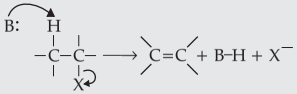
Density : Increases with increase in number of C/X atoms and atomic masses of the X atoms.

Solubility : Very slightly soluble in water.

  - Chemical :
    - (a) Nucleophilic substitution




    - (b) Elimination reaction




B = Base; X = Leaving group

    - (c) Reaction with metals

$CH_2CH_2Br + M \longrightarrow CH_3CH_2MgBr$

Wurtz reaction :

$2RX + 2Na \xrightarrow{Dry\ ether} RR + 2NaX$

# MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 11

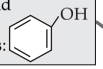
## Alcohols, Phenols And Ethers

### Classification

(i) Containing $C_{sp3}$ – OH bond

$-CH_2OH$ (1°) > CHOH (2°) ≥ COH (3°)

(ii) Containing $C_{sp2}$-OH bond

Vinylic alcohol : $CH_2 = CH - OH$ Phenols: 

Mono, Di, Tri, or polyhydric :

(i) Simple/symmetrical : Alkyl or aryl attached to $O_2$ are same.
(ii) Mixed/Unsymmetrical : Two groups are different.

Ethers

Common name : Alkyl group + ol; IUPAC name : substituting 'e' of alkane with suffix 'ol'

Alcohols

Common name : Terms ortho, meta and para are used. IUPAC name : Dihydroxy derivatives as 1,2–, 1,3–and 1,4–benzenediol

Phenols

Common name : alkyl/aryl groups in alphabetical order followed by ether. IUPAC name : In alkyl /aryl group 'e' replaced by oxy followed by parent hydrocarbon.

Ethers

### Nomenclature

•Oxygen of –OH group is attached to C by a σ bond formed by the overlap of $sp^3$ orbital of C with a $sp^3$ orbital of oxygen.
•In ethers, tetrahedral arrangement for four electron pairs.

Structures of functional groups

### Properties

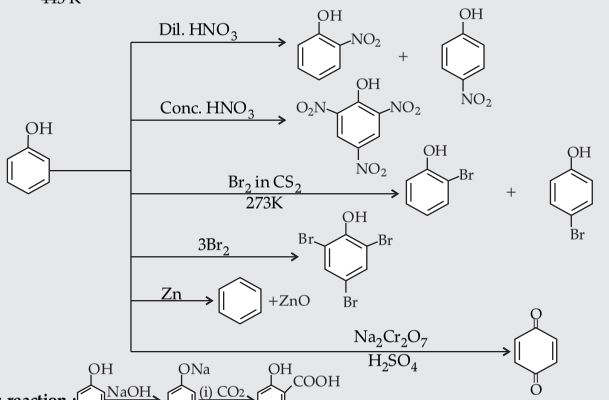
Alcohols

**(i) Physical :** •Boiling point increases with increase in the number of C atoms.
•Solubility decreases with increase in size of alky/aryl groups.

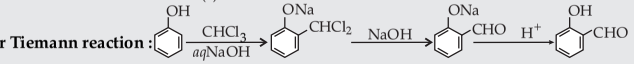
**(ii) Chemical :** $2R–O–H + 2Na \longrightarrow 2R–O–Na + H_2$ ;Acidity – primary > secondary > tertiary

$Ar/RO - H + R' - COOH \overset{H^+}{\rightleftharpoons} Ar/ROCOR' + H_2O$; $ROH + HX \longrightarrow R - X + H_2O$

$C_2H_5OH \xrightarrow[443\,K]{H_2SO_4} CH_2 = CH_2 + H_2O$; $RCH_2OH \xrightarrow{Oxidations} R\text{-}\underset{H}{\overset{H}{C}}=O \longrightarrow R\text{-}\underset{H}{C}=O$




**Kolbe's reaction :** 

**Reimer Tiemann reaction :** 

### Preparation

Alcohols

**1. From alkenes :-** (i) By acid catalysed hydration $>C=C< + H_2O \overset{H^+}{\rightleftharpoons} >\underset{H}{C}-\underset{OH}{C}<$

(ii) By hydroboration – oxidation

$CH_3–CH=CH_2 + (H–BH_2)_2 \longrightarrow CH_3–\underset{H}{CH}–\underset{BH_2}{CH_2} \xrightarrow{CH_3–CH=CH_2} (CH_3–CH_2–CH_2)_2BH$

$3CH_3–CH_2–CH_2–OH + B(OH)_3 \xrightarrow[3H_2O_2,OH]{H_2O} CH_3–CH_2–CH_2)_3B + CH_3–CH_2–CH_2$

**2. From carbonyl compounds :**

(i) By reduction of aldehydes and ketones

$RCHO + H_2 \xrightarrow{Pd} RCH_2OH, RCOR' \xrightarrow{NaBH_4} R–\underset{OH}{CH}–R'$

(ii) By reduction of carboxylic acids and esters

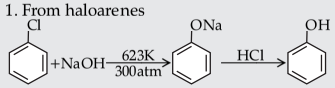
$RCOOH \xrightarrow[H^+]{R'OH} RCOOR' \xrightarrow[catalyst]{H_2} RCH_2OH + R'OH$

**3. From Grignard reagent**

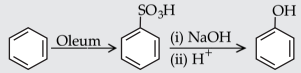
$>C=O + R–MgX \longrightarrow \left[>\underset{R}{C}–OMg–X\right] \xrightarrow{H_2O} >\underset{R}{C}–OH + Mg(OH)X$

Phenols

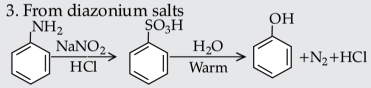
1. From haloarenes



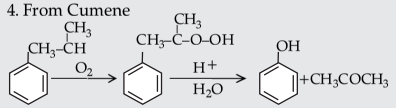

2. From benzene sulphonic acid




3. From diazonium salts




4. From Cumene



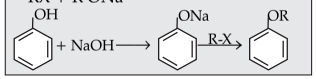

Ethers

1. By dehydration of alcohols

$CH_3CH_2OH \xrightarrow[413\,K]{H_2SO_4} C_2H_5OC_2H_5$

2. Williamson synthesis

$RX + R'ONa \longrightarrow R–O–R' + NaX$




### Commercially important alcohols

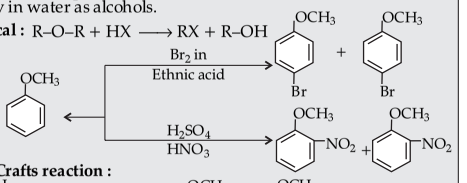
• **Methanol (Wood spirit) :**
Used as solvent in paint, varnishes and making formaldehyde

• **Ethanol :**
Used as solvent in paint industry and preparation of a number of carbon compounds.

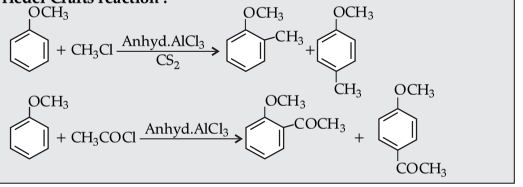
Ethers

**(i)Physical :**
• C–O bonds are polar.
• Boiling points comparable to those of alkanes.
• Solubility in water as alcohols.

**(ii)Chemical :** $R–O–R + HX \longrightarrow RX + R–OH$




**Friedel Crafts reaction :**



# MIND MAP : LEARNING MADE SIMPLE

## CHAPTER - 12

**Aldehydes, Ketones and Carboxylic Acids**

### Properties

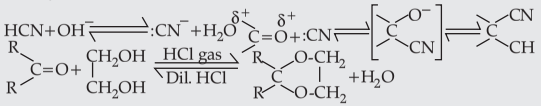
**ALDEHYDES AND KETONES:**

**(i) Physical:**

Boiling points are higher than hydrocarbons and ethers of comparable molecular masses.

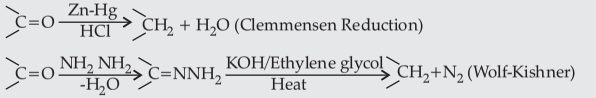
**(ii)Chemical :Nucleophilic addition reactions :**

Aldehydes are more reactive than ketones due to steric and electronic reasons.



**Reduction :** (a) To alcohols – aldehydes and ketones reduce to primary and. secondary alcohols respectively by $NaBH_4$ or $LiAlH_4$.

(b) To hydrocarbons –

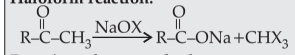


**Oxidation:** $RCHO \xrightarrow{[O]} R\text{–}COOH$

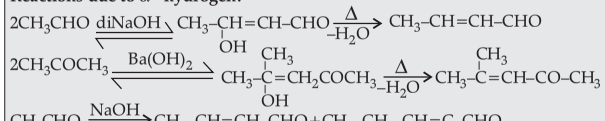
**Tollen's test :** $RCHO + 2[Ag(NH_3)_2]^+ + 3OH^- \longrightarrow RCOO^- + 2Ag + 2H_2O + 4NH_3$

**Fehling's test :** $RCHO + 2Cu^{2+} + 5OH^- \longrightarrow RCOO^- + Cu_2O + 3H_2O$ (Red brown ppt)

**Haloform reaction:**

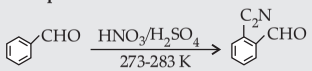


**Reactions due to α - hydrogen:**



Cannizzaro reaction : $2HCHO + \text{conc } KOH \xrightarrow{\Delta} CH_3OH + HCOOK$

**Electrophilic substitution reaction:**

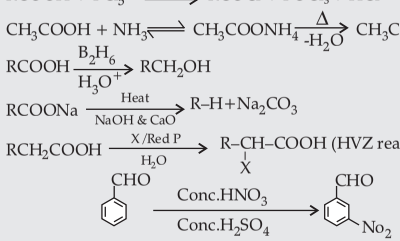


**Carboxylic acids:**

**(i) Physical:** Higher boiling points than aldehydes, ketones or alcohols. Solubility decreases with increasing number of C atoms

**(ii)Chemical :** $2RCOOH + 2Na \longrightarrow 2RCOONa + H_2$

Forms corresponding anhydride on heating with mineral acids



### Nomenclature

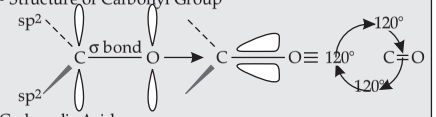
1. Aldehydes and Ketones

Common names :

- Replace corresponding carboxylic acids with aldehyde
- Alkyl phenyl ketones by adding acyl group as prefix to phenone.

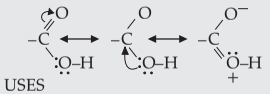
IUPAC names :

- Replacing –e with –al and –one as required.
- Structure of Carbonyl Group



2. Carboxylic Acids

- Common names : end with –ic
- IUPAC names : replace –e in the corresponding alkane with –oic acid.
- Structure of Carboxyl Group



3. USES

(a) Carboxylic acids

- Methanoic acid in rubber, textile, dyeing, leather industries.
- Ethanoic acid as solvent
- Higher tatty acids in manufacture of soaps and detergents.

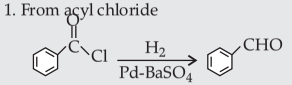
(b) Aldehydes of ketones

- As solvents.
- Starting materials and reagents for synthesis of products.

### Preparation

**ALDEHYDES:**

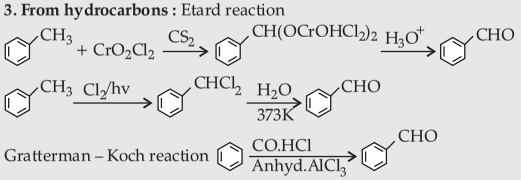
1. From acyl chloride



**2. From nitriles and esters :** Stephen reaction

$RCN + SnCl_2 + HCl \longrightarrow RCH = NH \xrightarrow{H_3O^+} R\,CHO$

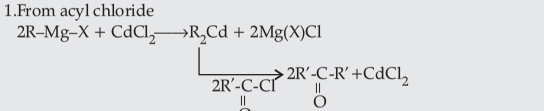
**3. From hydrocarbons :** Etard reaction



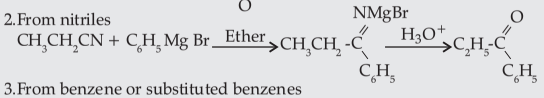
Gratterman – Koch reaction 

**KETONES:**

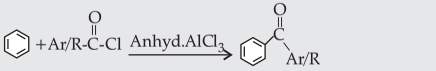
1.From acyl chloride



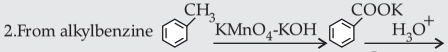
2.From nitriles



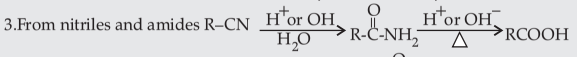
3.From benzene or substituted benzenes

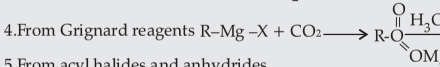


**Carboxylic Acids:**

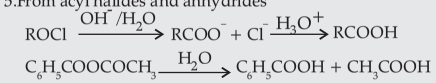
1.From primary alcohols and aldehydes 

2.From alkylbenzene 

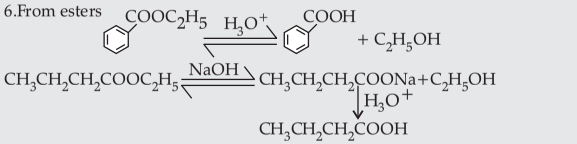
3.From nitriles and amides R–CN 

4.From Grignard reagents R–Mg –X + $CO_2$ 

5.From acyl halides and anhydrides



6.From esters



# MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 13

## Amines

### Chemical reactions

**(i) Basic character of amines**

- Reacts with acids to form salts $R-NH_2 + HX \rightleftharpoons R-NH_3X$ (salt)
- Reacts with base to regenerate parent amines
  $RNH_3X + OH \longrightarrow RNH_2 + H_2O + X$
- Order of stability of ions : $1° > 2° > 3°$

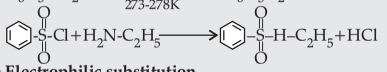
**(ii)** $C_2H_5-NH+CH_3-\underset{O}{\overset{}{C}}-Cl \xrightarrow[\text{Base}]{} C_2H_5-N(C_2H_5)-\underset{O}{\overset{}{C}}-CH_3+HCl$

**(iii) Carbylamines reaction :** $R-NH_2 + CHCl_3 + 3KOH \xrightarrow{\Delta} R-NC + 3KCl + 3H_2O$

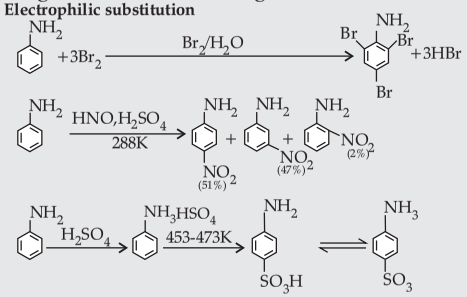
**(iv) With nitrous acid**

$RNH_2 + HNO_2 \xrightarrow{NaNO_2+HCl} [R-N_2Cl] \xrightarrow{H_2O} ROH + N_2 + HCl$

$C_6H_5NH_2 \xrightarrow[273-278K]{NaNO_2+HCl} C_6H_5N_2Cl + NaCl + 2H_2O$

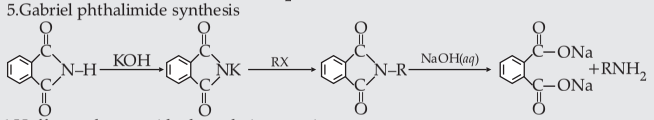
**(v)** 

**(vi) Electrophilic substitution**



### Preparation :

1. Reduction of nitro compounds: $Ar-NO_2 \xrightarrow[\text{Ethanol}]{H_2/Pd} Ar-NH_2$ ; $Ar-NO_2 \xrightarrow[\text{or Fe+HCl}]{Sn+HCl} Ar-NH_2$
2. Ammonolysis of alkyl halides: $NH_3 + R-X \longrightarrow R-\overset{+}{N}H_3\overset{-}{X}$
3. Reduction of nitriles: $R-C\equiv N \xrightarrow[Na(Hg)/C_2H_5]{H_2/Ni} R-CH_2NH_2$
4. Reduction of amides: $R-\underset{O}{\overset{}{C}}-NH_2 \xrightarrow[H_2O]{LiAlH_4} R-CH_2-NH_2$
5. Gabriel phthalimide synthesis



6. Hoffmann bromamide degradation reaction

$R-\underset{O}{\overset{}{C}}-NH_2 + Br_2 + 4NaOH \longrightarrow R-NH_2 + Na_2CO_3 + 2NaBr + 2H_2O$

### Physical properties

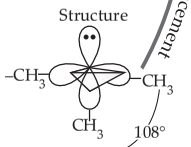
- Lower aliphatic amines are gases. Primary amines with three or more C atoms are liquid and higher ones are solid.
- Arylamines are colourless but get coloured on storage.
- Lower aliphatic amines are soluble in water, while higher are insoluble.
- Primary and secondary amines form intermolecular association
- Boiling point : primary > secondary > tertiary

### Importance of diazonium salts in synthesis of aromatic compounds :

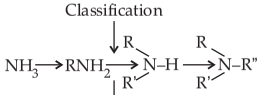
In preparation of substituted aromatic compounds which cannot be prepared by direct substitution in benzene/ substituted benzene.

### Derivatives of ammonia, obtained by replacement of one, two or all the three Hatoms by alkyl and/or aryl groups

Structure



Classification



**Nomenclature:**

**Common name :** Aliphatic amine is named by prefixing alkyl group to amine. In secondary and tertiary amines prefix di or tri is put before name of alkyl group. IUPAC name : replacement of 'e' of alkane by the word amine. Suffix 'e' of arene is replaced by amine.

### Diazonium Salts ($RN_2^+X^-$)

**Preparation :**

$C_6H_5NH_2 + NaNO_2 + 2HCl \xrightarrow{273-278K} C_6H_5N_2Cl + NaCl + 2H_2O$

**Physical properties :** Colourless crystalline solid, soluble in water, stable in cold but reacts with water on warming.

**Chemical properties :**

(i) Sandmeyer reaction: $ArN_2X \xrightarrow[Cu_2Br_2/HBr]{Cu_2Cl_2/HCl} ArCl + N_2$ ; $\xrightarrow{} ArBr + N_2$ ; $\xrightarrow[CuCN/KCN]{} ArCN + N_2$

**Gattermann reaction :**

$ArN_2X \xrightarrow[Cu/HBr]{Cu/HCl} ArCl + N_2 + CuX$ ; $\xrightarrow{} ArBr + N_2 + CuX$

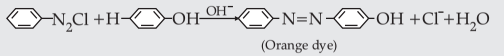
(ii) $ArN_2Cl + KI \longrightarrow ArI + KCl + N_2$

(iii) $ArN_2Cl + HBF_4 \longrightarrow ArN_2BF_4 \xrightarrow{\Delta} ArF + BF_3 + N_2$

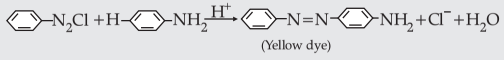
(iv) $ArN_2Cl + H_3PO_2 + H_2O \longrightarrow ArH + N_2 + H_3PO_3 + HCl$

(v) $ArN_2Cl + H_2O \longrightarrow ArOH + N_2 + HCl$

(iv) **Coupling reaction :**



(Orange dye)



(Yellow dye)

# MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 14

## Biomolecules

### Proteins

(Polymers of α–amino acids)
Amino acids contain $–NH_2$ and –COOH group.

**Classification:**

- On the basis of relative number of $–NH_2$ and –COOH group
  - (I) Neutral–equal number of $–NH_2$ and –COOH group.
  - (ii) Basic – more number of $–NH_2$ than –COOH group.
  - (iii) Acidic – more number of –COOH than $–NH_2$ group.
- On the basis of place of synthesis
  - (i) Essential – cannot be synthesized in the body.
  - (ii) Non-essential – synthesized in the body.
- On the basis of shape
  - (I) Fibrous – fibre –linke structure
  - (ii) Globular – spherical

Structure : $H_2N – CH_2 –$ [CO–NH] (Peptide linkage) $– CH(CH_3) – COOH$

**Denaturation of proteins :**
When a protein in its native form is subjected to physical change, globules unfold, helix get uncoiled and protein loses its biological activity.

### Carbohydrates

Optically active polyhydroxy aldehydes or ketones or compounds which produce such units on hydrolysis.

- **Classification:**

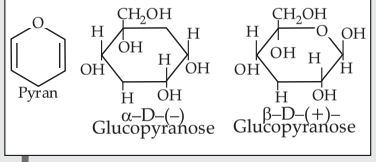
(I) Monosaccharides : (Aldehyde group – aldose, keto group –ketose)
Glucose : Preparation :

(a) From sucrose : $C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$
Sucrose → Glucose + Fructose

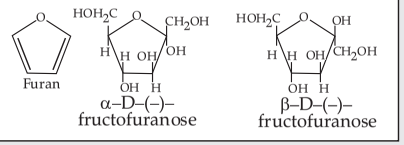
(b) From starch : $(C_6H_{10}O_5)n + nH_2O \xrightarrow[393K;\ 2\text{-}3\ atm]{H^+} nC_6H_{12}O_6$

- **Structure:** CHO–(CHOH)$_4$–CH$_2$OH

Cylcic Structure




Structure of Fructose




CHO–(CHOH)$_4$–CH$_2$OH reacts with:

- HI, Δ → $CH_3CH_2CH_2CH_2CH_3$
- $NH_2OH$ → CH=N–OH, (CHOH)$_4$, CH$_2$OH
- HCN → CH(CN)OH, (CHOH)$_4$, CH$_2$OH
- $Br_2$ Water → COOH, (CHOH)$_4$, (CH$_2$OH)
- Acetic Anhydride → CHO, O, (CH–O–C–CH$_3$)$_4$, O, CH$_2$–O–C–CH$_3$
- Oxidation → COOH, (CHOH)$_4$, COOH

(ii) Disaccharides : Linkage between 2 monosaccharides– Glycosidic linkage (Sucrose, maltose)
(iii) Polysaccharides : Large number of monosaccharides units joined by glycosidic linkages.
(a) Starch : Polymer of α–glucose with two components amylase and amylopectin
(b) Cellulose
(c) Glycogen

**Importance:**

- Form a major portion of food.
- As storage molecules.
- Cellulose forms cell wall of bacteria and plants.
- Raw materials for industries like textiles, paper, lacquers and breweries.

### Vitamins

Organic compounds required in diet in small amounts to perform specific biological functions for maintenance and growth.

**Classification:**
(i) Fat soluble : Soluble in fats and oils but insoluble in water. (vitamins A,D,E and K)
(ii) Water soluble : B group and vitamin C are soluble in water.

### Nucleic Acids

**Chromosomes :** Particles in nucleus responsible for heredity. Chromosomes are made up of proteins and nucleic acid.
**Two types :** Deoxyribonucleic acid (DNA), ribonucleic acid (RNA)
**Composition :** In DNA, sugar is β–D–2–deoxyribose whereas in RNA is β–D–ribose. DNA contains A,G,C,T whereas RNA has A,G,C,U.
**Structure : –**
**Nucleoside :** Formed by attachment of a base to 1′ of sugar′
Nucleotide : Formed by link to phosphoric acid at 5′ of sugar.

Base / Sugar–Phosphate–[Base / Sugar–Phosphate]–Base / Sugar–

Types of RNA : m–RNA, r–RNA, t–RNA

**Biological Functions :**

- Chemical basis of heredity.
- Responsible for identity of different species of organisms.
- Nucleic acids are responsible for protein synthesis in cell.

### DNA Fingerprinting: Unique sequence of bases on DNA.

### Enzymes

Globular proteins specific for particular reaction and for particular substrate. Mechanism : Reduces the magnitude of activation energy

# MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 15

**Polymers**

Very large molecules having high molecular mass

Copolymerization : A mixture of more than one monomeric species undergoes polymerization

$nCH_2=CH-CH=CH_2 + C_6H_5(CH=CH_2) \longrightarrow [CH_2-CH=CH-CH_2-CH(C_6H_5)-CH_2]_n$

Butadiene + Styrene → Butadiene – styrene copolymer

Rubber

Types :

**(i) Natural rubber :** natural and manufactured from rubber latex. It is a liner polymer of isoprene.

**(ii) Synthetic rubber :** Any vulcanisable rubber. These are homopolymers of 1,3 butadiene derivatives.

$N-CH_2=\underset{\displaystyle C}{\underset{|}{Cl}}-CH=CH_2 \xrightarrow{\text{Polymerisation}} [CH_2-\underset{\displaystyle Cl}{\underset{|}{C}}=CH-CH_2]_n$

Molecular mass of polymers

- Expressed as an average.
- Determined by chemical and physical methods.

Biodegradable polymers

Contain functional groups similar to biopolymers (PHBV, Nylon 2– nylon 6)

Classification

- **Based on source**:
  - **(i) Natural polymers :** Found in plants and animals. (Proteins, rubber)
  - **(ii) Semi–synthetic polymers :** (Cellulose derivatives)
  - **(iii) Synthetic polymers :** Man-made. (Polythene, Buna –S)
- **Based on structure of polymers high density**:
  - **(i) Linear polymers :** Long and straight. (Polythene, PVC)
  - **(ii) Branched chain polymers :** Linear chains with branches (low density polythene)
  - **(iii) Cross linked or network polymers :** Strong covalent bond between various linear polymer chains. (Bakelite, Melamine)
- **Based on mode of polymerization**:
  - **(i) Addition polymers :** Repeated addition of monomers containing double or triple bonds. (Polythene from ethene )
    Homopolymer : Single monomeric species (Polythene)
    Copolymer : Two different monomers (Buna–S, Buna–N)
  - **(ii) Condensation polymers :** Repeated condensation between two different bi–functional or tri–functional monomeric units. (Terylene, Nylon 6)
- **Based on Molecular Forces:**
  - **(I) Elastomers :** Rubber–like solids with elastic properties (Buna–S, Buna–N)
  - **(ii) Fibres :** Thread forming solids. (Nylon 6,6, Terylene)
  - **(iii) Thermoplastic polymers :** Linear or slightly branched long chain molecules capable of repeatedly softening on heating and hardening on cooling. (polythene, polystyrene)
  - **(iv) Thermosetting polymers :** Cross linked or heavily branched molecules which on heating undergo extensive cross linking in moulds and become infusible. (Bakelite)

Preparation

- Polythene
  Low density : Polymerization of ethene under 1000–2000 atm at 350–570 K + catalyst
  Higher density : addition polymerization of ethene in a hydrocarbon solvent at 333–343 K and 6–7 atm + catalyst
- Teflon: $nCF_2 = CF_2 \xrightarrow[\text{High pressure}]{\text{Catalyst}} [CF_2-CF_2]_n$
- Polyacrylonitrile: $nCH_2=CHCN \xrightarrow[\text{Peroxide}]{\text{Polymerisation}} [CH_2-\underset{\displaystyle CN}{\underset{|}{CH}}]_n$
- Nylon 6,6: $nHOOC(CH_2)_4COOH + nH_2(CH_2)_6NH_2 \xrightarrow{\text{533K, High pressure}} [-N-(CH_2)_6-N-C-(CH_2)_4-C-]_n$
- Nylon 6: Caprolactum $\xrightarrow[H_2O]{\text{533 - 543 K}} [-C-(CH_2)_5-N-]_n$

Types of Polymerization Reactions

- (i) Addition/Chain Growth : Molecules of the same/different monomers add together on a large scale.
  Free radical mechanism :
  (a) Chain initiation step:
  $C_6H_5-C(=O)-O-O-C(=O)-C_6H_5 \longrightarrow 2C_6H_5-C(=O)-O\cdot \longrightarrow 2C_6H_5\cdot$
  $C_6H_5\cdot + CH_2=CH_2 \longrightarrow C_6H_5-CH_2-CH_2\cdot$
  (b) Chain propagating step:
  $C_6H_5-CH_2-CH_2\cdot + CH_2=CH_2 \longrightarrow C_6H_5-CH_2-CH_2-CH_2-CH_2\cdot \longrightarrow C_6H_5-(CH_2-CH_2)n-CH_2-CH_2\cdot$
  (c) Chain terminating step:
  $2[C_6H_5-(CH_2-CH_2)n-CH_2-CH_2\cdot] \longrightarrow C_6H_5-(CH_2-CH_2)n-CH_2-CH_2-CH_2-(CH_2-CH_2)n-C_6H_5$
- (ii) Condensation/Step Growth : Repetitive condensation reaction between two bi–functional monomers. (Formation of terylene)

# MIND MAP : LEARNING MADE SIMPLE

## CHAPTER - 16

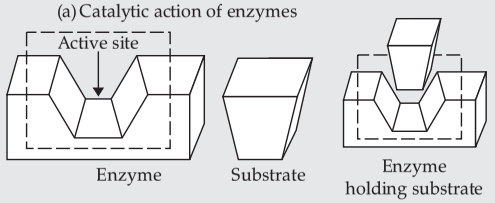
**Chemistry in Everyday Life**

### Therapeutic Action of Different Classes of Drugs

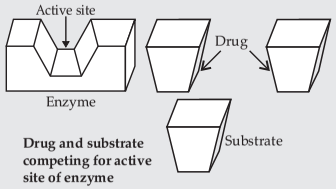
- **Antacids :** Substances that neutralize the excess HCl and raise pH in stomach (Ranitidine, Cimetidine)
- **Antihistamines :** Interfere with natural action of histamine by competing with histamine for binding sites of receptor where histamine exerts its effect
- **Neurologically Active Drugs**
  - (a) **Tranquilizers :** Class of chemical compounds used for the treatment of stress and mild or even severe mental diseases. (Iproniazid, Phenelzine)
  - (b) **Analgesics :** Reduce/abolish pain without causing impairment of consciousness, mental confusion, incoordination or paralysis or other disturbances of nervous system. These are classified as
    - (i) Non-narcotic (non-addictive) : (Aspirin, Paracetamol)
    - (ii) Narcotic : (Morphine)
- **Antimicrobials**
  - (a) Antibiotics : Drugs to treat infections because of their low toxicity for humans and animals. (Prontosil)
  - (b) Antiseptics and Disinfectants : Chemicals which either kill or prevent the growth of microorganisms. Antiseptics are applied to living tissues whereas disinfectants are applied to inanimate objects.
- **Antifertility Drugs :** Birth control pills (Norethindrone, ethynylestradiol)

### Medicines: Chemicals which generate therapeutic and useful biological response

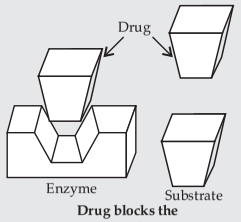
- Drugs are chemicals of low molecular masses. Interact with macromolecular targets to produce a biological response.
- **Classification of drugs:**
  - (a) On the basis of pharmalogical effect : Provides range of drugs available for a particular type of problem. (Analgesics, Antiseptics).
  - (b) On the basis of drugs action : (Antihistamines inhibit action of histamine responsible for causing inflammation in the body.
  - (c) On the basis of chemical structure : Common structural features. (Sulphonamides)
  - (d) On the basis of molecular targets : Most useful.
- **Drugs Target Interaction:**
  - (i) Enzymes as Drug Targets
    - (a) Catalytic action of enzymes



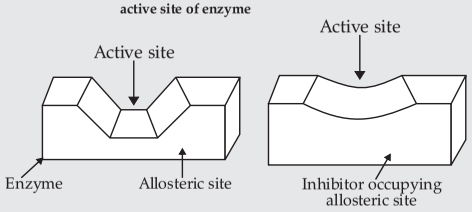

    - (b) Drug–enzyme interaction




Drug and substrate competing for active site of enzyme




Drug blocks the active site of enzyme




  - (ii) **Receptors as Drug Targets**: Receptors are proteins crucial for body's communication and are embedded in cell membrane.

### Chemicals In Food

**Purpose:**

- For their preservation.
- Enhancing their appeal.
- Adding nutritive value.
  - (a) Artificial Sweetening Agents : Natural sweeteners (sucrose), artificial sweeteners (Aspartame, Saccharin)
  - (b) Food Preservatives : Prevent spoilage of food due to microbial growth. (Table salt, sugar)

### Cleansing Agents

#### Types

#### Detergents

(i) **Soap (Saponification)**

Glyceryl ester of stearic acid (fat) + Sodium hydroxide ⟶ Sodium stearate + Glycerol

(ii) **Synthetic Detergents :**

- Anionic detergents : Sodium salts of sulphonated long chain alcohols or hydrocarbons. (sodium salts of alkyl benzene sulphonates)
- Cationic detergents : Quaternary ammonium salts of amines with acetates, chlorides or bromides as anions. (Cetyltrimethylammonium bromide)
- Non-ionic Detergents : Non-ionic type.