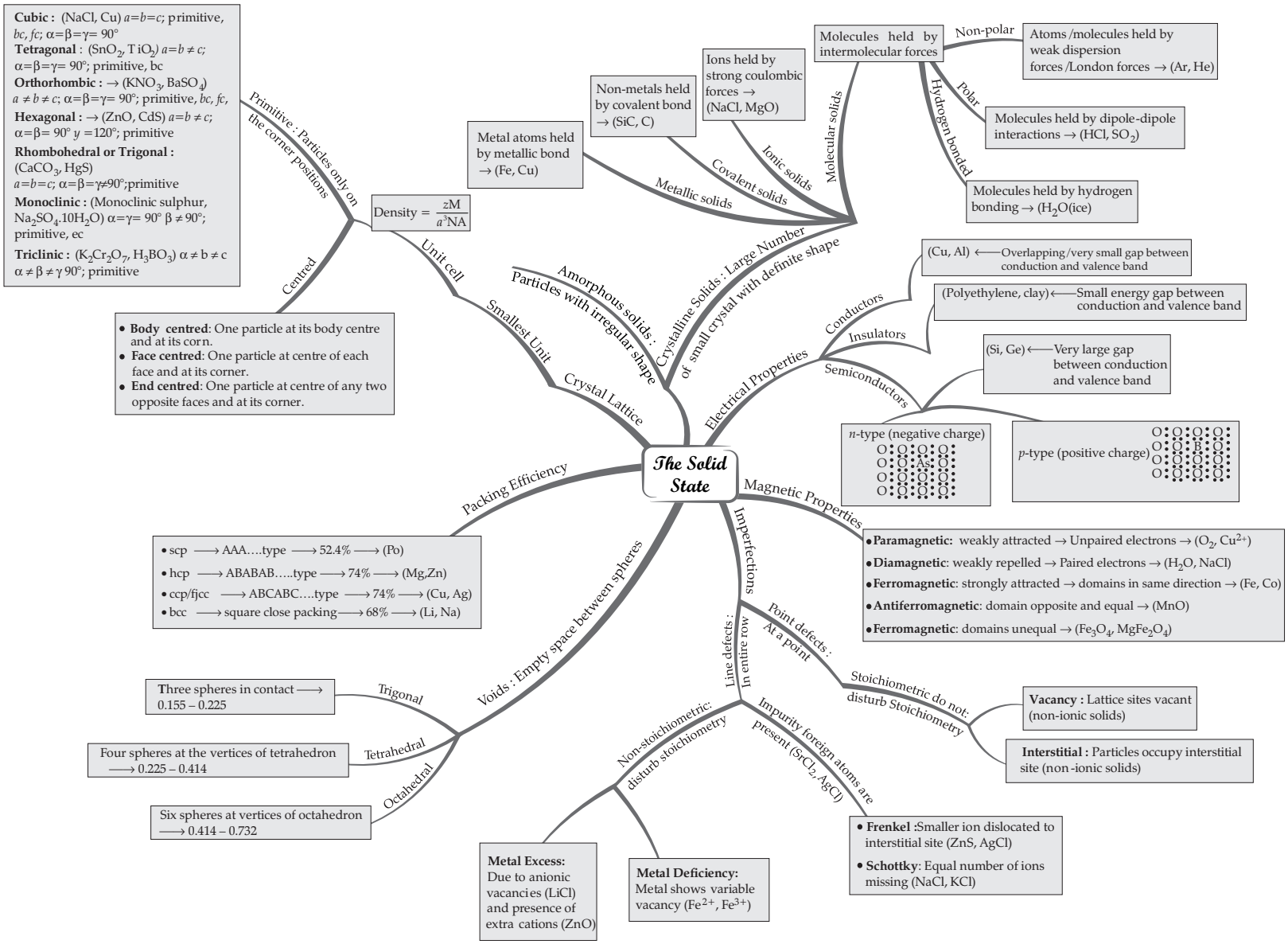
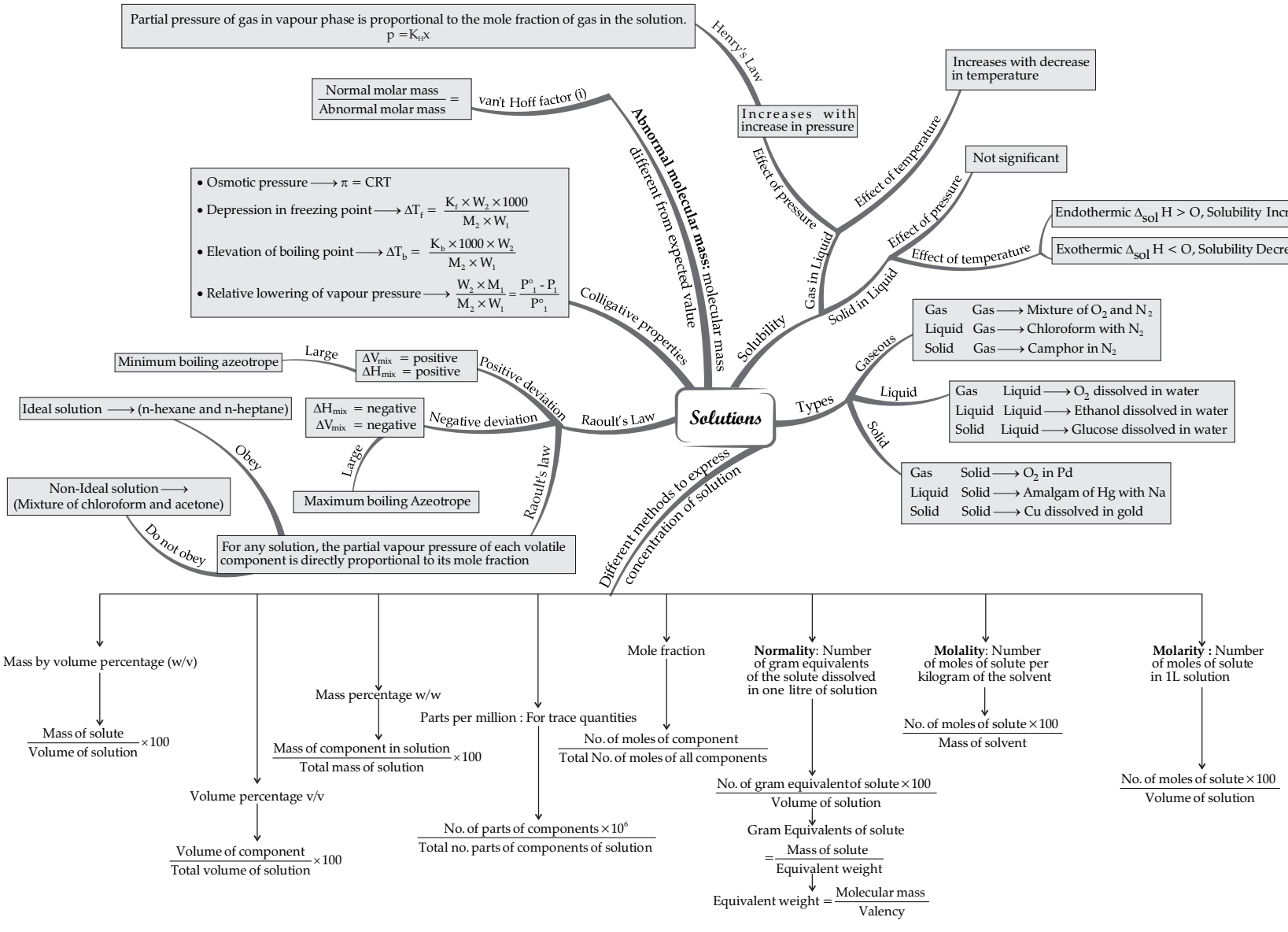
MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 1



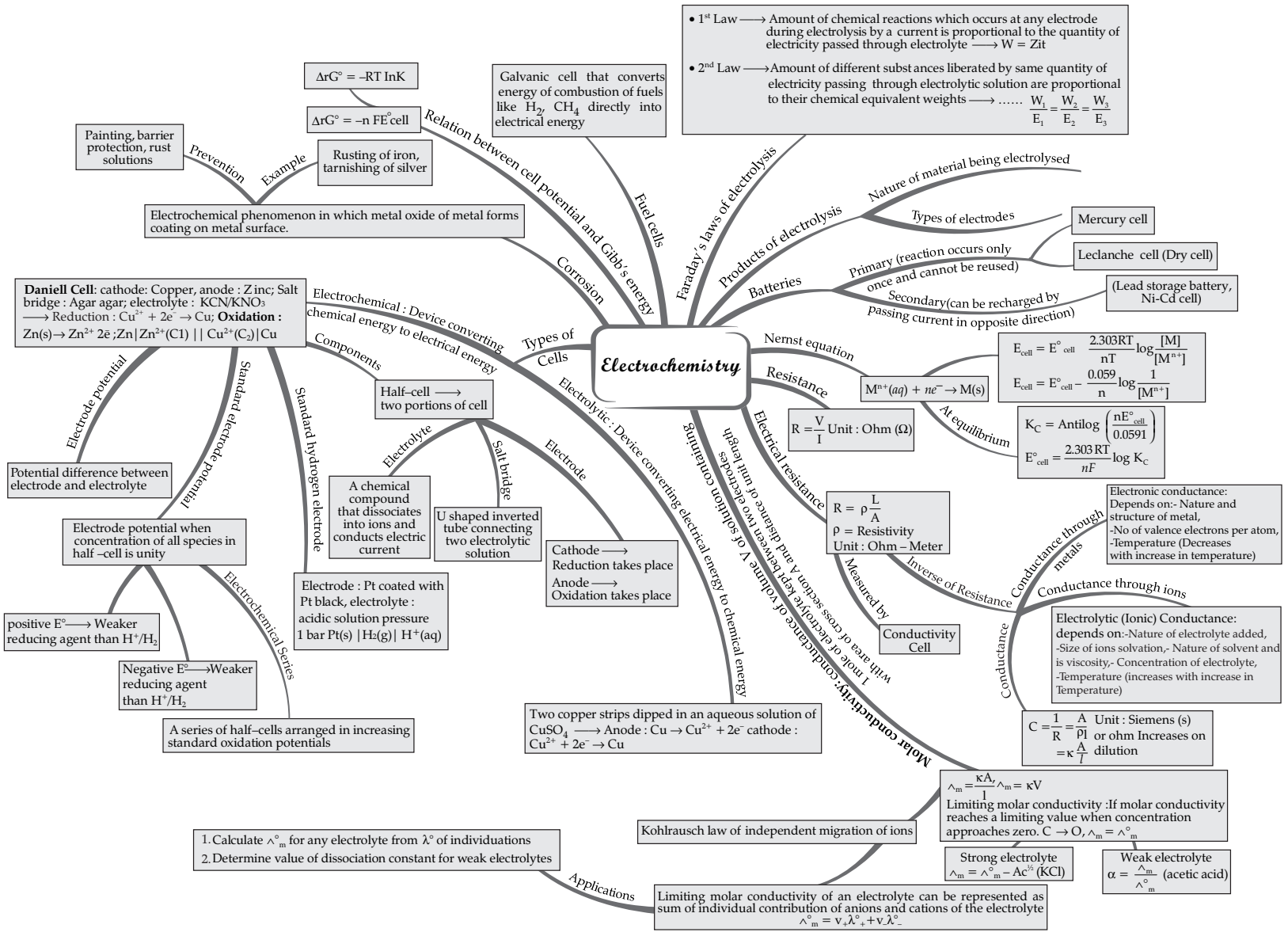
MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 2



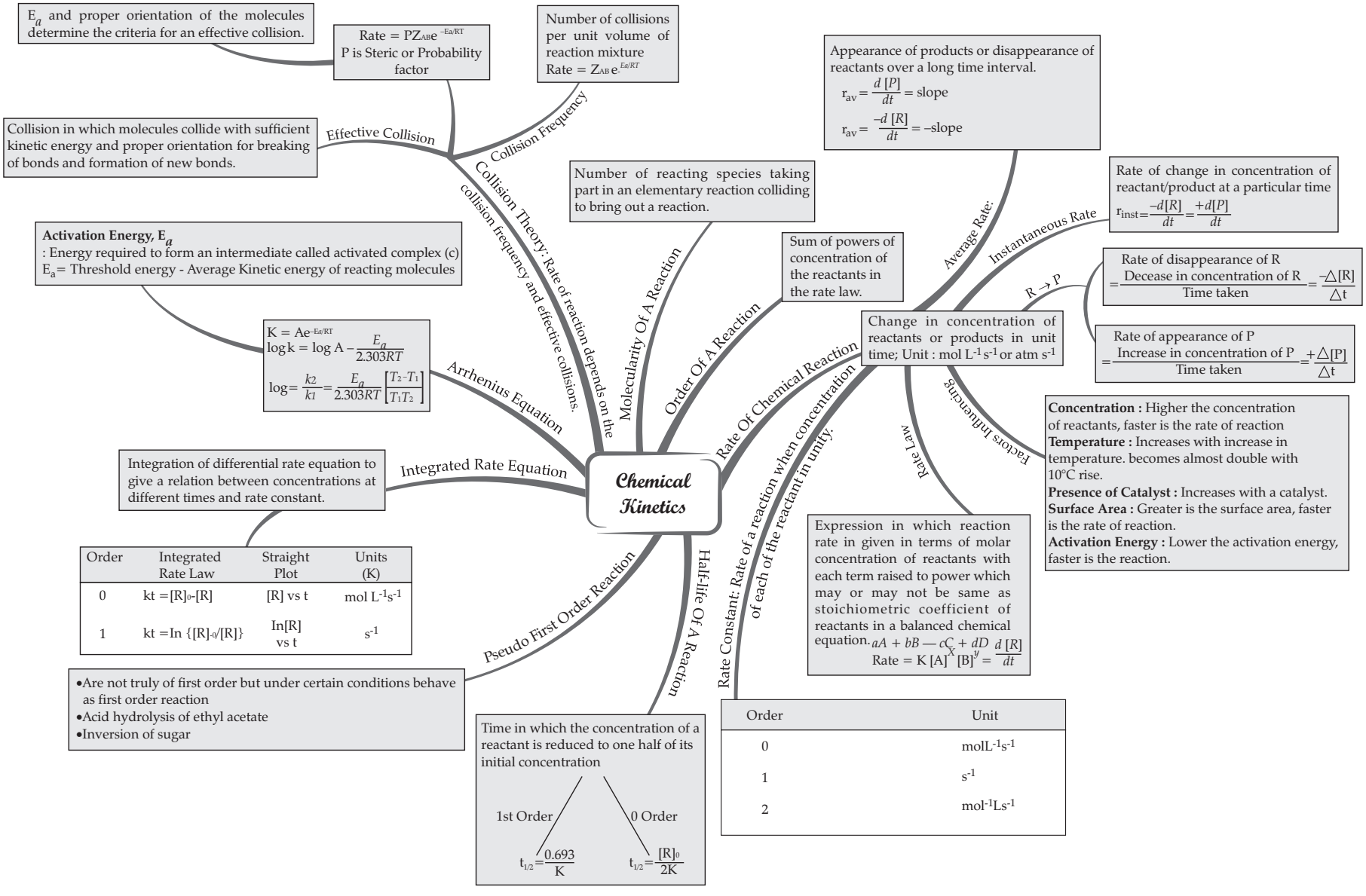
MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 3



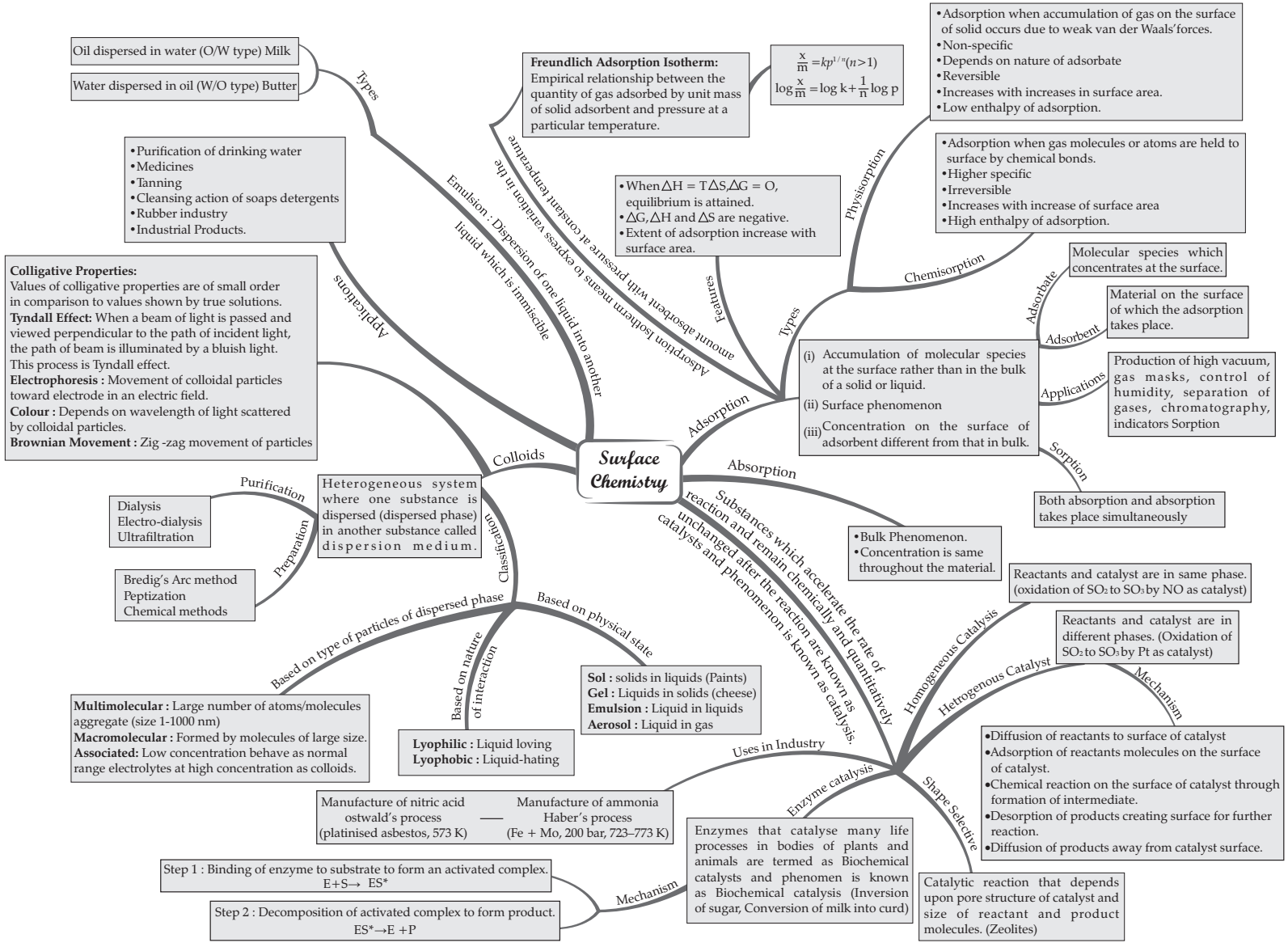
MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 4



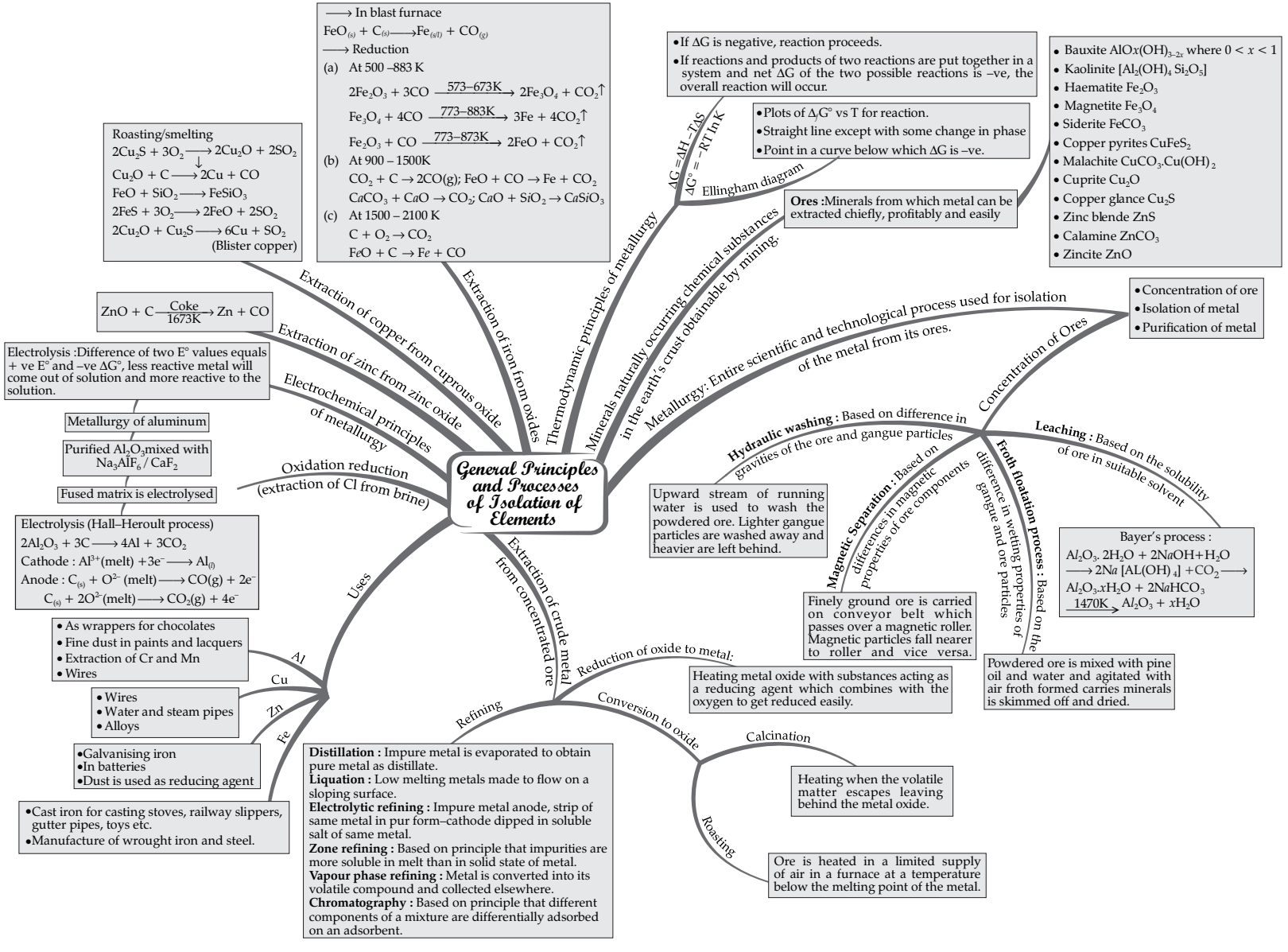
MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 5



MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 6



MIND MAP : LEARNING MADE SIMPLE

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**

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.

Chlorine

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'_3sp^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

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

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

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

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

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

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

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

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

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 $K_2Cr_2O_7$

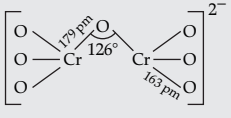
  Preparation : $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$

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

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

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

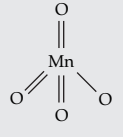
  $3\,MnO_4^{2-} + 4H^+ \rightarrow 2\,MnO_4^- + MnO_2 + 2H_2O^+$

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

  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+}

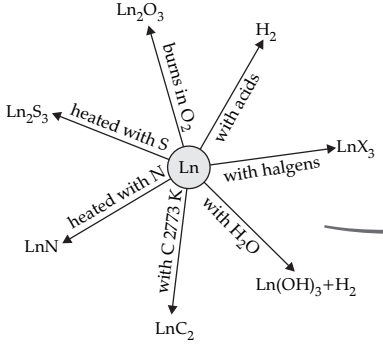
Actinoids

- 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 $\beta_n = k_1 \times k_2 \times k_3 \ldots k_n$

Double salt : Dissociate completely into simple ions when dissolved in water.

(Mohr's salt $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

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

Naming of mononuclear

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)

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.

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. Δ_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

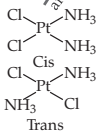
Isomerism

Structural: different bonds

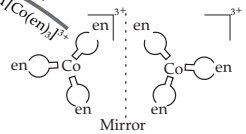
- $[CO(NO_2)(NH_3)_5]Cl$ $[CO(ONO)(NH_3)_5]Cl$ — Linkage occurs in ambidentate ligand
- $[CO(NH_3)_6]$ $[Cr(CN)_6]$ $[Cr(NH_3)_6]$ $[CO(CN)_6]$ — Coordination interchange of ligands between catonic and anionic entities of different metal ions
- $[Co(NH_3)_5SO_4]Br$ $[CO(NH_3)_5Br]SO_4$ — Ionisation counter 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** — • Solvent for fats, alkaloids, I etc. • Production of Freon
- **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.

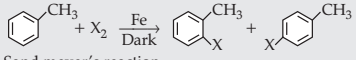
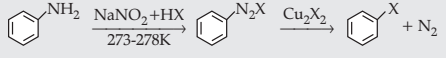
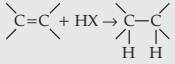
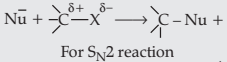
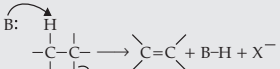
Racemisation S_N1

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

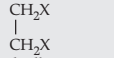
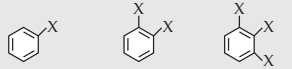
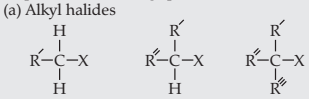
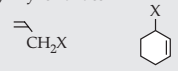
S_N2 Stereochemical inversion

- (a) Dextro (+/d)
- (b) laevo (–/l)

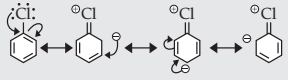
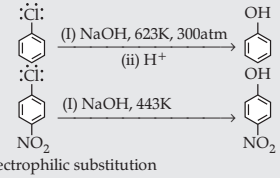
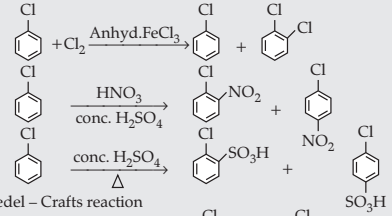
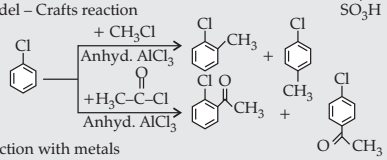
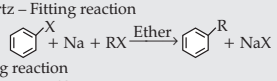
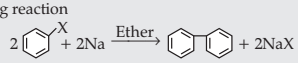
Haloalkanes

- 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
      - 
      - $H_2C=CH_2 + Br_2 \xrightarrow{CCl_4} BrCH_2–CH_2Br$
  - 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
      - 
      - For S_N2 reaction
      - Tertiary, Secondary, Primary
      - For S_N1 reaction
    - (b) Elimination reaction
      - 
      - B = Base; X = Leaving group
    - (c) Reaction with metals
      - $CH_2CH_2Br + M \longrightarrow CH_3CH_2MgBr$
    - Wurtz reaction :
      - $2RX + 2Na \xrightarrow{\text{Dry ether}} RR + 2NaX$

Classification

- No. of halogen atoms
  - C_2H_5X — Monohaloalkane
  -  — Dihaloalkane
  -  — Monohaloarene, Dihaloarene, Trihaloarene
- 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
    - 

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
      - 

MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 11

Alcohols, Phenols And Ethers

Classification

- Mono, Di, Tri, or polyhydric :
  - (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:
- Ethers
  - (i) Simple/symmetrical : Alkyl or aryl attached to O_2 are same.
  - (ii) Mixed/Unsymmetrical : Two groups are different.

Nomenclature

- Alcohols: Common name : Alkyl group + ol; IUPAC name : substituting 'e' of alkane with suffix 'ol'
- Phenols / Ethers: Common name : Terms ortho, meta and para are used. IUPAC name : Dihydroxy derivatives as 1,2–, 1,3–and 1,4–benzenediol
- 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.

Structures of functional groups

- •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.

Properties

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

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

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

- Dil. HNO_3 → o-nitrophenol + p-nitrophenol
- Conc. HNO_3 → 2,4,6-trinitrophenol
- Br_2 in CS_2, 273K → o-bromophenol + p-bromophenol
- $3Br_2$ → 2,4,6-tribromophenol
- Zn → benzene + ZnO
- $Na_2Cr_2O_7$, H_2SO_4 → p-benzoquinone

Kolbe's reaction : phenol $\xrightarrow{NaOH}$ sodium phenoxide $\xrightarrow[(ii)\ H^+]{(i)\ CO_2}$ o-hydroxybenzoic acid

Reimer Tiemann reaction : phenol $\xrightarrow[aq.NaOH]{CHCl_3}$ o-hydroxybenzaldehyde $\xrightarrow{NaOH}$ $\xrightarrow{H^+}$ o-hydroxybenzaldehyde

Preparation

1. From alkenes :- (i) By acid catalysed hydration

$>C=C< + H_2O \overset{H^+}{\rightleftharpoons} >C-C<$ (H, OH)

(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

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

Alcohols

1. From haloarenes: chlorobenzene $\xrightarrow[300atm]{+NaOH,\ 623K}$ sodium phenoxide $\xrightarrow{HCl}$ phenol
2. From benzene sulphonic acid: benzene $\xrightarrow{Oleum}$ benzenesulphonic acid $\xrightarrow[(ii)\ H^+]{(i)\ NaOH}$ phenol
3. From diazonium salts: aniline $\xrightarrow[HCl]{NaNO_2}$ benzenediazonium chloride $\xrightarrow[Warm]{H_2O}$ phenol $+N_2+HCl$
4. From Cumene: cumene $\xrightarrow{O_2}$ cumene hydroperoxide $\xrightarrow[H_2O]{H^+}$ phenol $+CH_3COCH_3$

Phenols

1. By dehydration of alcohols: $CH_3CH_2OH \xrightarrow[413\ K]{H_2SO_4} C_2H_5OC_2H_5$
2. Williamson synthesis: $RX + R'ONa \longrightarrow R–O–R' + NaX$

phenol + NaOH → sodium phenoxide $\xrightarrow{R\text{-}X}$ OR

Ethers

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

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

- anisole + Br_2 in Ethnic acid → o-bromoanisole + p-bromoanisole
- anisole + H_2SO_4, HNO_3 → o-nitroanisole + p-nitroanisole

Friedel Crafts reaction :

- anisole + CH_3Cl, Anhyd.$AlCl_3$, CS_2 → o-methylanisole + p-methylanisole
- anisole + CH_3COCl, Anhyd.$AlCl_3$ → o-methoxyacetophenone + p-methoxyacetophenone

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.

MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 12

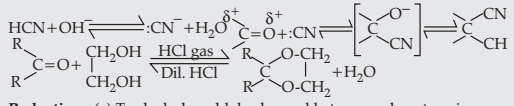
ALDEHYDES AND KETONES:

(i) Physical:

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

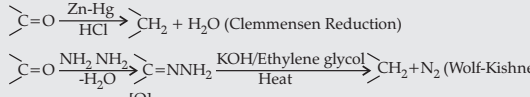
(ii)Chemical :Nucleophilic addition reactions :

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 –

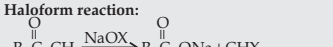


Oxidation: $RCHO \xrightarrow{[O]} R\text{–}COOH$

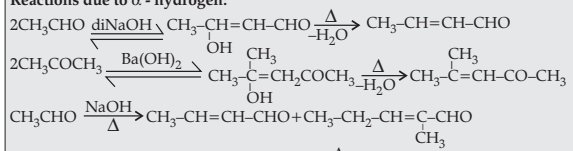
Tollen's test : $RCHO + 2[Ag(NH_3)_2]^+ + 3OH^- \longrightarrow RCOO^- + 2Ag + 2H_2O + 4NH_3$

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

Haloform reaction:

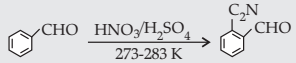


Reactions due to α - hydrogen:



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

Electrophilic substitution reaction:

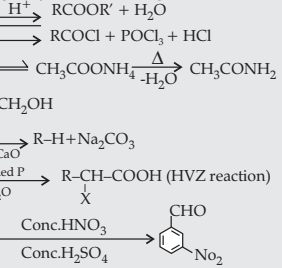


Carboxylic acids:

(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



Aldehydes, Ketones and Carboxylic Acids

Properties | Preparation | Nomenclature

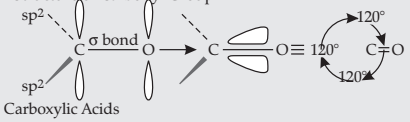
1. Aldehydes and Ketones

Common names :

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

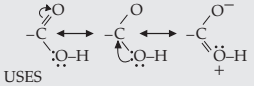
IUPAC names :

- 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

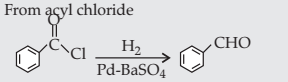
- Methanoic acid in rubber, textile, dyeing, leather industries.
- Ethanoic acid as solvent
- Higher tatty acids in manufacture of soaps and detergents.

(b) Aldehydes of ketones

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

ALDEHYDES:

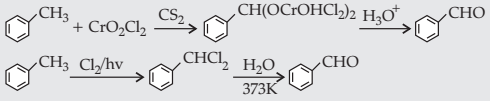
1. From acyl chloride



2. From nitriles and esters : Stephen reaction

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

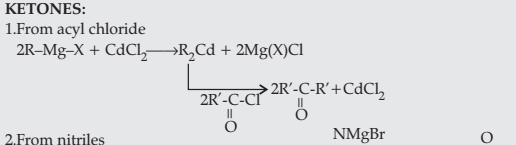
3. From hydrocarbons : Etard reaction



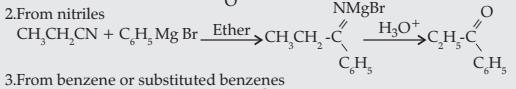
Gratterman – Koch reaction 

KETONES:

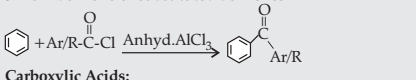
1.From acyl chloride



2.From nitriles

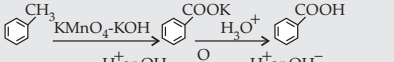


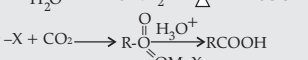
3.From benzene or substituted benzenes



Carboxylic Acids:

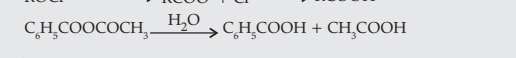
1.From primary alcohols and aldehydes $RCH_2OH \xrightarrow[H_3O^+]{\text{alk. } KMnO_4} RCOOH$

2.From alkylbenzine 

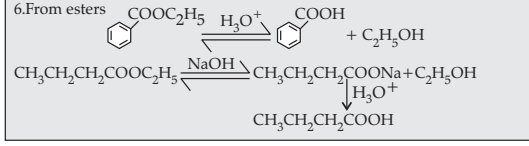
3.From nitriles and amides R–CN 

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) $C_2H_5-NH+CH_3-\underset{\underset{O}{\|}}{C}-Cl \xrightarrow{\text{Base}} C_2H_5-\underset{\underset{C_2H_5}{|}}{N}-\underset{\underset{O}{\|}}{C}-CH_3+HCl$

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

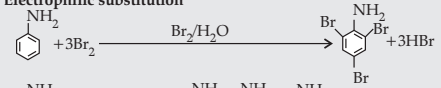
(iv) With nitrous acid

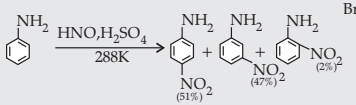
$RNH_2 + HNO_2 \xrightarrow{NaNO_2+HCl} [R-N_2Cl] \xrightarrow{H_2O} ROH + N_2 + HCl$

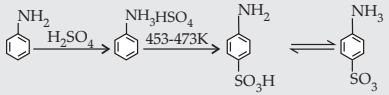
$C_6H_5NH_2 \xrightarrow[273\text{-}278K]{NaNO_2+HCl} C_6H_5N_2Cl + NaCl + 2H_2O$

(v) $C_6H_5-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-Cl + H_2N-C_2H_5 \longrightarrow C_6H_5-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-H-C_2H_5 + HCl$

(vi) Electrophilic substitution

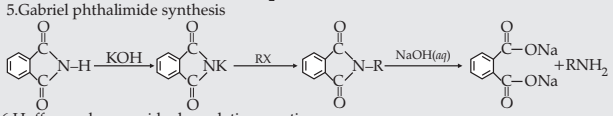






Preparation :

1. Reduction of nitro compounds: $\ce{ArNO2 ->[H2/Pd][Ethanol] ArNH2}$; $\ce{ArNO2 ->[Sn+HCl][or Fe+HCl] ArNH2}$
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: $R-\underset{\underset{O}{\|}}{C}-NH_2 \xrightarrow[H_2O]{LiAlH_4} R-CH_2-NH_2$
5. Gabriel phthalimide synthesis



6. Hoffmann bromamide degradation reaction

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

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

Preparation :

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

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

Chemical properties :

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

Gattermann reaction :

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

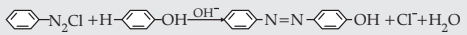
(ii) $ArN_2Cl + KI \longrightarrow ArI + KCl + N_2$

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

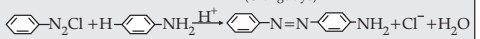
(iv) $ArN_2Cl + H_3PO_2 + H_2O \longrightarrow ArH + N_2 + H_3PO_3 + HCl$

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

(iv) **Coupling reaction :**



(Orange dye)



(Yellow dye)

Physical properties

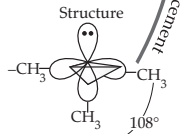
- Lower aliphatic amines are gases. Primary amines with three or more C atoms are liquid and higher ones are solid.
- Arylamines are colourless but get coloured on storage.
- Lower aliphatic amines are soluble in water, while higher are insoluble.
- Primary and secondary amines form intermolecular association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

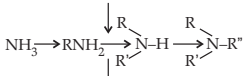
Derivatives of ammonia, obtained by replacement of one, two or all the three H atoms by alkyl and/or aryl groups

Structure



K

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.

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.

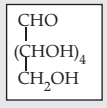
- **Classification:**

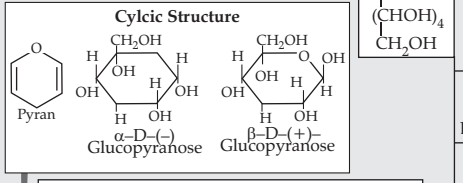
(I) Monosaccharides : (Aldehyde group – aldose, keto group –ketose)
Glucose : Preparation :

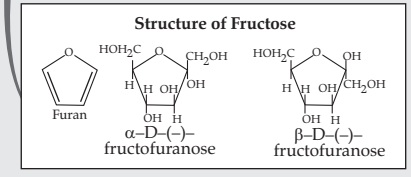
(a) From sucrose : $C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$ (Sucrose → Glucose + Fructose)

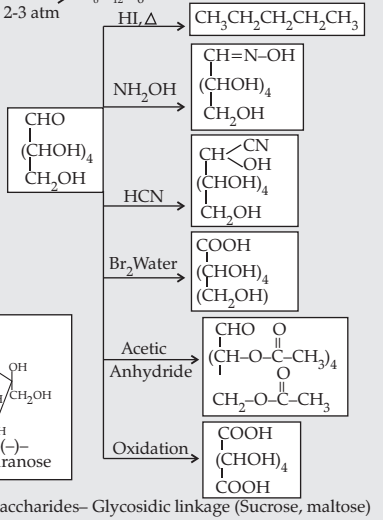
(b) From starch : $(C_6H_{10}O_5)n + nH_2O \xrightarrow[393K;\ 2\text{-}3\ atm]{H^+} nC_6H_{12}O_6$

- **Structure:**









(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

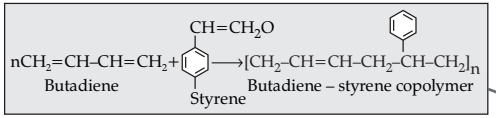
MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 15

Polymers

Very large molecules having high molecular mass

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

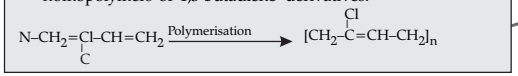


- Rubber

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.



- Molecular mass of polymers

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

- Biodegradable polymers

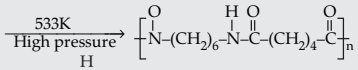
Contain functional groups similar to biopolymers (PHBV, Nylon 2– nylon 6)

- Classification

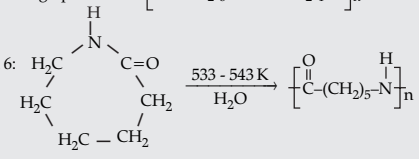
- **Based on source**:
  - **(i) Natural polymers :** Found in plants and animals. (Proteins, rubber)
  - **(ii) Semi–synthetic polymers :** (Cellulose derivatives)
  - **(iii) Synthetic polymers :** Man-made. (Polythene, Buna –S)
- **Based on structure of polymers high density**:
  - **(i) Linear polymers :** 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: $nCH_2=CHCN \xrightarrow[\text{Peroxide}]{\text{Polymerisation}} -[CH_2–\underset{CN}{CH}]_n-$
- Nylon 6,6: $nHOOC(CH_2)_4\ COOH + nH_2(CH_2)_6NH_2$

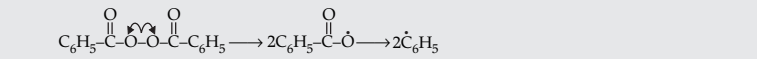


- Nylon 6:



- 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:



$\dot{C}_6H_5 + CH_2 = CH_2 \longrightarrow C_6H_5–CH_2–\dot{C}H_2$

  (b) Chain propagating step:

$C_6H_5–CH_2–\dot{C}H_2 + CH_2 = CH_2 \longrightarrow C_6H_5–CH_2–CH_2–CH_2–\dot{C}H_2 \longrightarrow C_6H_5–(CH_2–CH_2)n–CH_2–\dot{C}H_2$

  (c) Chain terminating step:

$2[C_6H_5–(CH_2–CH_2)n–\dot{C}H_2–CH_2] \longrightarrow C_6H_5–(CH_2–CH_2)n–CH_2–CH_2–CH_2–(CH_2–CH_2)n–C_6H_5$

- (ii) Condensation/Step Growth : Repetitive condensation reaction between two bi–functional monomers. (Formation of terylene)

MIND MAP : LEARNING MADE SIMPLE

CHAPTER - 16

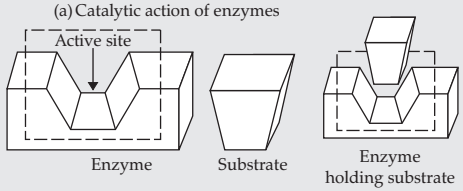
Chemistry in Everyday Life

Therapeutic Action of Different Classes of Drugs

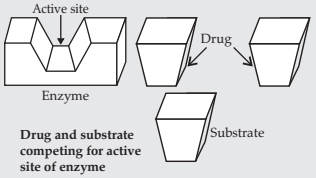
- **Antacids :** Substances that neutralize the excess HCl and raise pH in stomach (Ranitidine, Cimetidine)
- **Antihistamines :** Interfere with natural action of histamine by competing with histamine for binding sites of receptor where histamine exerts its effect
- **Neurologically Active Drugs**
  - (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)

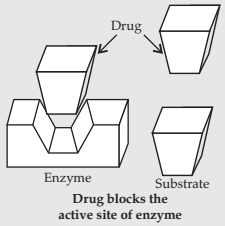
Medicines: Chemicals which generate therapeutic and useful biological response

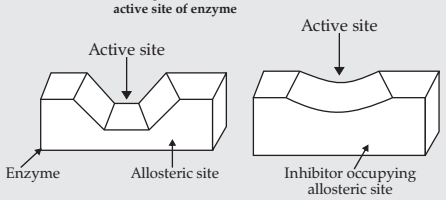
- Drugs are chemicals of low molecular masses. Interact with macromolecular targets to produce a biological response.
- **Classification of drugs:**
  - (a) On the basis of pharmalogical effect : Provides range of drugs available for a particular type of problem. (Analgesics, Antiseptics).
  - (b) On 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







  - (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 Detergents Types

(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.