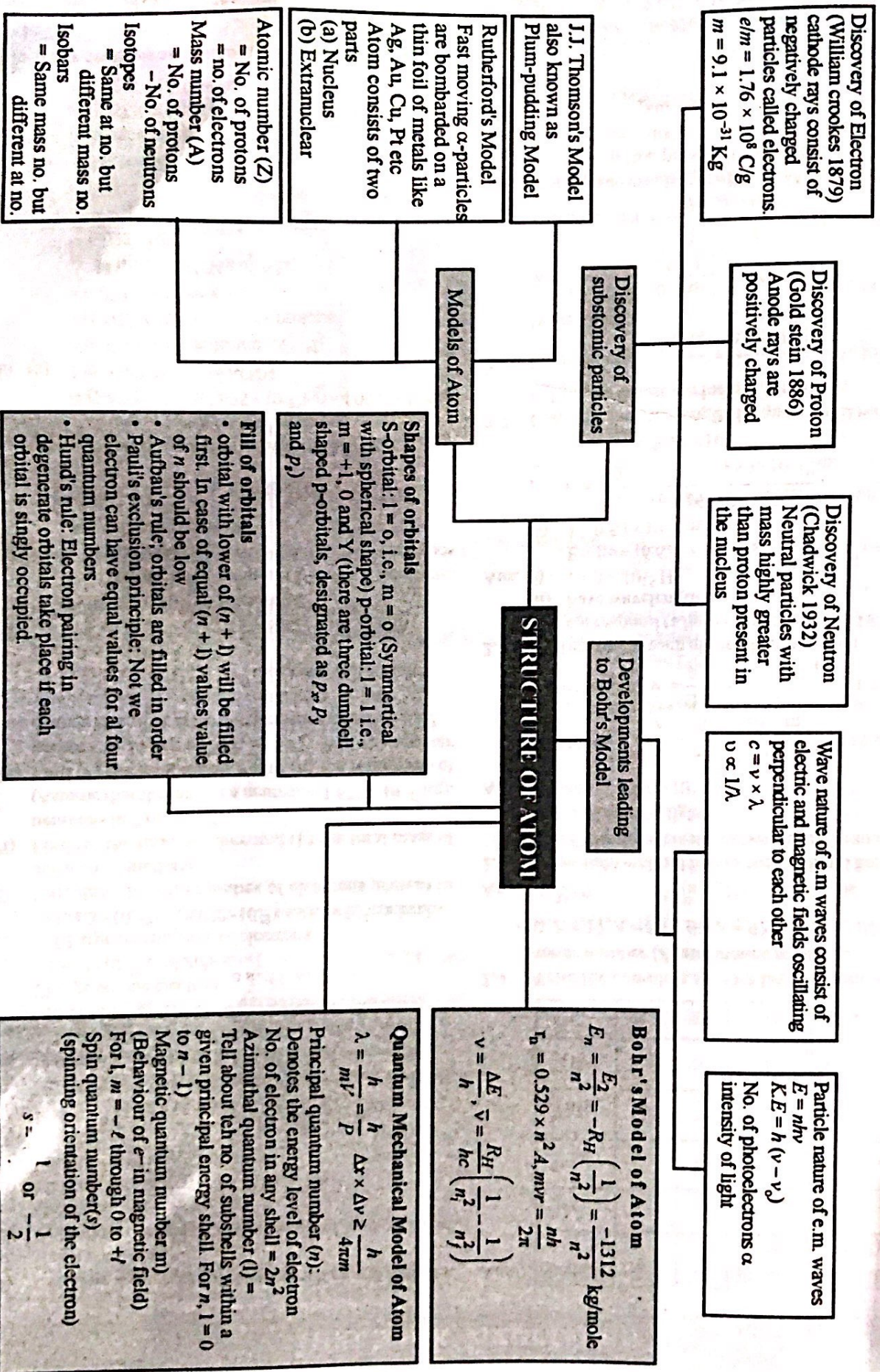
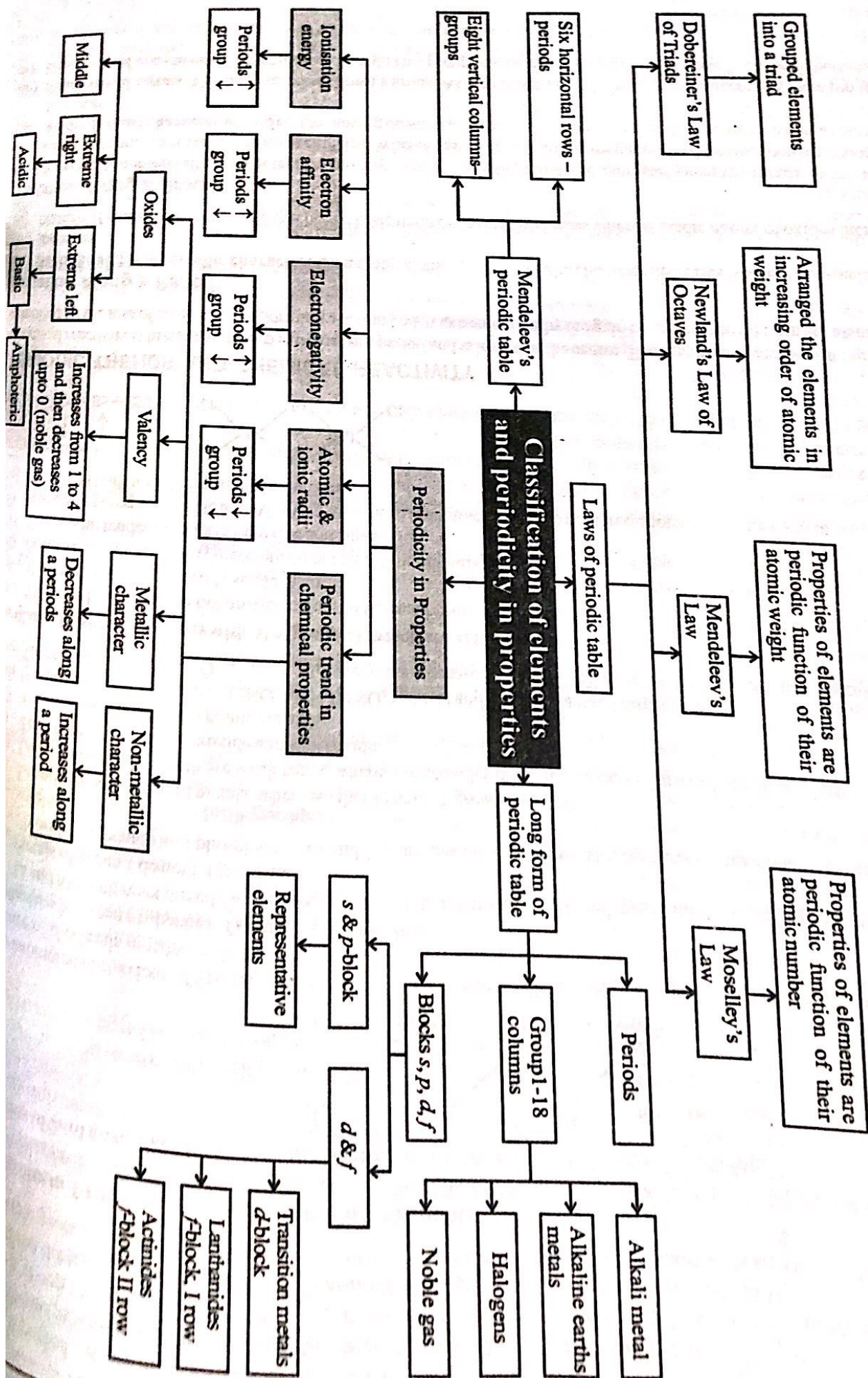
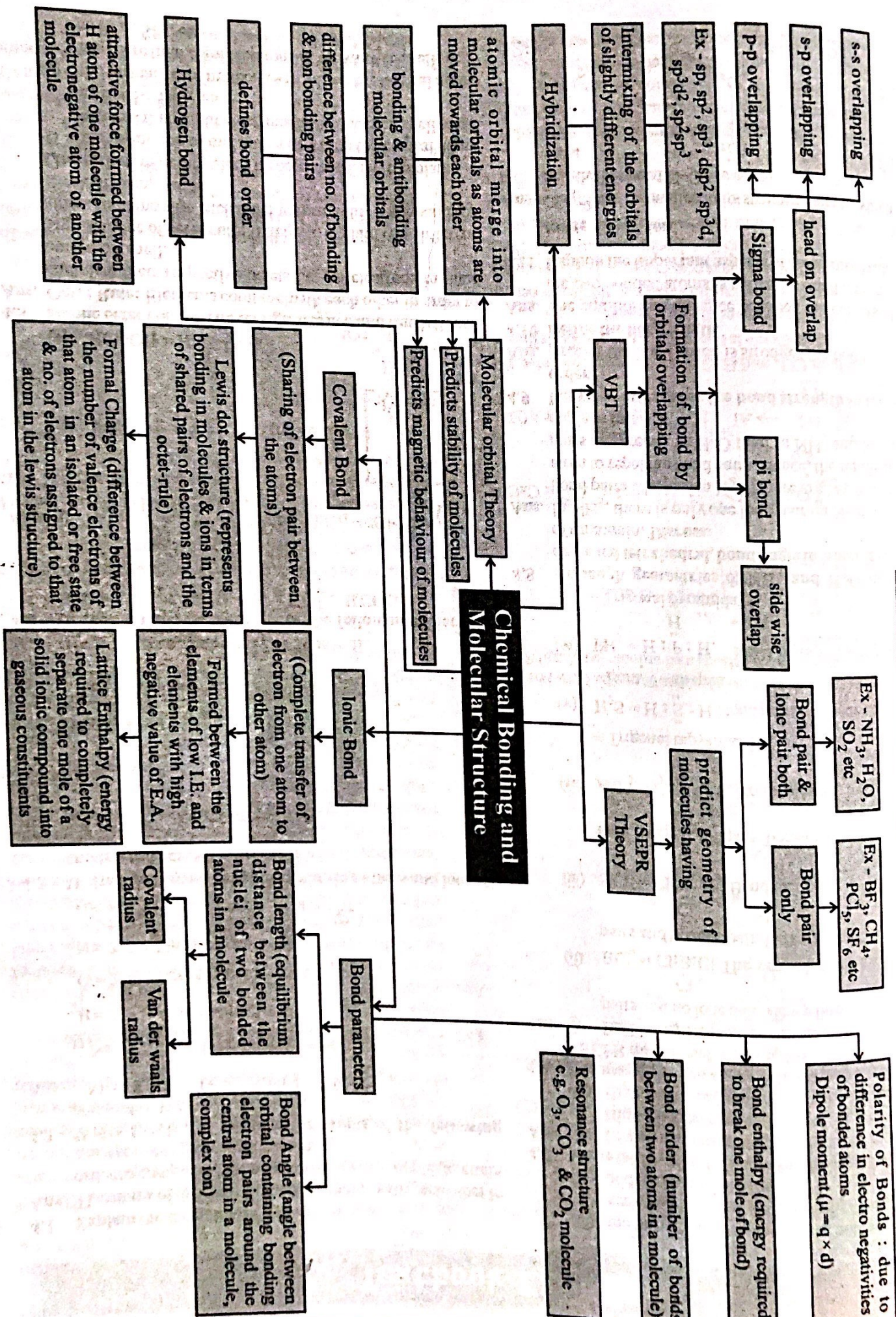


CONCEPT MAP



CONCEPT MAP





Intermolecular Interactions Dispersion or London Forces: (act between induced momentary dipoles)

Dipole-Dipole Force:

(act between molecules possessing permanent dipoles)

Dipole-Induced Dipole Forces:

(act between molecules having permanent dipole and molecules lacking it)

Hydrogen Bonding:

(It is a special case of dipole-dipole interactions)

Kinetic Theory of Gases.

All the gases are made up of molecules moving randomly in all the directions.

$$K.E = \frac{3}{2} RT, c = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3P}{d}}$$

$$\text{Average speed} = \sqrt{\frac{8RT}{\pi M}} = 0.9213 \times \text{rms speed}$$

$$\text{Most probable speed} = \sqrt{\frac{2RT}{M}}$$

$$MPs = 816 \times RMS$$

Behaviour of Real Gases

Two faulty assumptions of kinetic theory lead van der Waal to modify ideal gas equation as,

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

$$\text{Compressibility factor } Z = \frac{PV}{nRT}$$

For ideal gas $Z = 1$; For real gas $Z \neq 1$

$Z > 1$ the gas shows +ve deviation

$Z < 1$ the gas shows -ve deviation

Gas Laws

Boyle's Law: $V \propto 1/P$

$$P_1 V_1 = P_2 V_2, P \propto d$$

Charles's Law: $V \propto T$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Gay Lussac's Law: $P \propto T$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Avogadro's Law: $V = Kn$

$$M = Kd$$

$$\text{Graham's Law: } \frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}}$$

Ideal Gas Equation: $PV = nRT$

Value of $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$, $0.0822 \text{ atm K}^{-1} \text{ mol}^{-1}$, $8.314 \text{ Pa m}^3 \text{ K}^{-1} \text{ mol}^{-1}$ and $8.314 \times 10^{-2} \text{ bar LK}^{-1} \text{ mol}^{-1}$

Equation of state:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Dalton's Law $P_{\text{Total}} = P_1 + P_2 + P_3 + \dots$ (at const. T, V)

STATES OF MATTER

Liquefaction of Gases

$$T_c = \frac{8a}{27bR} \quad (\text{temperature above which gas can not be liquified})$$

$$P_c = \frac{a}{27b^2} \quad (\text{minimum pressure required to liquify a gas at its critical temperature})$$

$$V_c = 3b \quad (\text{Volume occupied by one mole of gas at } T_c \text{ and } P_c)$$

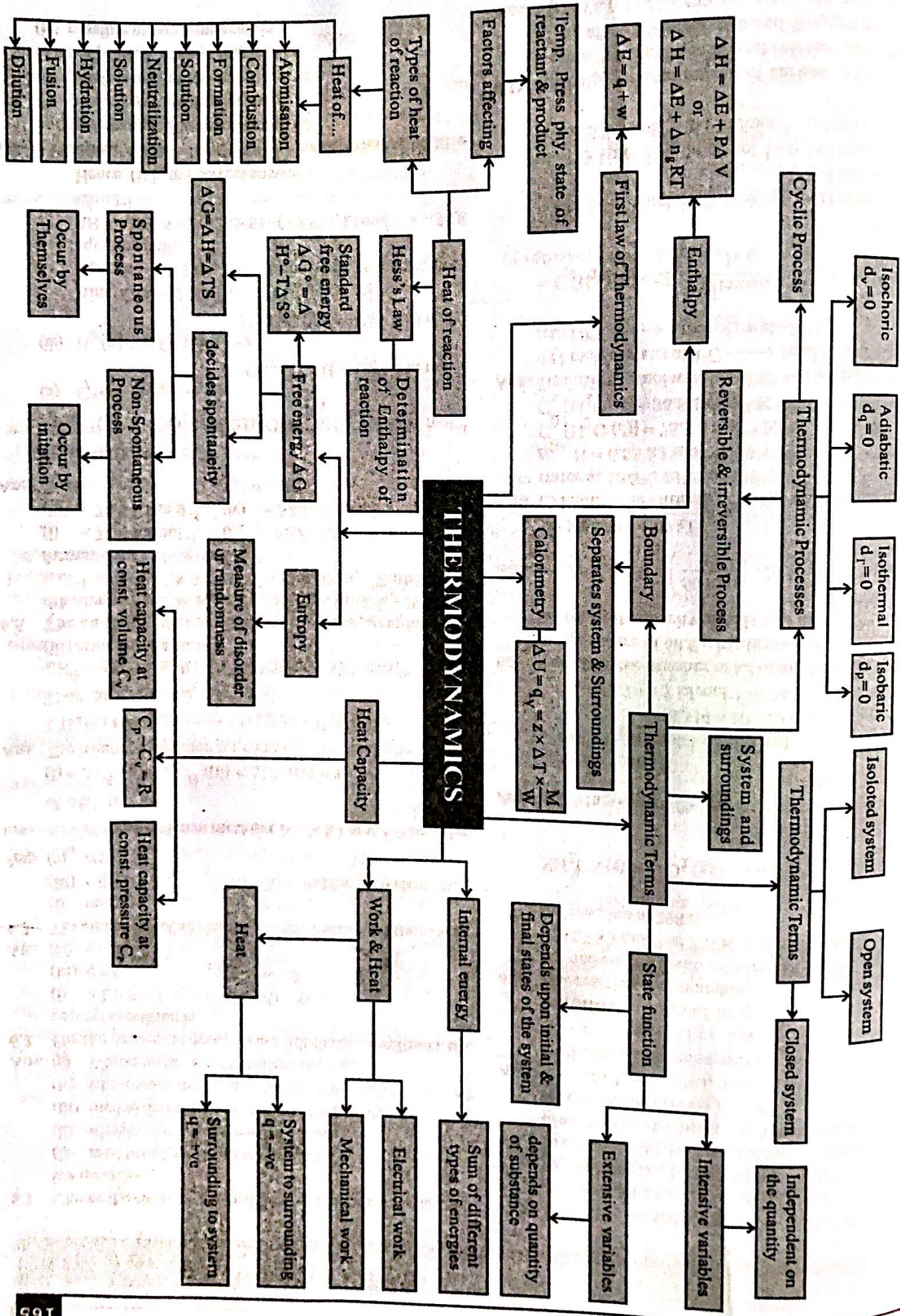
Liquid State: Intermolecular forces are stronger than gaseous state and have definite volume.

Vapour pressure: Pressure exerted by the vapour in equilibrium with the liquid at that temperature. It increases with increase in temperature.

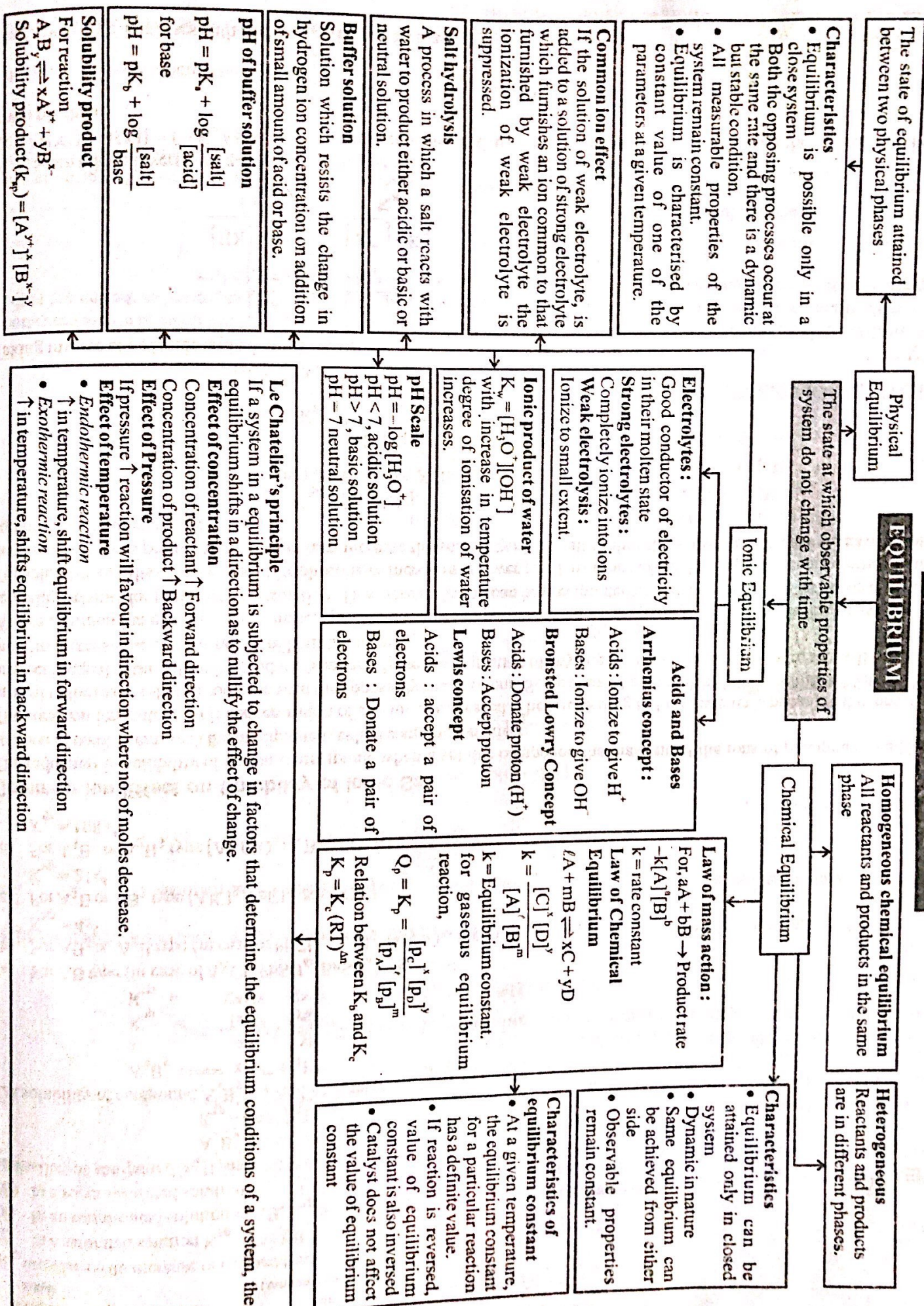
Surface Tension: Force acting at right angles to the surface along 1 cm length of the surface. Unit dynes per cm or Nm^{-1} SI System. It decreases with increase in temperature.

Viscosity: It is a measure of resistance to flow which arises due to internal friction between layers of fluid as they slip past one another as the liquid flows.

CONCEPT MAP



CONCEPT MAP



CONCEPT MAP

Position in Periodic table : Outer shell electronic configuration resembles both alkali metals and halogens, still unique and hence H is placed separately

Dihydrogen

Occurrence : Most abundant element in the universe (70% of the total mass of the universe)

Isotopes : Protium (${}^1_1\text{H}$), deuterium (${}^2_1\text{H}$) and tritium (${}^3_1\text{H}$)

Preparation : Reaction of Zn with dil. acid or aqueous alkali.

Electrolysis of acidified water, by product in manufacture of NaOH and Cl_2 .

Reaction of steam on hydrocarbons or coke at high temperatures in presence of catalyst.

Properties : It is a colourless, odourless, combustible gas, insoluble water. It undergoes reaction with X_2 , O_2 , N_2 , metals, organic compounds etc.

Uses

It is used in,

- Synthesis of NH_3
- Manufacture of vanaspathi fat
- Manufacture of organic compounds
- Cutting and welding properties

Hydrides : Binary compounds formed by combination of metals and non-metals with H_2 .

- Ionic Hydrides:** Stoichiometric compounds of H_2 with s-block elements
- Covalent Hydrides:** Dihydrogen forms molecular compounds with most of the p-block elements.
- Metallic Hydrides:** Non-stoichiometric compounds of H_2 with Be, Mg and d- and f-block elements. Metals of group 7, 8 and 9 do not form hydride.

HYDROGEN

Water : Major part of all living organism.

Properties : Colourless, tasteless liquid with intermolecular H - bonding. This leads to high freezing point, high boiling point, high heat of vaporization, high heat of fusion etc. It has amphoteric nature, undergoes hydrolysis reaction and form hydrates.

Hard water : It contains bicarbonates, chlorides and sulphate of calcium and magnesium.

Temporary water hardness is due to bicarbonates of Ca and Mg.

Permanent water hardness is due to chloride and sulphates of Ca and Mg.

Hydrogen Peroxide (H_2O_2)

Preparation : By the action of H_2SO_4 , H_2CO_3 or H_3PO_4 on $\text{BaO}_2 \cdot 8\text{H}_2\text{O}$

Manufacture: Electrolysis of 50% H_2SO_4

Properties: Syrupy pale blue liquid, viscous, diamagnetic and miscible with water, alcohol and ether. H_2O_2 acts as both oxidising as well as reducing agent.

Storage : Kept in wax lined bottles.

Uses : For bleaching, as antiseptic, as oxidant for rocket, used to control environmental pollution etc.

Heavy Water (D_2O)

Preparation : On a large scale, it is produced by repeated electrolysis of ordinary water having alkali. Physical properties of D_2O are different from H_2O whereas chemical properties of D_2O are similar to H_2O .

Uses : As a moderator in nuclear reactor and as a tracer compound.

Hydrogen Economy

It is one of the alternative to meet the energy need as dihydrogen releases large quantities of heat in combustion without causing any major pollution.

CONCEPT MAP

Physical properties:

In alkali metals, on moving from Li to Cs

- atomic or ionic radii increases
- density increases
- m.p. and b.p. decrease
- I.E. decreases
- electropositive character increases
- electronegativity decreases
- hydration energy decreases

Characteristics of alkali metal compounds.

Li forms Li_2O , Na forms Na_2O , and others form MO_2 , ionic character, m.p., b.p. thermal stability and solubility increases from LiOH to CsOH decreasing order of hydrolysis
 $\text{LiCl} > \text{NaCl} > \text{KCl} > \text{RbCl} > \text{CsCl}$
 Stability of carbonates and bicarbonates increases from Li to Cs whereas solubilities also increase on descending the group.

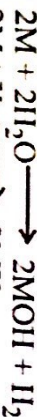
Physical properties

In alkaline earth metals, on moving from Be to Ba:

- atomic or ionic radii increases
- density increases
- m.p. and b.p. decreases
- I.E. decreases
- electropositive character increases
- electronegativity decreases
- hydration energy decreases
- reducing character increases.

Chemical properties:

Li forms monoxide, Na forms peroxide and other metals forms superoxides on reaction with air.



Alkali metals are strong reducing agents.

Alkali metals dissolve in NH_3 to give blue, conducting and paramagnetic solution.

Alkali Metals

The s-Block Elements

Alkaline Earth Metals

Chemical properties

Be, Mg, Ca and Sr form MO type oxides whereas Ba and Ra forms peroxides.



Alkaline earth metals are also strong reducing agents although weaker than alkali metals.

Alkaline earth metals like alkali metals also get dissolved in NH_3 forming coloured solutions.

Some Important Compounds of Sodium

NaCl: HCl is passed through the filtered solution of crude NaCl.

NaOH: Electrolysis of NaCl in Castner-Kellner cell by using a Hg cathode and Canode.

Na_2CO_3 : CO_2 is passed through brine saturated with NH_3 . NaHCO_3 formed is then heated to give Na_2CO_3

NaHCO_3 : Saturating a cold solution of Na_2CO_3 with CO_2 .

Some Important Compounds of Calcium

CaO: By heating limestone at 1070–1270K.

$\text{Ca}(\text{OH})_2$: By adding water to quick lime.

$\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$: By heating gypsum at 393K

Portland cement: It is essentially a mix full of limestone and clay. Its approximates composition.

CaO 62%, SiO_2 22%, Al_2O_3 7.5%, MgO 2.5% and Fe_2O_3

Characteristics of alkali earth metal compounds

MO are prepared either by heating the metal in O_2 or by decomposing metal carbonate. Solubility, thermal stability and basic character of hydroxides increases on moving down the group, covalent character decreases from BeCl_2 to BaCl_2 . The thermal stability of carbonates, bicarbonates and sulphates increases from Be to Ba

CONCEPT MAP

Group 13 Elements

Chemical Properties

- Reaction with air: $4M + 3O_2 \rightarrow 2M_2O_3$, $2M + N_2 \rightarrow 2MN$
- Reaction with acids: $2M + 6H^+ \rightarrow 2M^{3+} + 3H_2$
- Reaction with alkalis: $2M + 2NaOH + 6H_2O \rightarrow 2Na^+[M(OH)_4]^- + 3H_2$
- Reaction with halogens: $2M + 3X_2 \rightarrow 2MX_3$

Physical Properties

- On moving down in a group from B to Tl
- metallic or electropositive character increases
 - atomic and ionic radius increases
 - b.p. decreases, m.p. decreases from B to Ga and then increases
 - I.E. decreases
 - density increases
 - electronegativity first decreases from B to Al and then increases marginally.

Physical Properties

- On moving down in a group from C to Pb
- metallic or electropositive character increases
 - atomic and ionic radius increases
 - m.p. and b.p. decreases
 - I.E. decreases
 - electronegativity decreases

Chemical Properties

- Reaction with air: $2M + O_2 \rightarrow 2MO$
 $M + O_2 \rightarrow MO_2$
- Reaction with water: $Sn + 11H_2O \rightarrow SnO_2 + 2H_2$
- Reaction with halogens: Except carbon all other elements react directly with halogens.

THE p-BLOCK ELEMENTS

Group 14 Elements

Anomalous Behaviour of Boron

- Characteristics shown by boron and not by other elements of the group are following:
- B is a non-metal and forms covalent compounds
 - B is a bad conductor of electricity
 - Tribalides of B exist as monomer.
 - hydroxides and oxides of B are acidic in nature
 - B exhibits maximum covalency of four

Some Important Compounds of Boron

- H_3BO_3 Preparation:**
- Colemanite mineral powder is mixed with water and SO_2 is passed through the solution.
 - By addition of HCl or H_2SO_4 to conc. solution of borax.
 - By hydrolysis of boron compounds
- $Na_2B_4O_7 \cdot 10H_2O$ Preparation:**
- Powdered colemanite is boiled with Na_2CO_3 solution.
 - Boric acid when boiled with soda-ash gives borax
- B_2H_6 Preparation:**
- Quantitatively by reaction AlH_3 with BCl_3
 - In laboratory by oxidation of $NaBH_4$ with I_2
 - On industrial scale by reaction of BF_3 with NaH

Anomalous Behaviour of Carbon

- Characteristics shown by carbon and not by other elements of the group are following:
- exhibit covalence upto four only
 - ability to form pr-multiple bonds.
 - maximum tendency for catenation.
 - Carbon remains unaffected by alkalis

Allotropes of Carbon

- Diamond:** It has a rigid 3D network
- Graphite:** It has layered structure in which layers are held by van der waal's forces.
- Fullerenes:** It is large cage like spheroidal molecule with general formula C_{2n} .
- Some important compounds of C and Si:**
- Oxides of Carbon**
- $$CO : 2C(s) + O_2(g) \xrightarrow{\Delta} 2CO(g)$$
- $$HCOOH \xrightarrow[373\text{ K}]{\text{conc. } H_2SO_4} H_2O + CO$$
- $$C(s) + H_2O(g) \xrightarrow[473-1273\text{ K}]{\Delta} CO(g) + H_2(g)$$
- $$CO_2 : C(s) + O_2(g) \xrightarrow{\Delta} CO_2(g)$$
- $$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O$$
- $$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$$
- SiO_2 :** It is covalent, three dimensional network solid in which each Si atom is covalently bonded in tetrahedral manner.
- Silicones:** Group of organic silicon polymers having $-(R_3SiO)-$ as a representing unit.
- Silicates:** Their basic structural unit is SiO_4^{4-} . Each Si atom is bonded to four O-atoms in tetrahedral fashion.
- Zeolites:** Formed when aluminium atoms replace few silicon atoms in three-dimensional network of silicon.

CONCEPT MAP

1. Select longest c-chain in molecule
2. Branched carbon must have lowest number
3. Assign lowest number to substituent which comes first as per alphabetical order.
4. Identical substituent are indicated by prefix such as di, tri, tetra etc.
5. If side chain is on the same c-atom than named as per alphabetical order.
6. If functional groups is present than it must have possible lowest number based on order.

Functional groups: determine how molecule react, e.g.,

Alkane C_nH_{2n+2}	R-X alkyl halide	Carboxylic acid $R-COOH$	Acid anhydride $(RCO)_2O$
Alkane C_nH_{2n}	Alcohol $R-OH$	Ester $R-COOR$	Ether alkoxy (ROR)
Alkene C_nH_{2n-2}	Aldehyde $R-CHO$	Amide $R-CONH_2$	Amine $R-NH_2$
Arene $\odot$	Ketone $R-COR$	Acid chloride $R-COCl$	Nitrile $(-NC)$

Saturated (single bond)
 $CH_3-CH_2-C_nH_{2n+2}$

Unsaturated

Open chain compounds
 (Aliphatic or acyclic)
 e.g., $-C-C-C-C-$

Alkyne C_nH_{2n-2}

Alkene C_nH_{2n}

Allylic compounds eg. $\Delta, \square$

Aromatic compounds eg. Benzene

Aromatic heterocyclic compounds eg. $\odot$

Aliphatic heterocyclic compounds CH_2-CH_2 (oxirane)

Line structure C_nH_n

Lewis formula $H \cdot \ddot{C} \cdot H$

Structural formula $CH_3-CH_2-CH_3$

Condensed structure C_3H_8

3D representation $H-C-H$

1° (primary) (Attached to one c-atom)

2° (secondary) (Attached to two c-atom)

3° (tertiary) (Attached to three c-atom)

4° (Quaternary) (Attached to four c-atom)

Functional isomerism: (Functional group with same molecular formula)

Position isomerism: (Position of functional group)

Chain isomerism: (Carbon skeleton)

Optical isomerism: due to different rotation of plane of polarised light

Geometrical isomerism: different geometry of compound

Stereo isomerism: Same molecular formula but differ in arrangement of atom in space.

Structural isomerism: Same molecular formula but different structure

IUPAC system of nomenclature

Homologous series (group of compound differ by 1 unit)

Classification of organic compound

Close chain compounds cyclic or ring, e.g., $\Delta, \square$

Heterocyclic compounds

Homocyclic compounds

Alkyne C_nH_{2n-2}

Alkene C_nH_{2n}

Allylic compounds eg. $\Delta, \square$

Aromatic compounds eg. Benzene

Aromatic heterocyclic compounds eg. $\odot$

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Condensed structure C_3H_8

3D representation $H-C-H$

Sublimation: to separate sublime comp.

Crystallization: for solid organic compounds.

Chromatography: to separate mixture into their component

Distillation: to separate volatile liquid having large difference in B.P.

Fractional distillation: to separate volatile liquid with close B.P.

Distillation under reduced pressure: to separate liquid having high B.P.

Steam distillation: to separate steam volatile and water insoluble sub.

Differential extraction: to separate two immiscible liquids

Qualitative analysis (by chemical tests)

Quantitative analysis

Reaction mechanism: Substrate $\rightarrow$ Intermediate $\rightarrow$ Product (Attacking reagent)

Electron displacement effect

Rearrangement reaction

Addition reaction

Elimination reaction

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CONCEPT MAP

