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PHYSICAL CHEMISTRY ATOMIC STRUCTURE

1.
$$r_n = \frac{n^2 h^2}{4\pi^2 m Z e^2} = 0.529 \left(\frac{n^2}{Z}\right) A, r_n = n^2 \times r_1$$

2.
$$E_T = KE = \frac{PE}{2} = -13.6 \frac{Z^2}{n^2} eV$$

3.
$$\Delta E = \frac{hc}{\lambda} = \frac{2\pi^2 me^4}{h^2} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

4.
$$\overline{v} = \frac{1}{\lambda} = RZ^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right], \left[R = 1.0968 \times 10^7 m^{-1} \right]$$

- 5. Total no. of spectrum lines= $\frac{n(n-1)}{2}$
- 6. Heisenberg Uncertainty Principle $(\Delta x)(\Delta p) \ge h/\pi$

7. Moseley's law :
$$\sqrt{v} = a(Z-b), E_n = -\frac{13.7}{n^2} eV / atom$$

8. Nodes (n -1) = total nodes, I= angular nodes, (n - I - 1) = Radial nodes

9. Photoelectric effect: $hv = hv_0 + \frac{1}{2}mv^2$ 10. Orbital angular momentum: $\sqrt{l(l+1)}\frac{h}{2\pi}$

CHEMICAL BONDING

- 1. % ionic character = $\frac{\text{Actual dipole moment}}{\text{Calculated dipole moment}}$
 - —×100
- 2. Fajan's Factors: following factors are helpful in including covalent character in ionic compounds
- (a) Small cation
- (b) Big anion
- (c) High charge on cation
- (d) High charge on anion
- (e) Cation having pseudo inert gas configuration (ns²p⁶d¹¹) e.g. Cu+, Ag⁺, Zn²⁺, Cd²⁺

3.
$$-\Delta H_f = H_s + \frac{1}{2}H_d + IE + \Delta H_{EG} - E_L$$

4. M.O. theory:

(a) Bond order $=\frac{1}{2}(N_b - N_a)$

(b) Higher the bond order, higher is the bond dissociation energy, greater is the stability, and shorter is the bond length.

(C) Species ond order H_2 H_2^{\dagger} 0.5 Li

Magnetic properties Diamagnetic Paramagnetic Diamagnetic

- 5. $Q = \frac{1}{2} [V + SA (\pm q)]$
- 6. Former charge = V- $\left(L + \frac{1}{2}S\right)$
- 7. VSEPR theory

(a) (LP - LP) repulsion > (LP - BP) > (BP - BP)

(b) For NH₃ \rightarrow Bond Angle 106^o45' because H₂O molecule contains 2LP and 2BP where as NH has ILP and 3BP.

8. Bond angle:

Decrease in bond angle down the gp is due to LP – BP repulsion $(a)NH_3 > PH_3 > AsH_3$ $(b)H_2O > H_2S > H_2Se$

CHEMICAL EQUILIBRIUM

- 1. $K_p = K_{c}(RT)^{2n_g}$ where $\Delta n_g = n_p n_R$
- 2. Free Energy change($G\Delta$)
- (a) If $G\Delta=0$ then reversible reaction would be equilibrium.
- (b) If $G\Delta = (+)$ ve then equilibrium will displace in backward direction.
- (C) If $G\Delta = (-)$ ve then equilibrium will displace in forward direction.
- 3. (a) K_c unit $\rightarrow (\text{moles/li})^{\Delta n}$
 - (b) K_p unit $\rightarrow (atm)^{\Delta n}$
 - (C) Total molecule at equilibrium = [total initial moles $+\Delta n$]
 - (d) Time required to establish equilibrium $\alpha 1 / k_c$
 - (e) If in any heterogeneous equilibrium solid substance is also present then its active mass & partial pressure is assumed 1.
- 4. Le chatelier's principle
- (i) Increase of reactant conc. (Shift forward)
- (ii) Decrease of reactant conc. (Shift backward)
- (iii) Increase of pressure (from more moles to less moles)
- (iv) Decrease of pressure (from less moles to more moles)
- (v) For exothermic reaction decrease in temp. (Shift forward)
- (vi) For endothermic increase in temp. (Shift forward). Time Total

ACID BASE

1.(a). Lewis Acid (e⁻ pair acceptor) \rightarrow CO₂, BF₃, Alcl₃, Zncl₂, Fecl₃, PCl₃, Sicl₄, SF₆, normal cation

(b). Lewis Base (e- pair donor) NH₃, ROH, ROR, H₂O, RNH₂, R₂NH,R₃N, normal anion

- 2. Dissociation of Weak Acid & Weak Base \rightarrow
 - (a). Weak Acid $\rightarrow K_a = Cx^2 / (1-x) \text{ or } K_a = Cx^2$
 - (b). Weak Base $\rightarrow K_b = Cx^2 / (1-x) \text{ or } K_b = Cx^2$

3. Buffer solution:

- Acidic $\rightarrow pH = pK_a + \log\{salt / Acid\}$ for Maximum buffer action pH = pK_a
- (a) Range of Buffer $pH = pK_a \pm 1$
- (b) Alkaline \rightarrow pOH = pK_b+log {Salt/ Base} for max. Buffer range for basic buffer = pK_b ±1
- (C) Buffer Capacity = $\frac{\text{Moles/lit of Acid or Base Mixed}}{\text{Change in pH}}$ dCBOH dCHB

$$B = \frac{dODOH}{dpH} = -\frac{dOHD}{dpH}$$

4. Necessary condition for showing neutral colour of Indicator $pH = pK \ln or [HIn] = [In^{-}] or [InOH] = [In^{+}]$

IONIC EQULIBRIUM

1. Relation between ionisation neutral constant (K_i) & degree of ionisation (α) : –

$$Ki = \frac{\alpha^2}{(1-\alpha)V} = \frac{\alpha^2 C}{(1-\alpha)}$$
 (Ostwald's dilution law)

It is applicable to weak electrolytes for which $\alpha < <1$ then $\alpha = \sqrt{K_i V} = \sqrt{\frac{K_i}{C}} or V \uparrow C \downarrow \alpha \uparrow$

- 2. Common ion effect : By addition of X mole/ L of a common ion, to a weak acid (or weak base) α becomes equal to $\frac{K_a}{X} \left(or \frac{K_b}{X} \right)$ [where α =degree of dissociation]
- 3. (A) If solubility product = ionic product then the solution saturates.
 - (B). If solubility product > ionic product then the solution is unsaturated and more of the substance can be dissolved in it.
 - (C). Id ionic product > solubility product the solution is super saturated (principle of precipition).
- 4. Salt of weak acid and strong base:

 $pH = 0.5(pK_w + pK_a + \log c)$

Salt of weak base and strong acid

 $pH = 0.5(pK_w - pK_b - \log c)$

Salt of weak acid and weak base:

 $pH = 0.5(pK_w + pK_a - pK_b)$

CHEMICAL KINETICS

1. Unit of Rate constant:

 $K = mol^{1-\Delta n} lit^{\Delta n-1} \sec^{-1}$

2. First Order reaction:

$$K = \frac{2.303}{t} \log_{10} \frac{a}{a - x} \& t_{1/2} = \frac{0.693}{K}$$
$$[A]_t = [A]_0 e^{-kt}$$

3. Second Order Reaction:

When concentration of A and B taking same.

$$K_2 = \frac{1}{t} \left(\frac{x}{a(a-x)} \right)$$

When concentration of A and b are taking different-

$$K_{2} = \frac{2.303}{t(a-b)} \log \frac{b(a-x)}{a(b-x)}$$

4. Zero Order Reaction:

$$K = \frac{a_0 - a_t}{t}$$
$$x = kt \& t_{1/2} = \frac{a_0}{2K}$$

5. Arrhenius equation:

$$K = A e^{-E_a/RT} \& slope = \frac{-E_a}{2.303RK}$$

when $T \to \infty$, then $k = A (: e^{-E_a/RT} = 1)$

6.
$$\log\left(\frac{k_2}{k_1}\right) = \frac{E_a}{2.303R} \left(\frac{T_2 - T_1}{T_1 T_2}\right)$$

OXIDATION-REDUCTION

- 1. Oxidant itself is reduced (gives O_2) Or Oxidant $\rightarrow e(s)$ Acceptor Reductant itself is oxidised (gives H_2) Or reductant $\rightarrow e(s)$ Donor
- (i) Strength of acid α O.N
 (ii) Strength of base α 1/ O.N
- 3. (a) Electro Chemical Series:- Li, K, Sr, Ca, Na, Mg, Al, Mn, Zn, Cr, Fe, Cd, Co, Ni, Sn, Pb, H₂, Cu, I₂, Hg, Ag, Br₂, Cl₂, Pt, Au, F₂
 - (b)As we move from top to bottom in this series
 - (1) Standard Reduction Potential ↑
 - (2) Standard Oxidation Potential↓
 - (3) Reducing Capacity \downarrow
 - (́4) Ip↑
 - (5) Reactivity↓
- 4. (a) Formal charge = Group No. [No. of bonds+ No. of non- bonded e^{-s}]

(b)At A node \rightarrow Oxidation, Cathode \rightarrow Reduction

VOLUMETRIC ANALYSIS

- 1. Equivalent weight of element = $\frac{\text{Atomic wt of the element}}{n \text{ factor}}$
- 2. Equivalent weight of Compound = $\frac{\text{Formula wt of the compound}}{n \text{ factor}}$
- 3. Equivalent weight of an ion = $\frac{\text{Formula wt (or At. Wt.)of ion}}{\text{its valency}}$
- 4. The law of dulong and petit Atomic wt.× specific heat ≈ 6.4
- 5. Normality (N) = $\frac{\text{Number of equivalents of solute}}{\text{Volume of the solution in liters}}$
- 6. Molarity (M) = $\frac{\text{Number of moles of solute}}{\text{Volume of the solution in liters}}$
- 7. When a solution is diluted $N_1 \times V_1 = N_2 \times V_2$ (before dilution) (after dilution)

8. Common acid- base indicators

| Indicator | Colour in acidic medium | Colour in alkaline medium | pH range |
|-----------------|----------------------------|------------------------------|----------|
| Methylorange | Pink | Yellow | 3.0-4.4 |
| Methylred | Red | Yellow | 4.2-6.2 |
| Litmus | Red | Blue | 5.5-7.5 |
| Phenolphthalein | Colourless | Pink | 8.3-9.8 |

MOLE CONCEPT

1.Mole concept GAM \equiv 1gm atom \equiv 6.02×10²³ atom. GAM \equiv 1gm molecule \equiv 6.02×10²³ molecules. N_A=6.02×10²³

2.Moles (gases)at NTP= $\frac{volume(L)}{22.4}$

3.Molecular mass= $2 \times$ vapour density

CHEMICAL ENERGETICS

1. First Law: $\Delta E = Q + W$

Expression for pressure volume work $W = -P\Delta V$ Maximum work in a reversible expansion:

W = -2.303n RT log $\frac{V_2}{V_1}$ = -2.303*n*RT log $\frac{P_1}{P_2}$

2. Enthalpy and heat content: $\Delta H = \Delta E + P\Delta V$ $[q_{(p)}=q_{(v)} + \Delta n_g RT]$ $\Delta H = \Delta E + \Delta n_g RT$ $[\Delta n_g = n_{p(g)} - n_{r(g)}]$

3.Kirchoffs equation:

 $\Delta \mathbf{E}_{\mathrm{T}_{2}} = \Delta \mathbf{E}_{\mathrm{T}_{1}} + \Delta C_{v} (T_{2} - T_{1}) [cons \tan tV]$ $\Delta \mathbf{H}_{\mathrm{T}_{2}} = \Delta \mathbf{H}_{\mathrm{T}_{1}} + \Delta C_{p} (T_{2} - T_{1}) [cons \tan tP]$

4. Entropy(s): Measure of disorder or randomness

$$\Delta S = \sum S_p - \sum S_R$$

$$\Delta S = \frac{q_{rev}}{T} = 2.303 nr \log = \frac{V_2}{V_1} = 2.303 nr \log \frac{P_1}{P_2}$$

5. free energy change: $\Delta G = \Delta H - T\Delta S$ $\Delta G < 0$ (Spontaneous) [-ve] $\Delta G = 0$ (equilibrium) $\Delta G > 0$ (non-spontaneous) [+ve] $-\Delta G = W$ (maximum) -P ΔV

| фН | ¢S | ¢G | Reaction characteristics |
|----|----|---|--|
| - | + | Always Negative | Reaction is spontaneous at all temperature. |
| + | - | Always Positive | Reaction is no spontaneous at all temperature. |
| - | - | Negative at low temperature but positive at high temperature | Spontaneous at low temp. & non spontaneous at high temperature. |
| + | + | Positive at low temperature but negative at high temperature | Non spontaneous at low temperature & spontaneous at high temperature. |

ELECTRO CHEMISTRY

1. M = Z. I.t

2. Degree of dissociation: $\alpha = \frac{\lambda_{eq}}{\lambda_{eq}^{\infty}} = \frac{\text{Equivalent conductance at given concentration}}{\text{equivalent conductance at infinite dilution}}$ 3. *Kohlrausch'slaw*: $\Delta_m^0 = x \lambda_A^0 + y \lambda_B^0$

4.Nernst Equation

$$E = E^{0} - \frac{0.0591}{n} \log_{10} \frac{[\text{Pr} oducts]}{[\text{Re} ac \tan ts]} \& E^{0}_{cell} = E^{0}_{anode} + E^{0}_{cathode} \& \text{Keq} = \operatorname{antilog} \left[\frac{nFE^{0}}{0.0591} \right]$$
$$\Delta G = -nFE_{cell} \& \Delta G^{0} = -nFE^{0}_{cell}$$
$$-\Delta G^{0} = 2.303RT \log K_{c} \& W_{max} = +nFE^{0} \& \Delta G = \Delta H + T \left(\frac{\partial \Delta G}{\partial T} \right)_{p}$$

5. Calculation of pH of an electrolyte by using a calomel electrode:

$$pH = \frac{E_{cell} - 0.2415}{0.0591}$$

SOLUTION AND COLLIGATIVE PROPERTIES

1. Raoult's law

$$p = p_{A} + p_{B} = p_{A}^{0} X_{A} + p_{B}^{0} X_{B} = (1 - XB) p_{A}^{0} + p_{B}^{0} X_{B} = (p_{B}^{0} - P_{A}^{0}) X_{B} + p^{0}A$$
$$\frac{P_{0} - P_{S}}{P_{0}} = \frac{n}{n + N} \& \frac{P_{0} - P_{S}}{P_{0}} = \frac{w.m}{W.M}$$

- 2. Colligative α Number of particles Properties α Number of molecules (in case of nonelectrolytes) α Number of ions (in case of electrolytes) α Number of moles of solute α Mole fraction of solute
- 3. Depression of freezing point, $\Delta T_f = K_f m$

4. Elevation in boiling point with relative lowering of vapour pressure

$$\Delta T_b = \frac{1000K_b}{M_1} \left(\frac{p^0 - p}{p^0}\right) (M_1 = mol.wt.ofsolvent)$$

5. Osmotic pressure (P) with depression in freezing point $_{f}T\Delta$ $P = \Delta T_{f} \times \frac{dRT}{1000K_{f}}$

6. $i = \frac{\text{Normal molar mass}}{\text{Observed molar mass}} = \frac{\text{Observed colligative property}}{\text{Normal colligative property}}$ $i = \frac{\text{Observed osmotic pressure}}{\text{Normal osmotic pressure}} = \frac{\text{Actual number of particles}}{\text{No. of particles for no. ionisation}}$ degree of association(a) = (1-i) $\frac{n}{n-1}$ & degree of dissociation(α) = $\frac{i-1}{n-1}$

NUCLEAR CHEMISTRY

1. Radius of the nucleus: $R = R^0 A^{1/3}$

2. The amount N of the radioactive substance left after 'n' half lives = $\frac{N_0 \text{ (initial amount)}}{2^n}$

- 3. Half-life period $t_{1/2} = \frac{0.693}{\lambda}$
- 4. Rate of disintegration:

$$-\frac{dN}{dt} = \lambda . N \& \lambda = \frac{2.303}{t} \log_{10} \frac{N_0}{N} or N = N_0 e^{-\lambda t}$$

Average life $(t_{AV}) = \frac{\text{Total life time of all the atoms}}{\text{Total number of atoms}}$ 5. $= \frac{\int_{0}^{\infty} t dn}{N_0} = \frac{1}{\lambda} = 1.44t_{1/2}$

GASEOUS STATE

- 1. Ideal gas equation: PV = nRT
 - (i) $\tilde{R} = 0.0821$ litre atm. K⁻¹ mole⁻¹
 - (ii) R = 62.4 liters mm Hg K⁻¹ mole⁻¹
 - (iii) $R = 8.314 * 10^7 \text{ ergs } \text{K}^{-1} \text{ mole}^{-1}$ (iv) $R = 2 \text{ cals } \text{K}^{-1} \text{ mole}^{-1}$

 - R =8.314 J K⁻¹ mole⁻¹ (v)
- 2. Velocities related to gaseous state

RMS velocity C = $\sqrt{\frac{3PV}{M}} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3P}{d}}$ Average speed = $\sqrt{\frac{8RT}{\pi M}}$ & Most probable speed = $\sqrt{\frac{2RT}{M}}$

Average speed = 0.9213 * RMS speed MPS = .816 * RMS; RMS = 1.224 MPS MPS : A. V. speed : RMS = 1: 1.128 : 1.224

- 3. Rate of diffusion $\alpha \frac{1}{\sqrt{\text{density of gas}}}$
- 4. Vander Wall's equation $\left(P + \frac{n2a}{V2}\right)(V - nb) = nRT$ for n moles

5. Z (compressibility factor)=
$$\frac{PV}{nRT}$$
; Z = 1 for ideal gas

SOLID AND LIQUID STATE

1. Available space filled up by hard spheres (packing fraction): Simple cubic = $\frac{\pi}{6} = 0.52$

$$bcc = \frac{\pi\sqrt{3}}{8} = 0.68$$
 fcc. $= \frac{\pi\sqrt{2}}{6} = 0.74$
hcp $= \frac{\pi\sqrt{2}}{6} = 0.74$ diamond $= \frac{\pi\sqrt{3}}{6} = 0.34$

2. Radius ratio and co-ordination number (CN)

| Limiting radius ratio | CN | Geometry |
|-----------------------|----|------------------|
| [0.155- 0.225] | 3 | [plane triangle] |
| [0.255 – 0.414] | 4 | [tetrahedral] |
| [0.414 – 0.732] | 6 | [octahedral] |
| [0.732 – 1] | 8 | [bcc] |

3. Atomic radius r and the edge of the unit cell: Pure elements: Simple cubic =r = $\frac{a}{2}$

bcc r =
$$\sqrt{\frac{3a}{4}}$$
 fcc = $\sqrt{\frac{2a}{4}}$

- 4. Relationship between radius of void (r) and the radius of the sphere (R): r (tetrahedral) = 0.225 R; r(octahedral) = 0.414 R
- 5. Paramagnetic : Presence of unpaired electrons [attracted by magnetic field]
- 6. Ferromagnetic: Permanent magnetism [^^^^]
- 7. Antiferromagnetic: net magnetic moment is zero [$\uparrow\downarrow\uparrow\downarrow$]
- 8. Ferrimagnetic: net magnetic moment is there [^+++^]

SURFACE CHEMISTRY & COLLOIDAL STATE

- 1. Higher is the valency of active ion, the greater is its coagulating power.
- 2. Emulsion: Colloidal soln. of two immiscible liquids [O/ Wemulsion, W / O emulsion]
- 3. Emulsifier: Long chain hydrocarbons are added to stabilize emulsion.
- 4. Lyophilic colloid: Starchy gum, gelatin have greater affinity for solvent. Solution Can be easily prepared by bringing in contact with solvent and warming.
- 5. Lyophobic colloid: No affinity for solvent, special methods are used to prepare sol. [e.g. As₂S₃, Fe(OH)₃ sol]
- 6. Preparation of colloidal solution:
 - (i) Dipersion methods
 - (ii) Condensation method.
- 7. Properties of colloidal solution:
 - (i) Tyndall effect
 - (ii) Brownian movement
 - (iii) Coagulation
 - (iv) Filtrability

INORGANIC CHEMISTRY PERIODIC TABLE

1. General electronic configuration (of outer orbits)

| 0 | |
|---|--|
| 2 | |

| Properties | Pr(L to R) | Gr (T to B) |
|-------------------------|----------------------|--------------|
| (a) Atomic radius | \downarrow | ↑ |
| (b) Ionization | \uparrow | |
| potential | | |
| (c) Electron affinity | \uparrow | \checkmark |
| (d) Electron negativity | \uparrow | + |
| (e)Metallic character | ↓ () | ↑ |
| or electropositive | | |
| character | | |
| (f) Alkaline character | \downarrow | ↑ |
| of hydroxides | | |
| (g) Acidic character | \uparrow | ↓ |
| (h) Density | (i) Firstly increase | ↑ |
| | (ii)in between max | |
| | (iii)then decrease | |
| (i)Reducing property | \downarrow | \uparrow |
| (j) Oxidizing property | ↑ | \downarrow |
| (k)Non metallic | \uparrow | \downarrow |
| charcter | | |

- 3. IP $\alpha \frac{1}{\text{Metallic character}} \alpha \frac{1}{\text{Reducing character}} \alpha \frac{1}{\text{Basic Nature of oxide}} \alpha \frac{1}{\text{Basic nature of hydroxide}}$
- 4. $EA \alpha \frac{1}{size} \alpha$ neclear charge Second electron affinity is always positive. Electron affinity of chlorine is greater than fluorine.
- 5. The first element of a group has similar properties with the second element of the next group. This is called diagonal relationship.

EXTRACTIVE METALLURGY

- 1. Floatation is a physical method of separating a mineral from the gangue depending on differences in their wettabilities by a liquid
- 2. Roasting is the process of heating a mineral in the presence of air.
- 3. Calcination is the process of heating the ore in the absence of air.
- 4. Electrolytic reduction: Highly electropositive metals are extracted by the electrolysis of their oxides and hydroxides.

s- BLOCK ELEMENTS

- 1. Atomic radii: Li < Na < K < Rb < Cs
- 2. Ionic radii: $Li^{\dagger} < Na^{\dagger} < K^{\dagger} < Rb^{\dagger} < Cs^{\dagger}$
- 3. Electronegativity: Li > Na > K > Rb < Cs
- 4. First ionization potential: Li > Na > > K > Rb > Cs
- 5. Melting point: Li > Na > K > Rb > Cs'
- 6. Density: Li > Na > K > Rb > Cs
- 7. Colour of the flame Li- red, Na- Golden, K- Violet, Rb- Red, Cs- Blue, Ca-Brick Red, Sr- Blood red, Ba- Apple green
- 8. Rb and Cs show photoelectric effect.
- 9. Stability of hydrides: LiH > NaH > KH > RbH > CsH
- 10. Basic nature of hydroxides: [LiOH < NaOH < KOH < RbOH < CsOH]

BORON FAMILY

- 1. Stability of +3 oxidation state: B > AI > Ga > In > TI
- Stability of +1 oxidation state: Ga < In < TI
- 3. Reducing nature: Al > Ga > In > Tl
- Basic nature of the oxides and hydroxides: B < AI < Ga < In < TI
- 5. Relative strength of Lewis acid : $BF_3 < BCI_3 < BBr_3 < BI_3$

CARBON FAMILY

- 1. Reactivity: C < Si < Ge < Sn < Pb
- 2. Metallic character: C < Si < Ge < Sn < Pb
- 3. Acidic character of the oxides: $CO_2 > SiO_2 > GeO_2 > SnO_2 > PbO_2$ Weaker acidic (amphoteric)
- 4. Thermal stability and volatility of hydrides: $CH_4 > SiH_4 > GeH_4 > SnH_4 < PbH_4$
- Reducing nature of hydrides: CH₄ < SiH₄ > geH₄ > SnH₄ > PbCl₄
- 6. Reducing power , covalent nature of Hydrides: NH₃ < PH₃ <AsH₃ < SbH₃ < BiH₃
- 7. Stability of trihalides of nitrogen: $NF_3 > NCI_3 > NBr_3$
- 8. Ease of hydrolysis of trichlorides NCl₃ > PCL₃ > AsCl₃ > SbCl₃ > BiCl₃
- Lewis and strength of trihalides of P, As and Sb PF₃ > PCl₃ > PBr₃ > Pl₃
- 10. Lewis acid strength among phosphorus trihalides PF₃ > PCl₃ > PBr₃ > Pi₃
- 11. Bond angle, among the halides of phosphorus $PF_3 < PCI_3 < PBr_3 < PI_3$

OXYGEN FAMILY

- 1. Melting and boiling point of hydrides $H_2O > H_2Te > H_2Se > H_2S$
- 2. Volatility of hydrides $H_2O > H_2Te > H_2Se > H_2S$
- 3. Thermal stability of hydrides $H_2O > H_2S > H_2Se > H_2Te$
- 4. Reducing nature of hydrides $H_2S < H_2Se < H_2Te$
- 5. Covalent character of hydrides $H_2O < H_2S < H_2Se < H_2Te$
- 6. Bond angle & dipole moment of hydrides $H_2O > H_2S > H_2Se > H_2Te$ (104°) (92°) (91°) (90°)
- 7. Ease of hydrolysis of hexabalides: $SF_6 > SeF_6 > TeF_6$
- 8. The acidic character of oxides (element in the same oxidation state)
- 9. Acidic character of oxide of a particular element(e.g. S) AO₂ > SeO₂ > TeO₂ > PoO₂ So₃ > SeO₃ > TeO₃
- 10. Stability of dioxides $SO_2 > TeO_2 > SeO_2 > PoO_2$

HALOGEN FAMILY

- 1. Bond energy of halogens: $Cl_2 > Br_2 > F_2 > I_2$
- 2. Bond length in x_2 molecule: $F_2 > Cl_2 > Br_2 > l_2$
- 3. Solubility of halogen in water: $F_2 > CI_2 > Br_2 > I_2$
- 4. Oxidizing power: $F_2 > CI_2 > Br_2 > I_2$
- 5. Enthalpy of hydration of X⁻ ion: $F^- > CI^- > Br^- > I^-$
- 6. Reactivity of halogens: F > Cl > Br > I
- 7. Ionic character of M X bond in halide M F > M CI > M Br > M I
- 8. Reducing character of X⁻ ion: $I^- > Br^- > CI^- > F^-$
- 9. Thermal stability of hydrides: HF > HCl > HBr > HI
- 10. Acidic strength of halogen acids: HI > HBr > HCI > HF
- 11. Conjugate base strength of halogen acids I < Br < CI < F
- 12. Reducing power of hydrogen halides HF < HCI < HBr < HI
- 13.Dipole moment of hydrogen halides HF > HCI > HBr > HI
- 14.Oxidising power of oxides of chlorine $Cl_2O > ClO_2 > Cl_2O6 > Cl_2O_7$
- 15. Acidic character of oxyacids of chloride $HCIO < HCIO_2 < HCIO_3 < HCIO_4$
- 16.Strength of conjugate bases of oxyacids of chlorine $CIO^{-} > CIO_{2}^{-} > CIO_{3}^{-} > CIO_{4}^{-}$

HALOGEN FAMILY

- 17. Oxidizing power of oxyacids of chlorine $HCIO < HCIO_2 < HCIO_3 < HCIO_4$
- 18. Thermal stability of oxyacids of chlorine $HCIO < HCIO_2 < HCIO_3 < HCIO_4$
- 19. Stability of anions of oxyacids of chlorine $CIO^{-} > CIO_{2}^{-} > CIO_{3}^{-} > CIO_{4}^{-}$

TRANSITION ELEMENTS (D-BLOCK ELEMENTS)

- 1. The element with exceptional configuration are Cr^{24} [Ar] $3d^54s^1$, Cu^{29} [Ar] $3d^{10}4s^1$ Mo⁴² [Kr] $4d^55s^1$, Pd⁴⁶ [Kr] $4d^{10}5s^0$ Ag⁴⁷ [Kr] $4d^{10}5s^1$, Pt⁷⁸ [Xe] $4f^{14}5d^{10}6s^0$ Au⁷⁹ [Xe] $4f^{14}5d^{10}6s^1$
- 2. Ferromagnetic substances are those in which there are large number of electrons with unpaired spins and whose magnetic moments are aligned in the same direction.

COORDINATION COMPOUNDS

- 1. Coordination number is the number of the nearest atoms or groups in the coordination sphere.
- 2. Ligand is a Lewis base donor of electrons that bonds to a central metal atom in a coordination compound.
- 3. Paramagnetic substance is one that is attracted to the magnetic field, this result on account of unpaired electrons present in the atom/molecule/ion.
- Effective atomic number EAN = (Z Oxidation number) + (2 * Coordination number)
- 5. Factors affecting stability of complex
- (i) Greater the charge on the central metal ion, greater is the stability.
- (ii) Greater the ability of the ligand to donate electron pair (basic strength) greater is the stability.
- (iii) Formation of chelate rings increases the stability.

ORGANIC CHEMISTRY GOC

- 1. The order of decreasing electro negativity of hybrid orbital's is sp > sp² > sp^3
- 2. Conformational isomers are those isomers which arise due to rotation around a single bond.
- 3. A meso compound is optically inactive, even though it has asymmetric centers (due to internal compensation of rotation of plane polarized light)
- 4. An equimolar mixture of enantiomers is called racemic mixture, which is optically inactive
- 5. Tautomerism is the type of isomerism arising by the migration of hydrogen.
- Reaction intermediates and reagents: Homolytic fission → Free radicals Hetrolytic fission → Carbocation and carbanion
- 7. Nucleophiles electro rich Two types :

 Anions
 Neutral molecules

 With lone pair of electrons(Lewis bases) Electrophiles: electron deficient. Two types :

 Neutral molecules with vacant orbitals (Lewis acids)
- 8. Inductive effect is due to s
- 9. electron displacement along a chain and is permanent effect.
- 9. +I (inductive effect) increase basicity, I effect increases acidity of compounds.
- 10. Resonance is a phenomenon in which two or more structures can be written for the same compound but none of them actually exists.

ALKANES

- 1. Pyrolytic cracking is a process in which alkane decomposes to a mixture of smaller hydrocarbons, when it is heated strongly, in the absence of oxygen.
- 2. Combustion is a process in which hydrocarbons from carbon dioxide and H_2O (I) when they are completely burnt in air/ O_2 .

ALKENES

- 1. In dehydration and dehydro halogenations the order for removal of hydrogen is $3^{\circ} > 2^{\circ} > 1^{\circ}$ (Saytzeff's rule)
- 2. The lower the Δh_h (heat of dehydrogenation) the more stable the alkene is.
- 3. Alkenes undergo anti-Markonikov addition only with HBr in the presence of peroxides.

ALKYNES

- 1. All o and p-directing groups ring activating groups (expect X) They are: -OH, -NH₂, -X, R, -OR etc.
- 2. All m-directing groups are ring deactivating groups. They are: -CHO, -COOH, -NO₂, -CN, -NR₃ etc.

HALOGEN COMPOUNDS

- 1. The order of reactivity is
- (a)RI > RBr > RCI > RF
- (b)Ally halide > Alkyl halide > Vinyl halide
- (c) Alkyl halide > Aryl halide
- 2. $S_N 1$ reaction: mainly 3° alkyl halides undergo this reaction and form racemic mixture. $S_N 1$ is favoured by polar solvent and low concentration of nuclephile.
- 3. S_N2 reaction:Mainly 10 alkyl halides undergo this substitution. S_N² reaction is preferred by non-polar solvents and high concentration of nucleophile.

ALCOHOLS

1. Alkenes are converted to alcohol in different ways as follows

| Reagent |
|---------|
|---------|

| dil H_2SO_4 | |
|------------------|----------------------|
| B_2H_6 and F | I_2O_2 |
| Oxymercu | ration demercuration |

Types of addition

- Markovnikov
- Anti- Markovnikov
- Markovnikov
- 2. Oxidation of 1° alcohol \rightarrow aldehyde \rightarrow carboxylic acid (with same (with same no. of C atom) no. of C atom)
- 2[°] alcohol ketone carboxylic acid (with same (with less no. of C atom) no. of C atom)
- 3[°] alcohol ketone carboxylic acid (with less (with less no. of C atom) no. of C atom)

PHENOLS

- 1. Phenol <u>CHCl3/OH</u> Salicyaldehyde (Reimer- Tieman reaction)
- 2. Phenol $\xrightarrow{\text{CO}_2}$ Salicyclic acid (Kolbe reaction)
- 3. Acidity of phenols
 - (a) Increase by electron withdrawing substituents like -NO₂, -CN, -CHO, -COOH, -X, -NR₃
 - (b) Decrease by electron releasing substituent's like -R, -OH, $-NH_2$, $-NR_2$, OR

ETHERS

1.
$$2\text{ROH} \xrightarrow{\text{Al}_2\text{O}_3} \text{R} - \text{O} - \text{R} + \text{H}_2\text{O}$$

2. $\text{RONa} + \text{X} - \text{R'} \xrightarrow{} \text{ROR'} + \text{NaX}$ (Williamson's synthesis)
3. $\text{ROR} + 2 \text{H}_2\text{SO}_4 \xrightarrow{\Delta} 2\text{RHSO}_4 + \text{H}_2\text{O}$
4. $\text{ROR} + \text{H}_2\text{O} \xrightarrow{\text{dil.} \text{H}_2\text{SO}_4} 2\text{ROH}$

CARBONYL COMPOUNDS

- Formation of alcohols using RMgX

 (a) Formaldehyde + RMgX Hydrolysis
 →1⁰ alcohol
 (b) Aldehyde + RMgX → 2⁰ alcohol
 (other than HCHO) Hydrolysis
 (c)Ketone + RMgX → 3⁰ alcohol
- 2. Cannizzaro reaction (disproportionation) Aldehyde $\xrightarrow{Hot \text{ conc.}}$ Alcohol + salt of acid no α H-atom

Crossed- cannizzaro reaction gives alcohol with aryl group or bigger alkyl group.

3. Aldol condensation:

Carbonyl compound +dil. alkali $\longrightarrow \beta$ - hydroxy carbonyl compound (With α H-atom)

4. Benzoin condensation

Benzaldehyde ethanolic Benzoin

CARBOXYLIC ACIDS

- 1. The rate of esterification decrease when alcohol, acid or both have branched substitutents.
- 2. Ortho effect: All ortho substituted benzoic acids (irrespective of type of substitutent) are stronger than benzoic acid. As this group decrease outer resonance of ring towards acid which increase acidic nature.

NITROGEN COMPOUNDS

- 1. Order of basicity: (R = -CH₃ or C₂H₅) $2^{\circ} > 1^{\circ} > 3^{\circ} > NH_{3}$
- 2. Hofmann degradation Amides $\xrightarrow{\text{Br}_2/\text{KOH}}$ 1⁰ amine
- 3. The basicity of amines is
 - (a) Decreased by electron withdrawing groups
 - (b) Increased by electron releasing groups
- 4. Reduction of nitrobenzene in different media gives different products

| Medium | Product |
|---------|---------------------------------------|
| Acidic | Aniline |
| Basic | Azoxy, Azo and finally hydrazobenzene |
| Neutral | Phenyl hydroxyl amine |

CARBOHYHYDRATES, AMINO ACIDS AND POLYMERS

- 1. Carbohydrates are polyhydroxy aldehydes or ketenes.
- 2. Oligosaccharides are simple sugars, containing three to nine carbon atoms.
- 3. Polymer is a chemical species of high molecular weight made up from repeating units of low molecular weight.

CHARACTERISTIC REACTIONS OF DIFFERENT ORGANIC COMPOUNDS

Homologous series

(a) Alkanes

- (b) Alkenes and alkynes
- (c) Arenes
- (d)Alkyl halides
- (e) Aldehyde and ketones

Test to differentiate:

- 1°, 2°, and 3° alcohols
- 1°, 2°, and 3° amines
- 1° , 2° , and 3° nitro compounds
- Aryl halides and alkyl halides
- Aldehydes and ketones aromatic
- Aldehydes and aliphatic aldehydes

Type of reactions Substitution

(Mostly free radical)

Electrophilic addition

Electrophilic substitution

Neucleophilic Substitution

Nucleophilic addition

Lucas test Victormayer's test

Hinsberg test

Test with HNO_2 and KOH

Test with AgNO₃ solution

Tollen's test/ Fehling's test

Fehling's test

IMPORTANT REAGENT

- 1. DiH_2SO_4 [or Cons. $H_2SO_4 + H_2O_4$ $Use \longrightarrow Dehydrating agent (+HOH)$ (a) $CH_2 \longrightarrow CH_2 \xrightarrow{dil. H_2SO_4} CH_3 \longrightarrow CH_2 \longrightarrow OH$ (b) $C_2H_5OC_2H_5 \xrightarrow{dil. H_2SO_4} 2C_2H_5OH$ 2. Alc. KOH or Nanh₂ (Use $\longrightarrow -Hx_4$ $CH_3CH_2C1 \xrightarrow{alc. KOH} CH_2 \longrightarrow CH_2$ 3. Cu or ZnO / 300°C $1^0 alc \xrightarrow{"} ald, 2^0 alc \xrightarrow{"} ketone, 3^0 alc \xrightarrow{"} alkene (exception)$
- Lucas reagent Zncl₂ + Conc. HCl Use → for distinction between 1⁰, 2⁰ & 3⁰ alcohol
- 5. Tiden Reagent NOCI (Nitrosyl chloride) C₂H₃NH₂ → CH₂CI
 6. Alkaline KMNO₄ (Strong oxidant)
- Alkaline KMNO₄ (Strong oxidant) Toluene → Benzoic acid
- 7. Bayer's Reagent
 1 % alkaline KMNO₄ (Weak oxidant)
 Use: → for test of > C = C < or C^{=C}

 $\mathbf{CH}_2 = \mathbf{CH}_2 + \mathbf{H}_2\mathbf{O} + [\mathbf{O}] - \mathbf{H}_2\mathbf{O} + \mathbf{CH}_2\mathbf{O} + \mathbf$

- 8. Acidic K₂Cr₂O₇ (Strong oxidant) RCH₂OH [O] → RCHO
- SnCl₂ / HCl or Sn / HCl use → for reduction of nitrobenzene in acidic medium.

$$C_6H_5NO_2 \xrightarrow{SnCl_2 / HCl} C_6H_5NH_2$$

10. Lindlar's catalyst = pd / CaCO₃ + in small quantity(CH₃COO)₂Pb

2 - butyne $+H_2$ — Cis - 2 - butene (main product)

11. Ziegler- Natta Catalyst (C₂H₅)₃Al + TiCl₄ Use – In additional polymerization

Propene — Poly propene

MAIN USE OF COMPOUNDS

Alkane → Fuel, Alkene → Solvent making westron, Westrosol, General alkyl halide → as solvents, CHCl₃ → Anaesthetic., Germicide, CCl₄ → Pyrene & Fire extinguisher, CH₃OH → Antifreeze, deforming of alcohol, C₂H₅-O-C₂H₅ → Antiseptic, Natellite, HCHO → Formamint medicine, CH₃CHO → Antiseptic, CH₃COCH₃ → as solvent, CH₃COOC₂H₅ → Artificial silk & flavor, CH₃NH₂ → Refrigerating agent, C₂H₅NH₂ → in development of photography.

SMELL OF SOME COMPOUNDS

 $\begin{array}{cccc} CH_{3}COOC_{2}H_{5} & \longrightarrow & Fruity\\ CHCI_{3}, CH_{3}I, C_{2}H_{5}I & \longrightarrow & Sweetsmell\\ C_{6}H_{5}NO_{2}\&C_{6}H_{5}CHO & \longrightarrow & Like bitter almonds\\ CH_{3}COCI & \longrightarrow & Pungent\\ CH_{3}NH_{2}\&C_{6}H_{5}NH_{2} & \longrightarrow & Fishy,\\ Impure CH_{3}CONH_{2} & \longrightarrow & mice like,\\ ROH & \longrightarrow & Wine\\ RNCS & \longrightarrow & Mustard oil,\\ Methyl salicylate & \longrightarrow & wintergreen oil,\\ RNC & \longrightarrow & Foul smell.\\ \end{array}$

IDENTIFICATION TESTS

- (a) Unsaturated compound (Bayer's reagent) Decolorizing the reagent
- (b) Alcohols (Ceric Ammonium nitrate solution) Red coloration.
- (c) Phenols (Neutral FeCl₃ solution) violet/deep blue coloration.
- (d) Aldehydes and ketones (2, 4-D.N.P.) orange Precipitate
- (e) Acids (NaHCO₃ solution) Brisk effervescence (CO₂ is evolved)
- (f) 10 amine (CHCl₃ + KOH) Foul smell (isocyanide)
- (g)20 amine (NaNO2 + HCI) yellowoily liquid (Nitrosoamine)