CHEMISTRY CLASS-XII
REVISION CHEAT SHEET

PHYSICAL CHEMISTRY

CHEMICAL KINETICS

- **Unit of rate constant :** $k = mol^{1-n}\, lit^{n-1}\, sec^{-1}$
- **Order of reaction** It can be fraction, zero or any whole number.
- **Molecularity of reaction** is always a whole number. It is never more than three. It cannot be zero.
- **First Order Reactions :**

$$k = \frac{2.303}{t}\log_{10}\frac{a}{(a-x)}\ \&$$

$$t_{1/12} = \frac{0.693}{k}\quad [A]_t = [A]_0 e^{-kt}$$

- **Second Order Reactions :** 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 -

$$k_2 = \frac{2.303}{t(a-b)}\log\frac{b(a-x)}{a(b-x)}$$

- **Zero Order Reaction :** $x = kt$ and $t_{1/2} = \frac{a}{2k}$

The rate of reaction is independent of the concentration of the reacting substance.

- Time of *n*th fraction of first order process,

$$t_{1/n} = \frac{2{\cdot}303}{k}\log\left(\frac{1}{1-\frac{1}{n}}\right)$$

- Amount of substance left after 'n' half lives $= \frac{[A]_o}{2^n}$

- **Arrhenius equation :** $k = Ae^{-E_a/RT}$, slope $= \frac{-E_a}{2.303R}$

and Temperature Coefficient $\log\left(\frac{k_2}{k_1}\right) = \frac{E_a}{2.303R}\left(\frac{T_2 - T_1}{T_1 T_2}\right)$

- It has been found that for a chemical reaction with rise in temperature by 10 °C, the rate constant gets nearly doubled.

$$k = PZ_{AB}e^{-E_a/RT}$$

ELECTROCHEMISTRY

- Degree of dissociation : $\alpha = \frac{\lambda_{eq}}{\lambda_{eq}^{0}}$
- Specific conductance

$$\kappa = \frac{1}{\rho} = \frac{\ell}{R.a} = G \times \frac{\ell}{a} = G \times \text{cell constant } (G^*)\ ;$$

$$\Lambda_m = \frac{\kappa \times 1000}{M},\quad \Lambda_{eq} = \frac{\kappa \times 1000}{N}$$

- Kohlrausch's law : $\Lambda_m^0 = x\lambda_A^0 + y\lambda_B^0$
- Nernst Equation $E = E^o - \frac{0.0591}{n}\log_{10}\frac{[\text{Products}]}{[\text{Reactants}]}$

$\&\ E^o_{Cell} = E^o_{right} + E^o_{left}\ \&\ K_{eq.} = \text{antilog}\left[\frac{nE^o}{0.0591}\right]$

$\Delta G = -nFE_{cell}\ \&\ \Delta G^o = -nFE^o\ cell = -2.303\ RT\ \log K_c$

- Calculation of pH of an electrolyte by using a calomel electrode : $pH = \frac{E_{cell} - 0.2415}{0.0591}$
- Thermodynamic efficiency of fuel cell is 95%.

SOLUTIONS

- $P = K_H . x$
- Normality (N) $= \dfrac{\text{number of equivalents}}{\text{volume of the solution in litres}}$
- Molarity (M) $= \dfrac{\text{number of moles}}{\text{volume of the solution in litres}}$
- Raoult's law

  $P = p_A + p_B = p^\circ{}_A X_A + p^\circ{}_B X_B$
- **Characteristics of an ideal solution:**

  (i) $\Delta_{sol} V = 0$

  (ii) $\Delta_{sol} H = 0$
- Relative lowering of vapour pressure $= \dfrac{P_A^o - P_A}{P_A^o}$

  $$\frac{P_A^o - P_A}{P_A^o} = X_B = \frac{n_B}{n_A + n_B}$$
- Colligative properties $\propto$ Number of particles/ ions/ moles of solute
- Depression of freezing point, $\Delta T_f = K_f m$
- Elevation in boiling point with relative lowering of vapour pressure $\Delta T_b = \dfrac{1000 K_b}{M_1}\left(\dfrac{p^o - p}{p^o}\right)$ (M_1 = mol. wt. of solvent)
- Osmotic pressure (P) with depression in freezing point ΔT_f

  $$P = \Delta T_f \times \frac{dRT}{1000 K_f}$$
- Relation between Osmotic pressure and other colligative properties:

  (i) $\pi = \left(\dfrac{p_A^o - p_A}{p_A^o}\right) \times \dfrac{dRT}{M_B}$ Relative lowering of vapour pressure

  (ii) $\pi = \Delta T_b \times \dfrac{dRT}{1000 K_b}$ Elevation in boiling point

  (iii) $\pi = \Delta T_f \times \dfrac{dRT}{1000 K_f}$ Depression in freezing point
- $i = \dfrac{\text{Normal molar mass}}{\text{Observed molar mass}} = \dfrac{\text{Observed colligative property}}{\text{Normal colligative property}}$
- Degree of association $a = (1 - i)\dfrac{n}{n-1}$

  & degree of dissociation $(\alpha) = \dfrac{i-1}{n-1}$

INORGANIC CHEMISTRY

NITROGEN FAMILY

- Acidic strength of trioxides : $N_2O_3 > P_2O_3 > As_2O_3$
- Acidic strength of pentoxides

  $N_2O_5 > P_2O_5 > As_2O_5 > Sb_2O_5 > Bi_2O_5$
- Acidic strength of oxides of nitrogen

  $N_2O < NO < N_2O_3 < N_2O_4 < N_2O_5$
- Basic nature, bond angle, thermal stability and dipole moment of hydrides $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
- Stability of trihalides of nitrogen : $NF_3 > NCl_3 > NBr_3$
- Lewis base strength : $NF_3 < NCl_3 > NBr_3 < NI_3$
- Ease of hydrolysis of trichlorides

  $NCl_3 > PCl_3 > AsCl_3 > SbCl_3 > BiCl_3$
- Lewis acid strength of trihalides of P, As and Sb

  $PCl_3 > AsCl_3 > SbCl_3$
- Lewis acid strength among phosphorus trihalides

  $PF_3 > PCl_3 > PBr_3 > PI_3$
- Nitrogen displays a great tendency to form $p\pi - p\pi$ multiple bonds with itself as well as with carbon and oxygen.
- The basic strength of the hydrides

  $NH_3 > PH_3 > AsH_3 > SbH_3$
- The thermal stability of the hydrides decreases as the atomic size increases.

OXYGEN FAMILY

- Melting and boiling point of hydrides : $H_2O > H_2Te > H_2Se > H_2S$
- Volatility of hydrides: $H_2O < H_2Te < H_2Se < H_2S$
- Reducing nature of hydrides : $H_2S < H_2Se < H_2Te$
- Covalent character of hydrides : $H_2O < H_2S < H_2Se < H_2Te$
- The acidic character of oxides (elements in the same oxidation state) $SO_2 > SeO_2 > TeO_2 > PoO_2$; $SO_3 > SeO_3 > TeO_3$
- Acidic character of oxide of a particular element (e.g. S) $SO < SO_2 < SO_3$; $SO_2 > TeO_2 > SeO_2 > PoO_2$

HALOGEN FAMILY

- Bond energy of halogens : $Cl_2 > Br_2 > F_2 > I_2$
- Solubility of halogen in water : $F_2 > Cl_2 > Br_2 > I_2$
- Oxidising power : $F_2 > Cl_2 > Br_2 > I_2$
- Enthalpy of hydration of X^- ion : $F^- > Cl^- > Br^- > I^-$
- Reactivity of halogens : F > Cl > Br > I
- Ionic character of M - X bond in halides $M-F > M-Cl > M-Br > M-I$
- Reducing character of X^- ion : $I^- > Br^- > Cl^- > F^-$
- Acidic strength of halogen acids : HI > HBr > HCl > HF
- Conjugate base strength of halogen acids: $I^- < Br^- < Cl^- < F^-$
- Reducing property of hydrogen halides : HF < HCl < HBr < HI
- Oxidising power of oxides of chlorine $Cl_2O > ClO_2 > Cl_2O_6 > Cl_2O_7$

TRANSITION ELEMENTS (d- and f-BLOCK ELEMENTS)

- The element with exceptional configuration are

  $Cr^{24}[Ar]\,3d^54s^1$, $Cu^{29}[Ar]\,3d^{10}4s^1$

  $Mo^{42}[Kr]\,4d^55s^1$, $Pd^{46}[Kr]\,4d^{10}5s^0$ $Ag^{47}[Kr]\,4d^{10}5s^1$, $Pt^{78}[Xe]\,4f^{14}5d^{10}6s^0$

- **Inner Transition Elements**

  (i) **Electronic Configuration -** $[Xe]4f^{0-14}5d^{0-1}6s^2$

  (ii) **Magnetic properties -** Magnetic moment is given by the formula $\mu = \sqrt{4S(S+1)+L(L+1)}$ where L = Orbital quantum number, S = Spin quantum number

COORDINATION COMPOUNDS

- Coordination number is the number of the nearest atoms or groups in the coordination sphere.
- Ligand is a Lewis base donor of electrons that bonds to a central metal atom in a coordination compound.
- Paramagnetic substance is one that is attracted to the magnetic field, this results on account of unpaired electrons present in the atom/molecule/ion.
- 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.
- Isomerism in coordination compounds :
  - (i) Structural Isomerism
  - (ii) Ionization Isomerism
  - (iii) Hydration Isomerism
  - (iv) Linkage Isomerism
  - (v) Polymerisation Isomerism
  - (vi) Valence Isomerism
  - (vii) Coordination Position Isomerism
  - (viii) Stereo Isomerism
    - (a) *Geometrical Isomerism*
      - (1) *Square planar complexes of the type* MA_2X_2 ; $MABX_2$; MABXY
      - (2) Octahedral of the type : MA_4XY, MA_4X_2 MA_3X_3 $MA_2X_2Y_2$. $M(AA)_2X_2$ and M(ABCDEF).
    - (b) *Optical isomerism* : Shown by the compounds that are mirror images and cannot be superimposed on one another.

ORGANIC CHEMISTRY

HALOGEN COMPOUNDS

- The order of reactivity is

  (i) RI > RBr > RCl > RF

  (ii) Allyl halide > Alkyl halide > Vinyl halide

  (iii) Alkyl halide > Aryl halide

- **S_N1 reaction :** Mainly 3° alkyl halides undergo this reaction and form racemic mixture. S_N1 is favoured by polar solvent and low concentration of nucleophile.

- **S_N2 reaction :** Mainly 1° alkyl halides undergo this substitution. Walden inversion takes place. S_N2 reaction is preferred by non-polar solvents and high concentration of nucleophile.

- **Reaction with metals:**

  (*i*) $\underset{\text{Alkyl halides}}{R - X} + Mg \xrightarrow{\text{Dry ether}} \underset{\text{Grignard reagent}}{R - Mg - X}$

  (*ii*) **Wurtz reaction:**

  $R - \boxed{X + 2Na + X} - R \xrightarrow{\text{Dry ether}} \underset{\text{Alkane}}{R - R} + 2Na^+X^-$

ALCOHOLS

- Alkenes are converted to alcohol in different ways as follows

Reagent	**Types of addition**
dil H_2SO_4	Markovnikov
B_2H_6 and H_2O_2, OH^-	Anti-Markovnikov
Oxymercuration demercuration	– Markovnikov

- Oxidation of

  1° alcohol ⟶ aldehyde (with same no. of C atom) ⟶ carboxylic acid (with same no. of C atom)

  2° alcohol ⟶ ketone (with same no. of C atom) ⟶ carboxylic acid (with less no. of C atom)

  3° alcohol ⟶ ketone (with less no. of C atom) ⟶ carboxylic acid (with less no. of C atom)

PHENOLS

- $\text{Phenol} \xrightarrow{CHCl_3/OH^{\ominus}} \text{Phenolic aldehyde}$

  (Reimer-Tieman reaction)

- $\text{Phenol} \xrightarrow[\Delta]{CO_2} \text{Phenolic carboxylic acid}$ (Kolbe's reaction)

- Acidity of phenols

  (i) Increases by electron withdrawing substituents like

  $-NO_2, -CN, -CHO, -COOH, -X, -\overset{+}{N}R_3$

  (ii) decreases by electron releasing substituents like

  $-R, -OH, -NH_2, -NR_2, -OR$

ETHERS

- $2ROH \xrightarrow[250°C]{Al_2O_3} R - O - R + H_2O$

- $RONa + X - R' \longrightarrow ROR' + NaX$

  (Williamson's synthesis)

- $ROR + H_2O \xrightarrow[\Delta]{\text{dil. } H_2SO_4} 2ROH$

CARBONYL COMPOUNDS

- Formation of alcohols using RMgX

  (a) Formaldehyde + RMgX $\xrightarrow{\text{Hydrolysis}}$ 1° alcohol

  (b) Aldehyde + RMgX $\xrightarrow{\text{Hydrolysis}}$ 2° alcohol

  (other than HCHO)

  (c) Ketone + RMgX $\xrightarrow{\text{Hydrolysis}}$ 3° alcohol

- Cannizzaro reaction (Disproportionation)

  $\text{Aldehyde} \xrightarrow[\text{alkali}]{\text{Hot conc.}} \text{Alcohol + Salt of acid}$

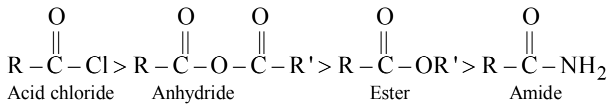
  (no α H-atom)

- Aldol condensation :

  Carbonyl compound + dil. alkali ⟶ β-hydroxy carbonyl compound

  (with α H-atom)

- The relative reactivities of different acid derivatives towards nucleophilic acyl substitution reaction follow the order:



$$\underset{\text{Acid chloride}}{R-\overset{\overset{O}{||}}{C}-Cl} > \underset{\text{Anhydride}}{R-\overset{\overset{O}{||}}{C}-O-\overset{\overset{O}{||}}{C}-R'} > \underset{\text{Ester}}{R-\overset{\overset{O}{||}}{C}-OR'} > \underset{\text{Amide}}{R-\overset{\overset{O}{||}}{C}-NH_2}$$

CARBOXYLIC ACIDS

- The rate of esterfication decreases when alcohol, acid or both have branched substituents.
- Ortho effect : All ortho substituted benzoic acids (irrespective of type of substituent) are stronger than benzoic acid.

NITROGEN COMPOUNDS

- Order of basicity :

  $(R = -CH_3 \text{ or } -C_2H_5)$ 2° > 1° > 3° > NH_3
- Hoffmann degradation

  Amides $\xrightarrow{Br_2/KOH}$ 1° amine
- The basicity of amines is (i) decreased by electron with drawing groups (ii) increased by electron releasing groups
- Reduction of nitrobenzene in different media gives different products

Medium	**Product**
Acidic	Aniline
Basic	Azoxy, Azo and finally hydrazobenzene
Neutral	Phenyl hydroxylamine

BIOMOLECULES

- Carbohydrates are polyhydroxy aldehydes or ketones.
- Monosaccharides are simple sugars, containing three to nine carbon atoms.

IDENTIFICATION TESTS

- Unsaturated compound (Bayer's reagent)

  Decolourising the reagent
- Alcohols (Ceric ammonium nitrate solution)

  Red colouration
- Phenols (Neutral $FeCl_3$ solution)

  Violet/deep blue colouration
- Aldehydes and ketones (2, 4-D.N.P.)

  Orange precipitate
- Acids ($NaHCO_3$ solution)

  Brisk effervescence (CO_2 is evolved)
- 1° amine ($CHCl_3 + KOH$)

  Foul smell (isocyanide)
- 2° amine ($NaNO_2 + HCl$)

  Yellow oily liquid (Nitrosoamine)

CHARACTERISTIC REACTIONS

Homologous series	**Type of reactions**
(i) Alkanes	Substitution Mostly free radical
(ii) Alkenes and alkynes	Electrophillic addition
(iii) Arenes	Electrophillic substitution
(iv) Alkyl halides	Nucleophillic substitution
(v) Aldehyde and ketones	Nucleophillic addition

- Tests to differentiate :

1°, 2° and 3° alcohols	(i) Lucas test (ii) Victor meyer's test
1°, 2° and 3° amines	Hinsberg test
1°, 2° and 3° nitro compounds	Test with HNO_2 and KOH
Aryl halides and alkyl halides	Test with $AgNO_3$ solution
Aldehydes and ketones	Tollen's test/Fehling's test
Aromatic aldehydes and Aliphatic aldehydes	Fehling's test