Acids, Bases and Salts

1. Acid and Base Concepts

Three important concepts are—

(1) **According to Arrhenius concept** of acid and bases, an acid is a substance which gives H^+ ions in the aqueous solution whereas a base is a substance which gives OH^- ions in the aqueous solution

(2) **According to Bronsted-Lowry concept of acids and bases,** an acid is a substance which can give a proton and a base is a substance which accepts a proton. A substance which can act both as an acid as well as base in different reactions is called **amphoteric**

2. Basicity of Acid

- The number of displacing protons in an acid is known as basicity of the acid.

  Monobasic acid has only one molecule of hydrogen ion and can combine with one hydroxyl (OH) group *e.g.*, HCl, HNO_3, CH_3COOH etc.

  Dibasic acid has two hydrogen ions and hence can combine with two hydroxyl groups to give two kinds of salts. *e.g.*, H_2SO_4, H_2SO_3, $(COOH)_2$ etc.

  Tribasic acid has three hydrogen ions and can combine with three hydroxyl groups to give three kinds of salts. *e.g.*, H_3PO_4 etc.

- Acidic strength of acids increase with increase in the size of atom.

  e.g., HI > HCl > HF.

- Acidic strength of acids increase with increase in electronegativity of elements.

  e.g., $H-F > H-OH > H-NH_2 > H-CH_3$

- Among oxyacids of some element, acidic strength increase with increase in the oxidation state of that element.

  e.g., $HClO_4 > HClO_3 > HClO_2 > HClO$

  $+7 \quad +5 \quad +3 \quad +1$

3. Organic Acids

- Presence of electron releasing groups decreases the acidic strength of acid and react.

  e.g., $HCOOH > CH_3COOH > C_2H_5COOH > C_3H_7COOH >$

- Presence of electron with drawing group increase the acidity or acidic strength of acids.

  e.g., $CF_3COOH > CCl_3COOH > CBr_3COOH > Cl_3COOH > CH_3COOH$

- Acid strength increase with increasing s-character in hybridization of carbon atom

  e.g., $H-C \equiv C-H > CH_2 = CH_2 > CH_3-CH_3$

4. Acidity of Base

The number of hydroxyl ions in a base is known as acidity of the base.

Monoacidic bases : KOH, NH_4OH, NaOH

Diacidic bases : $Ca(OH)_2$, $Fe(OH)_2$, $Zn(OH)_2$

Triacidic bases : $Fe(OH)_3$, $Al(OH)_3$

- Soluble base are known as alkali.
- KOH is a stronger base than NaOH.
- Ammonia is a stronger base than H_2O and the relative strength of $Mg(OH)_2$, $Cu(OH)_2$, $Ba(OH)_2$ is :

  $Mg(OH)_2 > Ca(OH)_2 > Ba(OH)_2$

- pH expresses the hydrogen ion concentration of a solution,

  – pH = 7 for pure water (or neutral solutions)

  – pH > 7 for bases

  – pH < 7 for acids.

- Lower pH means more acidity.

5. Relative strengths of some important acids and bases

Acid	Conjugate base
$HClO_4$	ClO_4^-
HI	I^-
H_2SO_4	HSO_4^-
H_3O^+	H_2O
HSO_4^-	SO_4^{2-}
CH_3COOH	CH_3COO^-
NH_4^+	NH_3
HCO_3^-	CO_3^{2-}
H_2O	OH^-
CH_3OH	CH_3O^-
NH_3	NH_2^-
OH^-	O^{2-}
H_2	H^-

6. Salts

Salts are regarded as compounds made up of positive and negative ions. The salts are generally crystalline solids. These are classified into the following classes :

(1) **Simple salts** : The salts formed by neutralisation process, are of three types—

(i) Normal salts are salts formed by the replacement of all replaceable hydrogen atoms at H^+ ions. For *e.g.* NaCl, KNO_3, $CuSO_4$, $FeSO_4$, etc.

(ii) Acid salt formed by the incomplete neutralisation of polyprotic basic acids which still contain some acidic hydrogen are called acidic salts *e.g.* $NaHCO_3$, $NaHSO_4$, NaH_2PO_4, Na_2HPO_4 etc.

(iii) Basic salt formed by incomplete neutralisation of poly acidic bases and still contains one or more than one hydroxyl groups *e.g.* Zn (OH) Cl, Mg (OH) Cl etc.

(2) **Double salts** : The addition compounds formed by combination of two or more simple salts and are stable in solid state only. *e.g.*, $FeSO_4$, $(NH_4)_2\ SO_4 \cdot 6H_2O$, $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$.

(3) **Complex salts** : The salts formed by combination of simple salts or molecular compound and are stable in solid state and on dissolving in water, they finish at least one complex ion. *e.g.*, $K_4[Fe(CN)_6]$, $[Cu(NH_3)_4]\ SO_4$.

(4) **Mixed salts** : The salts which furnish more than one cation or more than one anion when dissolved in water. *e.g.*, $Ca\begin{matrix} OCl \\ Cl \end{matrix}\ ,\ \begin{matrix} Na \\ K \end{matrix} SO_4$ etc.