Que : Explain : Arrhenius Concept of Acid and Base and write applications and limitations.

Ans: According to Arrhenius Concept,

An acid is any hydrogen containing compound which produces H^+ ions (or H_3O^+ ions) in aqueous solution.

Examples: HCl, HNO_3, CH_3COOH

$HCl \rightarrow H^+ + Cl^-$

$H^+ + H_2O \rightarrow H_3O^+$ (Hydronium ion)

Base is any compound which produces OH^- ions in aqueous solution.

Example : NaOH, NH_4OH

$NaOH \rightarrow Na^+ + OH^-$

Neutralisation reaction:

$H^+ + OH^- \rightarrow H_2O$

Applications of Arrhenius Concept

1. Aqueous solutions of oxides of non-metals (SO_2, SO_3, CO_2 etc.) are acidic as they produce H^+ ions in water.

2. Aqueous solutions of oxides of metals (CaO, Na_2O etc.) are basic as they produce OH^- ions in water.

3. Neutralisation of acid and base in aqueous solution can be understood by this concept.

Limitations of Arrhenius Concept:

1. HCl is an acid only in aqueous solution but is not considered as acid in gaseous state.

2.It does not explain acidic and basic character in non-aqueous solvents.

Eg. NH_4NO_3 in liquid NH_3 acts as an acid though it does not give H^+ ions.

3. It could not explain acidic character of $AlCl_3$ in aqueous solution.

Que : Explain Lowry Bronsted Concept (Protonic concept)

Ans : **According to this concept,** acid is a proton donor and acid is a proton acceptor.

For example:

HCl -->H^+ + Cl^- (HCl is an acid as it donates proton.)

Cl^- + H^+ -->HCl (Cl^- is a base as it accepts proton.)

Que : Explain : Lux -Flood Concept

This concept explains the acid base character in terms of “**oxide ion**”.

According to this concept, acid is a substance which accepts oxide ion and base is a substance that donates oxide ion.

Eg. CaO + SiO_2 $CaSiO_3$

Base Acid

CaO is oxide donor (base) (CaO Ca^{2+} + O^{2-})

and SiO_2 is oxide acceptor (acid) (SiO_2 + O^{2-} SiO_3^{2-})

Que : Write note on Hard and Soft Acids and Bases (HSAB) Concept.

Ans: Lewis acids and Bases are classified into hard and soft acids and bases . HSAB principle is based on the preferential bonding between metal ion and ligands.

Hard Acids (Class a Metals):

1. This class includes ions of alkali and alkaline earth metals , lighter transition metals in higher oxidation state like Ti^{4+}, Cr^{3+}, Fe^{3+}, and H^+.

2. These cations have small size.

3. These cations have high electronegativity.

4. These cations have low polarisabilty.(their outer electrons or orbitals are not easily distorted.)

5. They possess high polarising power.

6. They are more electropositive.

7. They possess Nobel gas configuration.

Hard Bases: (class “a” ligands):

The ligands which preferably combine with the metal ions ‘a’ are called hard bases.

i) Donor atoms of hard bases have high electronegativity.

ii) They include anions or neutral molecules which are not easily polarisable.

iii) They have low polarizability.

Eg. NH_3 , R_3N , H_2O, and F etc.

Soft Acids (Class b Metals):

1. This class includes metal cations of heavier transition metals in lower oxidation state like such as Cu^+, Ag^+, Hg^{2+}, Pd^{2+} and Pt^{2+}

2. These cations have large size.

3. These cations have low electronegativity.

4. These cations have high polarizability. (their outer electrons or orbitals are easily distorted.)

5. They possess less polarising power.

6. They are less electropositive.

7. They possess pseudo Nobel gas configuration.

Soft Bases: (class "b" ligands):

The ligands which preferably combine with metal ions 'b' are called hard bases.

i) Donor atoms of soft bases have low electronegativity.

ii) They include anions or neutral molecules which are easily polarisable.

iii) They have high polarizability.

Eg. H^-, CN^-, SCN^-, $S_2O_3{}^{2-}$, I^-, RS, R_2S, R_3P, S^{2-}etc

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Borderline acids : Fe^{2+} , CO^{2+}, Ni^{2+} ,Cu^{2+}, Zn^{2+}, Pb^{2+} etc.

Borderline Bases : Br^- , $NO_2{}^-$, $SO_3{}^{2-}$, C_6H_5N , $C_6H_5NH_2$ etc.

Pearson's principle : According to him **Hard acids** prefer to bind hard bases and soft acids prefer to bind soft bases to form complexes .

Eg. A + :B   A:B

Acid Base Complex

AB complex is more stable when A & B are either both soft acid or base or both hard acid and base. The complex is least stable when one of the reactants is very hard acid or base and other is very soft acid or base.

Application of HSAB concept:

1. Relative stabilities of the complexes:

Eg. $[AgI_2]^-$ is more stable than $[AgF_2]^-$ because Ag^+ is a soft acid and I^- is soft base ,hence they combine to give stable $[AgI_2]^-$. F^- is hard base and Ag^+ is a soft acid, hence $[AgF_2]^-$ is less stable.

2. Occurrence of minerals : Mg^{2+} , Ca^{2+} occur in nature as $MgCO_3$, $CaCO_3$ as cation(acids) and anions(bases) are both hard.