ACID BASE CONCEPTS

Presented

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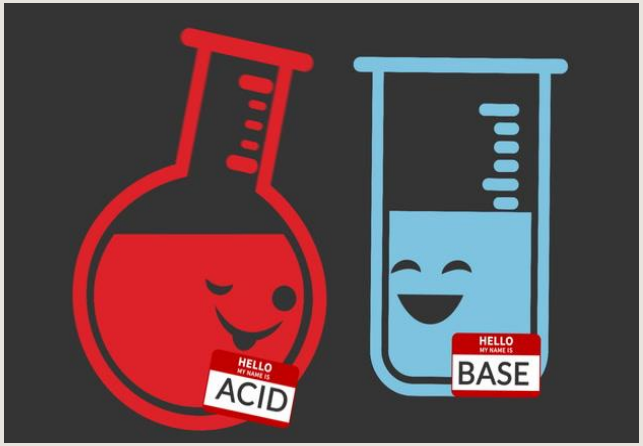

- Arrhenius Concept
- Bronsted Lowry Concept
- Lewis Acid-Base Concept
- Leveling & Differentiating Effect
- Theory of Solvent System
- HSAB Principle

Arrhenius Concept

- Acid: Species that liberate H(+) ion in aqueous solution. e.g. HCl, CH_3COOH, HNO_3, H_2SO_4 etc.

- Base: Species that liberate OH(-) ion in aqueous solution . e.g. NaOH, $Ca(OH)_2$

- Aqueous solution of non-metallic oxides are acidic. eg. SO_2, CO_2, N_20_3, P_40_6 etc.

  $CO_2 + H_2O \dashrightarrow H_2CO_3$ (acid)

- Aqueous solution of metallic oxides are basic. e.g. CaO, Na_2O etc.

  $CaO + H_20 \dashrightarrow Ca(OH)_2$ (basic)

Limitations

- In adequate for gaseous species e.g. HCl, NH_3
- Arrhenius Concept can't explain non aqueous solution
- The theory fails to explain the exception of neutralisation

Bronsted-Lowry Concept

- Acid: Species that can donate H(+) ion. e.g. HCl(g)

- Base: Species that can accept H(+) ion. e.g. NH_3(g)

- This conceptis foundation of conjugate acid-base concept.

  e.g.

  $H_3O(+) + NO_2(-) \text{-----} > HNO_2 + H_2O$

  (Acid) (Base) (Acid) (base)

  $H_3O(+) > HNO_2$ ---->acidity

  $NO_2(-) > H_2O$ ----> Basicity

In any solvent, the direction of reaction always favored the formation of weaker acid & base than the reactant.

Lewis Acid –Base Concept

- Acid: Species that accept electons from others

- Base: Species that donate electrons to others

For example:

BF3 + (:)NH3 --> [F3B <--- :NH3]

(Adduct)

BF3---> Lewis Acid & NH3---> Lewis Base.

- Lewis acid Base adduct involving metal ions are called co-ordination compound

e.g. Ag(+) + 2NH3 ----> [H3N:---->Ag<----:NH3](+)

Leveling & differentiating effect

- Leveling effect: All the acids behave as a strong acid in base

  $HNO_3 + NaOH \rightarrow H_2O + NaNO_3$

  $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

  Both HNO_3 & AcOH are strong acid in base.

  Both of them have same strength

- Differentiating effect: In a Differentiating solvent, various acids dissociate to different degrees & thus have different strenghs.

Theory of Solvent System

- Acid: Substances which give solvent cation when dissolved in that particular solvent or the substance which increases the concentration of solvent cation

- Base: Substances which give solvent anion when dissolved in that particular solvent or the substance which increases the concentration of solvent anion

H_2O Solvent

- Auto ionisation of H_2O

  H_2O <----> $H(+) + OH(-)$

Due to high charge density of $H(+)$ it will be taken by H_2O & formed $H_3O(+)$

- When any species forms these two cations is called acid & forms $OH(-)$ anion is called base

  e.g. $HCl + H_2O$--> $H(+) + Cl(-)$.

  So HCl is acid

- $NaOH + H_2O$--> $Na(+) + OH(-)$.

  So NaOH is base

NH_3 Solvent

Auto ionisation of NH_3 :

$NH_3 <----> H(+) + NH_2(-)$

$H(+) + NH_3 <---> NH_4(+)$

$2NH_3 <----> NH_4(+) + NH_2(-)$

Species give $NH_4(+)$ or $H(+)$ ions are called acid

Species gives $NH_2(-)$ ion are called base

e.g.

NH_4Cl (in NH_3)----> $NH_4(+) + Cl(-)$, NH_4Cl is acid

KNH_2 (in NH_3)---> $K(+) + NH_2(-)$, KNH_2 is base

SO_2 solvent

- Auto ionisation of SO_2 :

SO_2 <---> SO(2+) + O(2-)

O(2-) + SO2 <---> SO_3(2-)

2SO_2<----> SO(2+) + SO_3(2-)

- Species which will give SO(2+) as solvent cation, called acid
- Species which will liberate SO_3(2-) as solvent anion, called base

e.g.

$SOCl_2$ (in SO_2)----> SO(2+) + 2Cl(-), $SOCl_2$ acts as acid

Cs_2SO_3 (in SO_2) ---> 2Cs(+) + SO_3(2-), Cs_2SO_3 acts as base

HF solvent

- Auto ionisation of HF

  HF<---> H(+) + F(-)

  H(+) + HF<----> H2F(+)

  F(-) + HF<---> HF2(-)

- HF2(-) shows strong H-bonding so its very stable. HF tends to release F(-). So HF acts as very strong acid in maximum cases.
- Species gives H(+) or HF2(+) is called acid
- Species gives F(-) or HF2(-) is called base
- e.g.

  HNO3 + HF---> H2NO3(+) + F(-)

  F(-) + HF---> HF2(-)

  HNO3 acts as base

  HSO3F + HF---> H2F(+) + SO3F(-)

  Here HSO3F acts as acid

HSAB Principle

- Hard acids prefer binding to the hard bases to give ionic complexes whereas soft acids prefer binding to soft bases to give covalent complexes.
- The interactions between hard acid-soft base or vice-versa are mostly polar covalent and tend to be more reactive or less stable. The polar covalent compounds readily form either more ionic or more covalent compounds if they are allowed to react

APPLICATIONS OF HSAB PRINCIPLE

There are numerous applications of the HSAB principle. It helps in understanding organic reaction mechanisms, metal-ligand interactions in metal complexes, ore processing in metallurgy, precipitations in qualitative analysis etc.

- **In hydrogen bonding:**

The strong hydrogen bond is possible in cases of H_2O, NH_3, and HF, since the donor atoms (F, O & N) are hard Lewis bases and their interactions with partially positively charged H, which is a hard acid, are stronger.

Thank You!