Bronsted – Lowery theory of Acids and bases:

This is also called protonic theory .

Acid : which donates proton

Eg: HCl, H_2SO_4, HNO_3 etc.

Base : which accepts proton

Eg: NH_3, PH_3, N_2H_4, $R - NH_2$ etc.

- Bronsted acid could be a neutral molecule , anion, cation.

  Neutral molecule $\rightarrow$ HCl, HNO_3, H_2SO_4 etc.

  Cations $\rightarrow H_3O^+, NH_4^+$

  Anions $\rightarrow HSO_4^-, HCO_3^-, H_2PO_4^-, H(PO_4)^{2-}, H_2(PO_3)^-$ Bronsted base could be neutral, cation or anion

  Neutral $\rightarrow$ NH_3 , PH_3, N_2H_4 etc.

  anions $\rightarrow$ CN^- Br^- I^- OH^- etc.

  Cations $\rightarrow$ $[Al(H_2O)_5OH)]^{2+}$, $[Fe(H_2O)_5OH]^{2+}$

Neutralisation :

It involves transfer of proton from acid to base and formation of conjugate acid – base pair.

1) $\underset{A_1}{HCl} + \underset{B_2}{H_2O} \rightleftharpoons \underset{B_1}{Cl^-} + \underset{A_2}{H_3O^+}$

2) $\underset{B_1}{NH_3} + \underset{A_2}{H_2O} \rightarrow \underset{A_1}{NH_4^{\oplus}} + \underset{B_2}{OH^-}$

3) $\underset{B_1}{NH_3} + \underset{A_2}{HCl} \rightarrow \underset{A_1}{NH_4^+} + \underset{B_2}{Cl^-}$

- Amphoteric or Amphiprotic substance : The act as both acids and base because they donate proton and accept proton.

  Eg : H_2O

Conjugate acid – base pairs :

The acid base pair which differs by a proton is called conjugated acid base pair.

Acid − $H^{\oplus}$ = conjugate base

Base + $H^{\oplus}$ = conjugate acid

Eg :

Acid	Base
HCl	Cl^-
H_2SO_4	HSO_4^-
HSO_4^-	SO_4^{2-}
H_2S	HS^-
C_2H_2	$CH \equiv C^-$
CH_4	CH_3^-

$[Al(H_2O)_6]^{3+}$	$[Al(H_2O)_5OH]^{2+}$
$[Fe(H_2O)_6]^{3+}$	$[Fe(H_2O)_5OH]^{2+}$
H_2	H^-
H	e^-

- In any conjugate acid base pair, if the acid is stronger , the base is weak and if base is stronger , the acid is weak.

  Eg:

  1. HCl is strong acid, Cl^- is weak conjugate base.
  2. CH_3COOH is weak acid CH_3COO^- is strong base
  3. NH_3 is weak base, NH_4^+ strong acid
  4. $HClO_4$ is strongest acid, ClO_4^- weak base

- List of conjugate acid base pairs in a particular order of strength.

  [Decreases acidic strength]

	Acid	**Base**
1.	$HClO_4$	ClO_4^-
2.	HI	I^-
3.	HBr	Br^-
4.	H_2SO_4	HSO_4^-
5.	HCl	Cl^-
6.	HNO_3	NO_3^-
7.	H_3O^+	H_2O
8.	HSO_4^-	SO_4^{2-}
9.	H_3PO_4	$H_2PO_4^-$
10.	HF	F^-
11.	CH_3COOH	CH_3COO^-
12.	H_2CO_3	HCO_3^-
13.	HCN	CN^-
14.	NH_4^+	NH_3
15.	H_2O	OH^-
16.	NH_3	NH_2^-
17.	OH^-	O^{2-}
18.	CH_4	CH_3^-

- Strength of bronsted acids and bronsted bases will depend on the ability to donate or to accept proton.
- **Strong acids :** which have more ability to donate protons.

  Eg: $HClO_4$, HCl, H_2SO_4
- **Weak acids** : which have less tendency to donate proton.

Eg: HF, CH_3COOH, H_2CO_3, HCN

- Among Hydracids HCN is the weakest acid
- **Strong bases :** which have greater tendency to accept protons
  Eg: OH^- , CH_3COO^-,CH_3^- etc.
- Weak bases → which have less tendency to accept the proton.
  Eg: Cl^-, ClO_4^- ,Br^- ,I^- NH_3.....etc.

- **Levelling effect :** The strength of stronger acids like $HClO_4$, H_2SO_4, HCl, HNO_3 will become equal to the strength of H_3O^+ ion in presence of H_2O. This is called levelling effect
  $HClO_4 \approx H_2SO_4 \approx HCl \approx HNO_3 = H_3O^+$
- Similarly the strength of stronger bases like NaOH, KOH, CsOH will become equal to the strength of OH^- ion in presence of H_2O
  $NaOH \approx KOH \approx CsOH = OH^-$
- This levelling effect of acids is due to greater proton accepting tendency of H_2O and instantly conversion into H_3O^+ therefore the real strength cannot be determined.
- The acids like $HClO_4$, H_2SO_4 etc. cannot be determined in a levelling solvent like H_2O.
- Therefore the strongest acid that can exist in water is H_3O^+ and the strongest base that can exist is OH^- ion.
- In a solvent like glacial acetic acid, the real strength of acids can be determined because of poor tendency to accept protons. Therefore acetic acid is differentiating solvent and the strongest acid that can exist in acetic acid solvent is $HClO_4$.
- In acetic acid, $HClO_4 > H_2SO_4 > HCl > HNO_3$

Types of solvents: Based on proton donating or proton accepting tendency, solvents are classified into 4 types by bronsted lowery solvents.

1) Protophilic solvents : which accept proton
   Eg : H_2O, NH_3 , ether , C_2H_5OH etc.
   Protophilic solvents will increase acidic strength and decrease the basic strength.
2) Photogenic solvents : which donate H^+
   protogenic solvents will decrease the acidic strength and increase the basic strength.
3) Amphiprotic solvents : which donates and accept proton
   Eg : H_2O, C_2H_5OH
4) Aprotic solvents: which neither donates nor accepts proton.
   Eg : CCl_4, $CHCl_3$, C_6H_6, Acetone

Merits of Bronsted – Lowery theory :

1) It could explain acid base behaviour in non – aqueous solvents also .
   Eg: liquid SO_2, liquid NH_3

2) It could explain the basic nature of substances like NH_3.
3) It could explain the acidic nature of HCl gas.
4) It is more generalized than Arrhenius theory.

Limitations of Bronsted – Lowery theory :

1) This theory explains behaviour of acids only when there is a base (or) It explains behaviour of base only when there is a acid. (Acid base pairs must be present)
2) It fails to explain the acidic nature of electron deficient compound like BF_3, $AlCl_3$ etc.