

## Bronsted – Lowry theory of Acids and bases:

This is also called protonic theory .

Acid : which donates proton

Eg: HCl, H<sub>2</sub>SO<sub>4</sub>, HNO<sub>3</sub> etc.

Base : which accepts proton

Eg: NH<sub>3</sub>, PH<sub>3</sub>, N<sub>2</sub>H<sub>4</sub>, R – NH<sub>2</sub> etc.

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

Neutral molecule → HCl, HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub> etc.

Cations → H<sub>3</sub>O<sup>+</sup>, NH<sub>4</sub><sup>+</sup>

Anions → HSO<sub>4</sub><sup>-</sup>, HCO<sub>3</sub><sup>-</sup>, H<sub>2</sub>PO<sub>4</sub><sup>-</sup>, H(PO<sub>4</sub>)<sup>2-</sup>, H<sub>2</sub>(PO<sub>3</sub>)<sup>-</sup> Bronsted base could be neutral, cation or anion

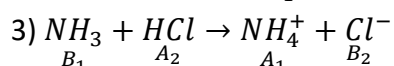
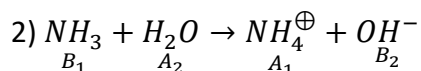
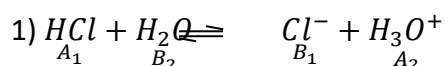
Neutral → NH<sub>3</sub> , PH<sub>3</sub>, N<sub>2</sub>H<sub>4</sub> etc.

anions → CN<sup>-</sup> Br<sup>-</sup> I<sup>-</sup> OH<sup>-</sup> etc.

Cations → [Al(H<sub>2</sub>O)<sub>5</sub>OH]<sup>2+</sup>, [Fe(H<sub>2</sub>O)<sub>5</sub>OH]<sup>2+</sup>

### Neutralisation :

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



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

Eg : H<sub>2</sub>O

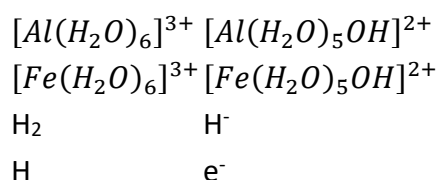
### Conjugate acid – base pairs :

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

Acid ⇌ H<sup>+</sup> = conjugate base

Base + H<sup>+</sup> = conjugate acid

Eg :	<b>Acid</b>	<b>Base</b>
	HCl	Cl <sup>-</sup>
	H <sub>2</sub> SO <sub>4</sub>	HSO <sub>4</sub> <sup>-</sup>
	HSO <sub>4</sub> <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>
	H <sub>2</sub> S	HS <sup>-</sup>
	C <sub>2</sub> H <sub>2</sub>	CH <sub>3</sub> <sup>-</sup>
	CH <sub>4</sub>	CH <sub>3</sub> <sup>-</sup>



- 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:

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

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

Acid	Base
[Decreases acidic strength]	
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<sub>3</sub>COOH, H<sub>2</sub>CO<sub>3</sub>, HCN

- Among Hydracids HCN is the weakest acid
- **Strong bases** : which have greater tendency to accept protons  
Eg: OH<sup>-</sup>, CH<sub>3</sub>COO<sup>-</sup>, CH<sub>3</sub><sup>-</sup> etc.
- Weak bases → which have less tendency to accept the proton.  
Eg: Cl<sup>-</sup>, ClO<sub>4</sub><sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup>, NH<sub>3</sub>.....etc.

- **Levelling effect** : The strength of stronger acids like HClO<sub>4</sub>, H<sub>2</sub>SO<sub>4</sub>, HCl, HNO<sub>3</sub> will become equal to the strength of H<sub>3</sub>O<sup>+</sup> ion in presence of H<sub>2</sub>O. This is called levelling effect  
HClO<sub>4</sub> ≈ H<sub>2</sub>SO<sub>4</sub> ≈ HCl ≈ HNO<sub>3</sub> = H<sub>3</sub>O<sup>+</sup>
- Similarly the strength of stronger bases like NaOH, KOH, CsOH will become equal to the strength of OH<sup>-</sup> ion in presence of H<sub>2</sub>O  
NaOH ≈ KOH ≈ CsOH = OH<sup>-</sup>
- This levelling effect of acids is due to greater proton accepting tendency of H<sub>2</sub>O and instantly conversion into H<sub>3</sub>O<sup>+</sup> therefore the real strength cannot be determined.
- The acids like HClO<sub>4</sub>, H<sub>2</sub>SO<sub>4</sub> etc. cannot be determined in a levelling solvent like H<sub>2</sub>O.
- Therefore the strongest acid that can exist in water is H<sub>3</sub>O<sup>+</sup> and the strongest base that can exist is OH<sup>-</sup> 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<sub>4</sub>.
- In acetic acid, HClO<sub>4</sub> > H<sub>2</sub>SO<sub>4</sub> > HCl > HNO<sub>3</sub>

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

1) Protophilic solvents : which accept proton

Eg : H<sub>2</sub>O, NH<sub>3</sub> , ether , C<sub>2</sub>H<sub>5</sub>OH etc.

Protophilic solvents will increase acidic strength and decrease the basic strength.

2) Protogenic solvents : which donate H<sup>+</sup>

protogenic solvents will decrease the acidic strength and increase the basic strength.

3) Amphiprotic solvents : which donates and accept proton

Eg : H<sub>2</sub>O, C<sub>2</sub>H<sub>5</sub>OH

4) Aprotic solvents: which neither donates nor accepts proton.

Eg : CCl<sub>4</sub>, CHCl<sub>3</sub>, C<sub>6</sub>H<sub>6</sub>, Acetone

**Merits of Bronsted – Lowry theory :**

1) It could explain acid base behaviour in non – aqueous solvents also .

Eg: liquid SO<sub>2</sub>, liquid NH<sub>3</sub>

- 2) It could explain the basic nature of substances like  $\text{NH}_3$ .
- 3) It could explain the acidic nature of  $\text{HCl}$  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 an acid. (Acid base pairs must be present)
- 2) It fails to explain the acidic nature of electron deficient compounds like  $\text{BF}_3$ ,  $\text{AlCl}_3$  etc.