

ionic

equilibrium

arrhenius

lewis

brønsted lowry.

Electrolytes:

- on the basis of their dissociation nature:

(A.) Strong electrolytes:

→ substances which are largely dissociated and are strong electrolytes.

eg: HCl , HNO_3 , H_2SO_4 , etc.

(B.) Weak electrolytes:

→ substances which dissociate only to a small extent in aqueous solution.

eg: HCN , H_3BO_3 , etc.

(C.) Non electrolytes:

→ which do not dissociate.

eg: Glucose, Urea (NH_2CONH_2), sucrose [$\text{C}_{12}\text{H}_{22}\text{O}_{11}$], etc.

Acid-Base Concept:

(A.) Arrhenius concept: (1880-1890)

→ according to him,

• substances which releases H^+ or H_3O^+ ion in aqueous solution are ACID.

• substances which releases OH^- ion in aqueous solution are BASE.

eg: ACID: HCl, HNO₃, H₂SO₄, etc.

BASE: Mg(OH)₂, Ca(OH)₂, NaOH, etc.

* Limitations:

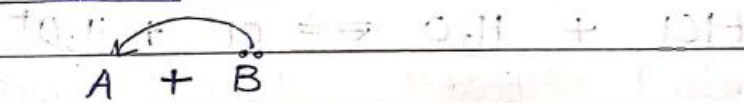
- it didn't justify acidic nature of AlCl₃, BF₃, PCl₃, and basic nature of NH₃ (ammonia), ether (COR), CH₃-O-CH₃, C₂H₅-OH, etc.

(B.) Lewis concept: (1923)

→ according to him,

• substances which accept lone paired electrons are known as LEWIS ACID.

• substances which donate lone paired electrons are LEWIS BASE.



(Lewis acid) (Lewis base)

(l.p acceptor) (l.p donator).



eg: L. ACID: AlCl₃, BF₃, PCl₃, FeCl₃, Cu²⁺, Fe²⁺, etc.

L. BASE: NH₃, C₂H₅-OH, CH₃-O-CH₃, ligands, etc.

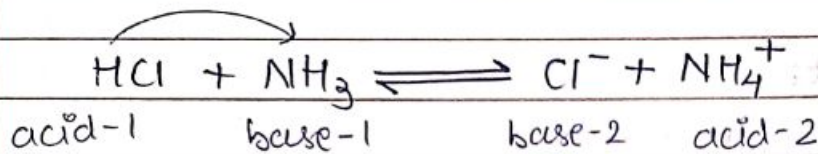
* AlCl ₃ , BF ₃ : octate : deficient
PCl ₃ , FeCl ₃ : vacant d-orbital
R-NH ₂ : amines (l. base).
ligands : CO, CN ⁻ , H ₂ O, NH ₃ , etc.)

(c.) Bronsted Lowry concept: (1923)

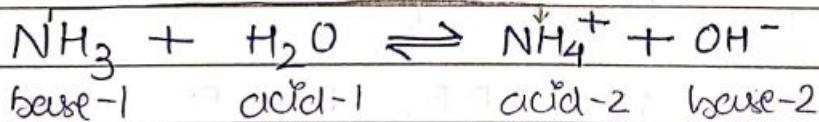
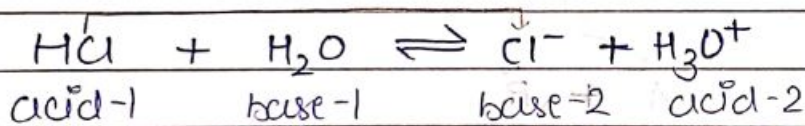
→ according to him,

• substances who donate protons (H^+) are ACIDS.

• substances who accept protons (H^+) are BASE.



* Water is amphoteric in nature. As it shows acidic behaviour with base and basic behaviour with acids.

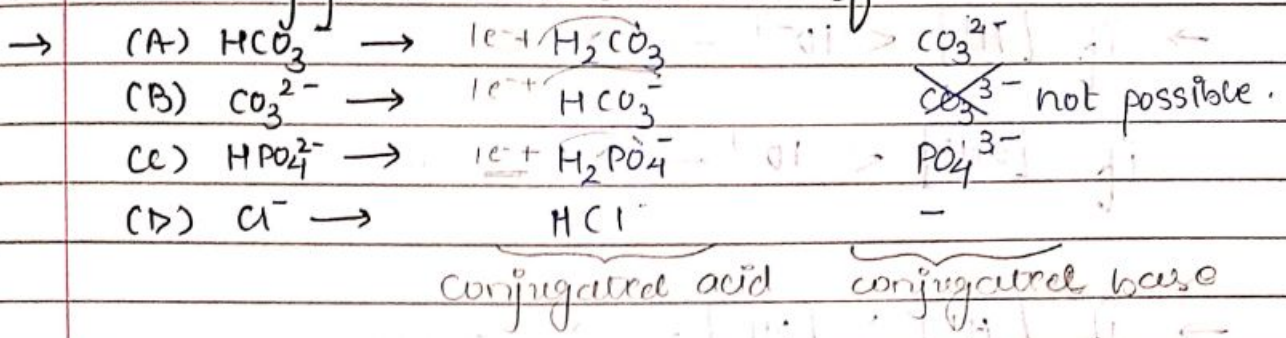


• pair of acid and base should be obtained which can be known as Conjugated acid-base-pair.

• Conjugated acid-base pair differs by only 1 proton (H^+).

• a strong acid have weak conjugated base and a strong base have weak conjugated acid.

Q:1 Find conjugated acid and base of:



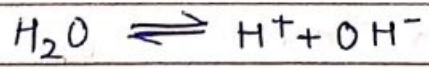
* here, HCO_3^- , HPO_4^{2-} are amphoteric.

Q:2 Conjugate base of Arrhenius acid H_2O and HF are:
 → OH^- and F^-

OH^- H^+ H^+ F^-

K_w # Ionic product of water and Ionisation constant for water:

- water is a weak electrolyte because only one molecule electrolyse of 10,000 molecules.



$$K = \frac{[\text{H}^+][\text{OH}^-]}{[\text{H}_2\text{O}]}$$

$$K \cdot [\text{H}_2\text{O}] = [\text{H}^+] \cdot [\text{OH}^-]$$

$$K_w = [\text{H}^+][\text{OH}^-]$$

- at 25°C, value of K_w is 10⁻¹⁴.

$$K_w = [\text{H}^+][\text{OH}^-] = 10^{-14} \text{ @ } 25^\circ\text{C}$$

$$[\text{H}^+] = [\text{OH}^-] = 10^{-7} \text{ (neutral state)}$$

→ if $[H^+] > 10^{-7}$ → acidic

if $[OH^-] > 10^{-7}$ → basic

→ if $[H^+] < 10^{-7}$ → basic

if $[OH^-] < 10^{-7}$ → acidic.

→ if $[H^+] > [OH^-]$ → acidic

if $[OH^-] > [H^+]$ → basic.

- at 90°C temp value of $K_w = 10^{-12}$

$$K_w = [H^+][OH^-] = 10^{-12} \text{ @ } 90^\circ\text{C}$$
$$[H^+] = [OH^-] = 10^{-6}$$

K_w = equilibrium constant of water.
= dissociation constant of water.
= ionisation constant of water.

Ostwald dilution law:

- Ostwald was the first scientist to apply law of mass action to ionic equilibrium.
- it is applicable only for weak electrolytes.

- according to this law,
 → when solution of weak electrolyte is diluted then degree of ionisation (α) of solution is increased.

	$AB(aq) \rightleftharpoons A^+(aq) + B^-(aq)$	
initial %	c 0 0	$\alpha = \frac{x}{c}$
concn at eq %	c-x x x	
	c-x α c α c α	$\alpha = \frac{x}{c}$

$$K = \frac{[A^+][B^-]}{[AB]} \rightarrow \frac{c^2 \alpha^2}{c(1-\alpha)} \quad \left| \quad K = \frac{c \alpha^2}{(1-\alpha)} \right.$$

here, $\alpha \ll \ll 1$. ($K = c \alpha^2$)

$\alpha = \sqrt{\frac{K}{c}}$	$c \propto \frac{1}{V}$	$\alpha (>> 1) \propto \sqrt{V}$
		$\alpha (>> 1) \propto \sqrt{\text{dilution}}$

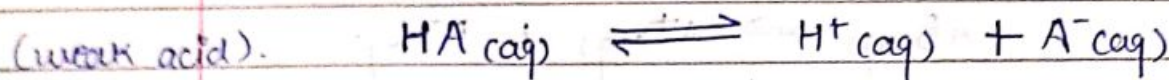
- for, weak electrolytes α is directly proportional to square root of dilution or inversely proportional to square root of concentration.

$\alpha \propto \sqrt{\text{dilution}} \quad \alpha \propto \sqrt{\frac{1}{\text{concentration}}}$

*** NOTE:**
 → at ∞ dilution value of α equals to 1. (100%)

Application of Ostwald dilution:

1.) To determine ionisation constant of weak acid (K_a):



initial concⁿ: C 0 0

concⁿ at eq^m: C - C α C(1 - α) C α C α

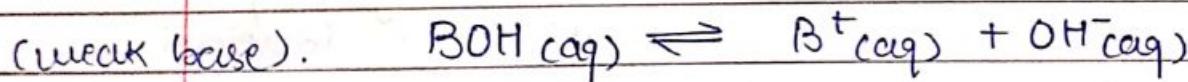
$$K_a = \frac{[H^+][A^-]}{[HA]} \rightarrow K_a = \frac{C\alpha^2}{C(1-\alpha)} \quad (\alpha \ll \ll 1)$$

$$\boxed{K_A = C\alpha^2}$$

$$\rightarrow H^+ = C\alpha \quad \left(\because \alpha = \sqrt{\frac{K_a}{C}} \right)$$

$$\therefore, \boxed{H^+ = \sqrt{K_a \times C}}$$

ii.) Determine pH of weak base:



initial concⁿ: C 0 0

concⁿ at eq^m: C(1 - α) C α C α

$$K_b = \frac{[B^+][OH^-]}{[BOH]} \rightarrow K_b = \frac{C\alpha^2}{C(1-\alpha)} \quad (\alpha \ll \ll 1)$$

$$\boxed{K_B = C\alpha^2}$$

$$\rightarrow OH^- = C\alpha \quad \left(\because \alpha = \sqrt{\frac{K_b}{C}} \right)$$

$$\therefore, \boxed{OH^- = \sqrt{K_b \times C}}$$