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Lecture 23

Acids and bases

Lewis base: electron pair donor

Lewis acid: electron pair acceptor

Bronsted acid: proton donor

Bronsted acid: proton acceptor

- Degree of hydration with acids is uncertain (H_3O^+ , H_5O_2^+ , H_7O_3^+ ...)

Conjugate acid-base pairs

$\text{B (base)} + \text{HA (acid)} \rightleftharpoons \text{HB}^+ \text{ (conjugate acid)} + \text{A}^- \text{ (conjugate base)}$

$\text{HB}^+ \text{ (acid)} + \text{A}^- \text{ (base)} \rightleftharpoons \text{B (conjugate base)} + \text{HA (conjugate acid)}$

Water

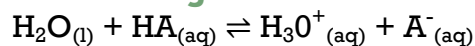
Self ionizes however position of equilibrium lies towards the left

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

In pure water: $[\text{H}^+] = [\text{OH}^-]$ hence solution is neutral

- $\text{pH} = -\log_{10}[\text{H}^+]$
- $\text{pOH} = -\log_{10}[\text{OH}^-]$
- $\text{pH} + \text{pOH} = 14$

Acid strength

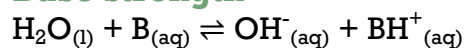


$$K_a = \frac{[\text{H}_3\text{O}^+][\text{A}^-]}{[\text{HA}]}$$

$$\text{p}K_a = -\log_{10}(K_a)$$

Strong acids have a high K_a but a small $\text{p}K_a$

Base strength



$$K_b = \frac{[\text{OH}^-][\text{BH}^+]}{[\text{B}]}$$

$$\text{p}K_b = -\log_{10}(K_b)$$

Strong bases have high K_b but a small $\text{p}K_b$

Strong acids

- Ionises completely in aqueous solutions
- Anions are very weak bases
- Conjugate base of strong acid is a very weak base

Strong base

- Conjugate acid of strong base is a very weak acid

$$K_a \times K_b = [\text{H}^+][\text{OH}^-]$$

$$K_a \times K_b = K_w$$

$$\text{p}K_a + \text{p}K_b = 14$$

Weak acids

- Undergo a small degree of dissociation
- Conjugate base of a weak acid is also a weak base
- $pH = \frac{1}{2}pK_a - \frac{1}{2}\log_{10}[HA]$
- **Assumption:** initial $[HA]$ can be used as only a very small amount dissociates
- If not making assumption: $K_a = \frac{[x]^2}{[initial-x]}$ where $x = [H_3O^+]$
- **5% rule:** if dissociation is $< 5\%$ ($\frac{[dissociation]}{[initial]}$), then approximation/assumption is valid

Weak bases

- Undergo a small degree of protonation
- $pOH = \frac{1}{2}pK_b - \frac{1}{2}\log_{10}[B]$

Amines

- Bases that are like ammonia
- Reacts with water to produce OH^-
- Reacts with acids to form acid salts therefore enhancing its solubility