Topic 18 Acids and bases (HL)

Syllabus:

18.1 Lewis acids and bases

Definition of Lewis acid and base

Coordinate bond is formed between Lewis acid and Lewis base.

A nucleophile is a Lewis base and an electrophile is a Lewis acid.

18.2 calculations involving acids and bases

K_a and K_b are the expression for the dissociation constant of a weak acid and weak base.

For a conjugate acid base pair, $K_w = K_a \times K_b$.

$pK_a = -\log K_a$ and $pK_b = -\log K_b$

18.3 pH curves

The characteristics of the pH curves produced by the different combinations of strong and weak acids and bases.

An acid-base indicator is a weak acid or a weak base where the components of the conjugate acid–base pair have different colours.

The relationship between the pH range of an acid–base indicator, which is a weak acid, and its pK_a value.

The buffer region on the pH curve represents the region where small addition of acid or base result in little or no change in pH.

The composition and action of a buffer solution.

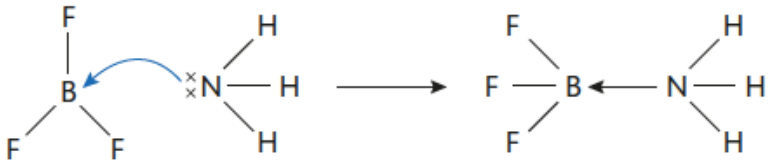
18.1 Lewis acids and bases

- A Lewis acid is electron pair acceptor.
- A Lewis base is electron pair donor.

Example:

$H^+ + NH_3 \rightarrow NH_4^+$

- Formation of coordinate bond involves Lewis acid and Lewis base.



In the above example, BF_3 is Lewis acid and NH_3 is Lewis base.

Coordinate bond is formed by donating a lone pair electron from NH_3 to BF_3.

- The formation of complex ion also involves Lewis acid and base.

  $Cu^{2+}(aq) + 6H_2O(l) \rightarrow [Cu(H_2O)_6]^{2+}(aq)$

  H_2O is a ligand and Lewis base which is a lone pair donor.

  Cu^{2+} is Lewis acid which is a lone pair acceptor.

- Lewis acid is an **electrophile**, an electron-deficient species that accepts a lone pair from another reactant to form a new covalent bond.
- Lewis base is a **nucleophile**, an electron-rich species that donates a lone pair to form a new covalent in a reaction.

- **All Brønsted-Lowry acid or base are Lewis acid or base.**

MCQ

1. Which descriptions are correct for both a Bronsted-Lowery acid and Lewis acid?

	Bronsted-Lowery acid	Lewis acid
A.	Proton donor	Electron pair donor
B.	Proton donor	Electron pair acceptor
C.	Proton acceptor	Electron pair donor
D.	Proton acceptor	Electron pair acceptor

2. Which substance can act as a Lewis acid but not as a Bronsted-Lowery acid?

   A. HCl
   B. CH_3COOH
   C. BF_3
   D. CF_3COOH

3. Which of the following is an example of a Lewis acid-base reaction, but not a Bronsted-Lowery acid-base reaction?

   A. $2CrO_4^{2-}(aq) + 2H^+(aq) \rightarrow Cr_2O_7^{2-}(aq) + H_2O(l)$
   B. $Co(H_2O)_6^{2+}(aq) + 4HCl(aq) \rightarrow CoCl_4^{2-}(aq) + 4H^+(aq) + 6H_2O(l)$
   C. $NH_3(aq) + H^+(aq) \rightarrow NH_4^+(aq)$
   D. $CH_3COO^-(aq) + H_2O(l) \rightarrow CH_3COOH(aq) + OH^-(aq)$

4. In which reaction does H_2O act as Lewis base but not as a Bronsted-Lowery base.

   A. $H_2O + NH_4^+ \rightarrow H_3O^+ + NH_3$
   B. $H_2O + CaO \rightarrow Ca^{2+} + 2OH^-$
   C. $H_2O + [Fe(H_2O)_6]^{3+} \rightarrow [Fe(OH)(H_2O)_5]^{2+} + H_3O^+$
   D. $6H_2O + [Ni(NH_3)_6]^{2+} \rightarrow 6NH_3 + [Ni(H_2O)_6]^{2+}$

18.2 Calculations involving acids and bases

(A) Dissociation of water

$H_2O(l) \rightleftharpoons H^+ + OH^-$ $\Delta H > 0$, Endothermic

$K_w = [H^+][OH^-]$

The value of K_w of 1.00×10^{-14} at 298K.

The value of equilibrium constant is temperature dependent.

$[H^+] = [OH^-]$ in water

Since the dissociation of water is an endothermic reaction, increasing temperature shifts the equilibrium position to right, the value of K_w increases and hence $[H^+]$ increases and the pH of water decreases.

Try to explain why the pH of water is 7 at room temperature (298K).