Topic 8 Acids and bases (SL)

Syllabus:

8.1 Theories of acids and bases

Definition of Brønsted-Lowry acid and base and amphiprotic species.

Introduce conjugated acid-base pair.

8.2 Properties of acids and bases

Chemical reactions of acids with reactive metals, metal oxides, metal hydroxides, hydrogen carbonates and carbonates.

Salt and water are produced in exothermic neutralization reactions.

8.3 The pH scale

$pH = -\log[H^+]$ and $[H^+] = 10^{-pH}$

A change of one pH unit represents a 10-fold change in the hydrogen ion concentration$[H^+]$.

pH values distinguish between acidic, neutral and alkaline solutions.

$K_w = [H^+]\,[OH^-] = 10^{-14}$ at 298K

8.4 Strong and weak acids and bases

Strong and weak acids and bases differ in the extent of ionization.

Strong acids and bases of equal concentrations have higher conductivities than weak acids and bases.

A strong acid is a good proton donor and has a weak conjugate base.

A strong base is a good proton acceptor and has a weak conjugate acid.

8.5 Acid deposition

Rain is naturally acidic because of dissolved CO_2 and has a pH of 5.6. Acid deposition has a pH below 5.6.

Acid deposition is formed when nitrogen or sulfur oxides dissolve in water to form HNO_3, HNO_2, H_2SO_4 and H_2SO_3.

Sources of the oxides of sulfur and nitrogen and the effects of acid deposition should be covered.

8.1 Theories of acids and bases

- **Brønsted-Lowry acid** is defined as a **proton (H^+) donor**.
- **Brønsted-Lowry base** is defined as a **proton (H^+) acceptor**.

$HCl + H_2O \rightarrow H_3O^+ + Cl^-$ **OR** $HCl \rightarrow H^+ + Cl^-$

HCl is Brønsted-Lowry acid because it donates H^+ to H_2O.
H_2O is Brønsted-Lowry base because it accepts H^+ from HCl.

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

H_2O is Brønsted-Lowry acid because it donates H^+ to NH_3
NH_3 is Brønsted-Lowry base because it accepts H^+ from H_2O.

Strong acid: HCl, HNO_3, H_2SO_4
Weak acid: H_2CO_3, H_3PO_4, CH_3COOH, carboxylic acid
Strong base: NaOH, KOH, MgO
Weak base: NH_3, amine (RNH_2)

- **Amphoteric species** can act as either acid and base, depending on the medium.

- **Amphiprotic species** can act as either a Brønsted-Lowry acid **(proton (H^+) donor)** or a Brønsted-Lowry base **(proton (H^+) acceptor)** depending on the reaction in which they are taking part. For example, H_2O.

$HSO_4^- + OH^- \rightleftharpoons SO_4^{2-} + H_2O$
$HSO_4^- + H_3O^+ \rightleftharpoons H_2SO_4 + H_2O$

- Not all amphoteric species are amphiprotic, For example, ZnO is Lewis acid (Topic 18) which accepts electron pair from OH but cannot donate a proton.

➢ **Conjugate acid-base pair**

Acid + Base ⇌ Conjugate base + Conjugate acid

- All acids have a conjugate base which has one less H^+ than the acid.
- All bases have a conjugate acid which has one more H^+ than the base.

Example:

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

Acid + Base ⇌ Conjugate base + Conjugate acid

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

Base + Acid ⇌ Conjugate acid + Conjugate base