A2 Chemistry: F325 – Equilibria, Energetics and Elements
5.1.3 – Acids, bases and Buffers.

Lesson 1 - Brønsted–Lowry Acids and Bases

Learning Outcomes:

All
- State the meaning of the term acid and base (5.1.3 a)

Most
- Write an ionic equation for the reaction of an acid with metals, carbonates, bases and alkalis (5.1.3 b)

Some
- Describe and use the term *conjugate acid– base pairs* and label them in an equation (5.1.3 c)

Background Information

The H+ ion is the active species in acids and is always involved in acid-base reactions.

- Bases are substances which react with and neutralise acids

- Alkalis are water-soluble bases which produce OH^- ions in aqueous solution. They
  - turn red litmus blue or UI paper blue
  - have a pH greater than 7
  - react with acids to form a salt and water only
  - $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
  - form weak or strong alkalis depending on the equilibrium position

- Acids produce 'H^+' ions in aqueous solution. They
  - turn blue litmus red or UI paper red
  - have a pH of less than 7
  - react with bases or alkalis to form a salt and water only
  - react with a metal carbonate to form a salt, carbon dioxide and water
  - $2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$
  - react with metals to form a salt and hydrogen
  - $2HNO_3(aq) + Mg(s) \rightarrow Mg(NO_3)_2(aq) + H_2(g)$
    (The metal must be above hydrogen in the Reactivity Series)

- The reaction between an acid and an alkali is called neutralisation:

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

When an acid is added to water it dissociates releasing H^+, hydrogen ions which is commonly called a proton as the hydrogen atom has lost an electron.

$$HCl(g) + aq \rightarrow H^+ + Cl^-(aq)$$

$$H_2SO_4(l) + aq \rightarrow H^+(aq) + HSO_4^-(aq)$$

aq = excess water

Different acids release different numbers of protons depending in their formulae. Acids that can release two protons are called di-basic acids, and those that can liberate three protons are called tri-basic acids.

(a) **The Bronsted-Lowry theory of acids and bases defines an <u>acid as a proton donor</u> and it may only function as such when in the presence of a <u>proton acceptor – a base</u>** e.g.

HCl	+	NH_3	→	Cl^-	+	NH_4^+
Acid Proton donor		Base Proton acceptor		Conjugate Base of HCl		Conjugate Acid of NH_3

Explain the meaning of the terms conjugate acid and conjugate base and how an acid-base pair are linked together.

(b) Reactions with Acids

(i) Acids Reacting with Metals

When an aqueous acid reacts with a metal a salt and hydrogen gas is produced. You must be able to write a balanced full equation and an ionic equation for these reactions involving common mineral acids such as sulfuric acid (H_2SO_4), nitric acid HNO_3, hydrochloric acid HCl and phosphoric acid (H_3PO_4)

ACID + METAL → SALT + HYDROGEN

$2HCl(aq) + 2Na(s) \rightarrow 2NaCl(aq) + H_2(g)$ Full equation

$2H^+(aq) + 2Cl^-(aq) + 2Na(s) \rightarrow 2Na^+(aq) + 2Cl^-(aq) + H_2(g)$

The spectator ions are removed from the equation. These are the ions that do not change their oxidation states during the reaction.

$2H^+(aq) + 2\,Na(s) \rightarrow 2Na^+(aq) + H_2(g)$ Ionic equation

(ii) **Acids Reacting with Carbonates**

ACID + METAL CARBONATE → SALT + CARBON DIOXIDE + WATER

$2HCl(aq) + MgCO_3(s) \rightarrow MgCl_2(aq) + CO_2(g) + H_2O(l)$ Full equation

Ionic equation

(iii) **Acids Reacting with Bases**

A base is a soluble metal oxide.

ACID + BASE → SALT + WATER

$2HNO_3(aq) + CaO(s) \rightarrow Ca(NO_3)_2(aq) + H_2O(l)$ Full equation

Ionic equation

(iv) **Acids Reacting with Alkalis**

ACID + ALKLAI → SALT + WATER

$H_2SO_4(aq)\ 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$ Full equation

Ionic equation

Answer questions 1 and 2 on page 137.

Answer the questions on Acids, bases and Buffers 1.

1. **Summary:**
   In no more than 150 words summarise the key points for these pages including chemical structures and diagrams where relevant.

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Peer review comment:

Additional Notes/Questions:

Include any questions that you have on this section for your teacher to cover along with any additional notes you wish to make to support your revision.