Types of Chemical Reactions

You must be able to:

- Explain whether a substance is oxidised or reduced in a reaction
- HT Explain oxidation and reduction in terms of loss and gain of electrons
- Predict the products of reactions between metals or metal compounds and acids.

Oxidation and Reduction

- When oxygen is added to a substance, it is **oxidised**.
- When oxygen is removed from a substance, it is **reduced**.
- The substance that gives away the oxygen is called the **oxidising agent**.
- The substance that receives the oxygen is the **reducing agent**.

copper oxide + hydrogen → copper + water

Copper oxide is the oxidising agent (it loses the oxygen). Hydrogen is the reducing agent (it gains the oxygen to form water).

HT Loss and Gain of Electrons

- Chemists modified the definition of oxidation and reduction when they realised that substances could be oxidised and reduced without oxygen being present.
- The definition now focuses on the loss or gain of electrons in a reaction:
  - If a substance gains electrons, it is reduced.
  - If a substance loses electrons, it is oxidised.

$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

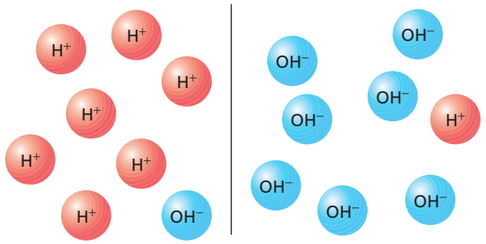
Sodium gives away the single electron in its outermost shell, so it has been oxidised. Chlorine receives the electrons from the two sodium atoms, so it has been reduced.

HT Key Point

OILRIG: Oxidation Is Loss (of electrons), Reduction Is Gain (of electrons).

Acids and Alkalis

- When an acid or alkali is dissolved in water, the ions that make up the substance move freely.
  - An **acid** produces hydrogen ions, $H^+(aq)$.
  - An **alkali** produces hydroxide / hydroxyl ions, $OH^-(aq)$.
- For example, a solution of hydrochloric acid, HCl, will dissociate into $H^+(aq)$ and $Cl^-(aq)$ ions.
- A solution of sodium hydroxide, NaOH, will dissociate into $Na^+(aq)$ and $OH^-(aq)$ ions.



low pH = lots of H^+ | lots of OH^- = high pH

Neutralisation

- **Neutralisation** occurs when an acid reacts with an alkali or a **base**, to form a **salt** and water.

LEARN: **acid + base → salt + water**

- For example, hydrochloric acid reacts with sodium hydroxide to produce sodium chloride and water:

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

- The reaction can be rewritten to only show the species that change:

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

Reacting Metals with Acid

- Many metals will react in the presence of an acid to form a salt and hydrogen gas.

LEARN: **metal + acid → salt + hydrogen**

- The reactivity of a metal determines whether it will react with an acid and how vigorously it reacts.
- Metals can be arranged in order of reactivity in a **reactivity series**.
- If there is a reaction, then the name of the salt produced is based on the acid used:
  - Hydrochloric acid forms chlorides.
  - Nitric acid forms nitrates.
  - Sulfuric acid forms sulfates.

magnesium + hydrochloric acid → magnesium chloride + hydrogen

$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

Reacting Metal Carbonates with Acid

- Metal carbonates also react with acids to form a metal salt, plus water and carbon dioxide gas.

LEARN: **metal carbonate + acid → salt + water + carbon dioxide**

- The salts produced are named in the same way as for metals reacting with acids.

magnesium carbonate + sulfuric acid → magnesium sulfate + water + carbon dioxide

$MgCO_3(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l) + CO_2(aq)$

Quick Test

1. What gas is made when metal carbonates react with acid?
2. What salt is made when zinc oxide is reacted with nitric acid?
3. Write the word equation for the reaction between copper oxide and sulfuric acid.

Revise

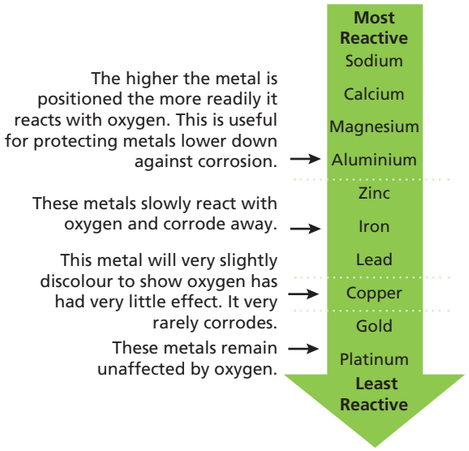
Key Point

Remember, ionic substances separate from each other when dissolved or molten. The ions move freely and are not joined together.

Key Point

Water is not an ionic compound. It is a polar molecule (it has positively charged hydrogen and negatively charged oxygen), which means that ionic substances can dissolve easily into it.

Reactivity Series



The higher the metal is positioned the more readily it reacts with oxygen. This is useful for protecting metals lower down against corrosion.

These metals slowly react with oxygen and corrode away.

This metal will very slightly discolour to show oxygen has had very little effect. It very rarely corrodes.

These metals remain unaffected by oxygen.

Key Words

- oxidised
- reduced
- oxidising agent
- reducing agent
- acid
- alkali
- neutralisation
- base
- salt
- reactivity series