AQA Chemistry A-level

3.2.4: Period 3 Elements

Detailed Notes

3.2.4.1 - Properties

Period 3 Metals

Sodium and magnesium both react **ionically** to form positive ions. Sodium reacts to form 1+ ions whereas magnesium forms 2+ ions.

Example:

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

$$Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$$

Sodium is **more reactive** than magnesium as it only has to lose one electron to form an ion, whereas magnesium has to lose two electrons. Therefore **less energy is required** to ionise sodium making it more reactive.

This means the reaction above with magnesium is **slow**. However the speed of reaction can be increased by using **steam** instead of water. Steam provides the reaction with greater energy resulting in a **violent reaction** in which magnesium burns with a **bright white flame**. It produces hydrogen and magnesium oxide.

Example:

$$Mg + H_2O(g) \longrightarrow MgO(s) + H_2$$

Period 3 Oxides

The period 3 elements react with oxygen to form **oxides** with each element in their **highest oxidation state**. This number is often the same as the group number.

Example:

$$Al \longrightarrow +3 \qquad P \longrightarrow +5$$

It is very useful to learn the oxides that form from the **period 3 elements**:

Na_2O	-	Sodium Oxide	+1
MgO	-	Magnesium Oxide	+2
Al_2O_3	-	Aluminium Oxide	+3
SiO_2	-	Silicon Dioxide	+4
P_4O_{10}	-	Phosphorus Oxide	+5
SO_2	-	Sulfur Dioxide	+4
SO_3	-	Sulfur Trioxide	+6

Sulfur can also react to form SO_3 with an oxidation state of +6 but this requires **high temperatures and a catalyst**.

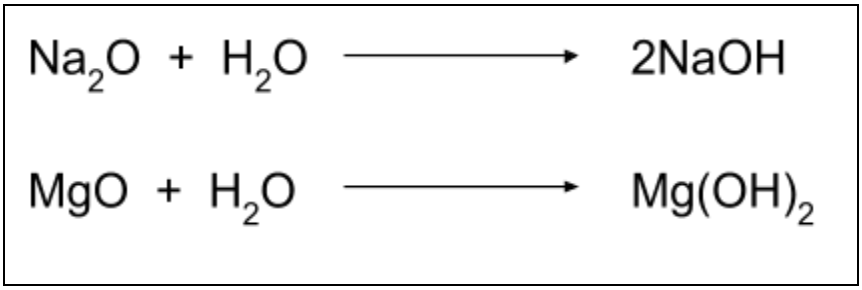
These oxides have different **structures and bonding** that affects the **reactivity** and **melting points** of the compounds:

Oxide	Structure and Bonding	Relative Melting Point (°C)	Reactivity
Na_2O	Ionic	≈ 1250	Vigorous
MgO	Ionic	≈ 2750	Vigorous
Al_2O_3	Ionic (covalent character)	≈ 2000	Slow (faster if powdered)
SiO_2	Macromolecular	≈ 1500	Slow
P_4O_{10}	Simple covalent	≈ 500	Vigorous
SO_2	Simple covalent	≈ -10	Burns steadily

Reactions with Water

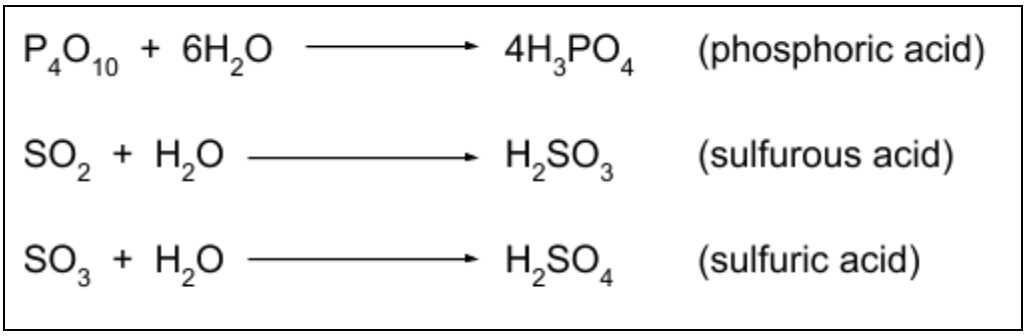
The **ionic oxides** combine with water to form **alkaline solutions** with a pH around 10-14.

Examples:



The **simple covalent oxides** of sulfur and phosphorus combine with water to form **acidic solutions** with a pH around 0-2.

Examples:

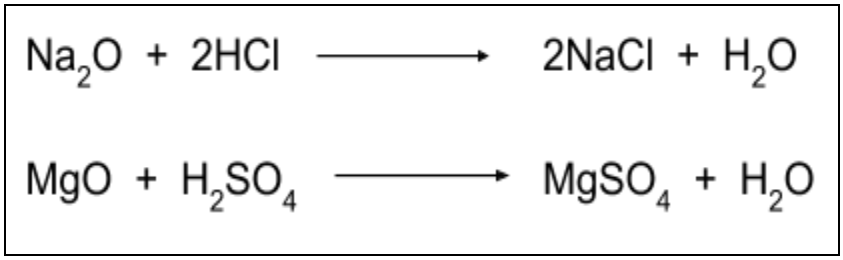


When in solution, these acids **dissociate into H^+ ions** and ions of **conjugate base**.

Acid-base Reactions

Basic, ionic oxides react with acids to produce a **salt and water**. This is a **neutralisation** reaction.

Examples:



Acidic, covalent oxides react with bases to produce a **salt and water** in a **neutralisation** reaction.

Example:

$$SiO_2 + 2NaOH \longrightarrow Na_2SiO_3 + H_2O$$

$$P_4O_{10} + 12NaOH \longrightarrow 4Na_3PO_4 + 6H_2O$$

$$SO_2 + 2NaOH \longrightarrow Na_2SO_3 + H_2O$$

$$SO_3 + 2NaOH \longrightarrow Na_2SO_4 + H_2O$$

The bonding in **aluminium oxide** is partially ionic and covalent meaning it is **insoluble** in water as the ions don't dissociate. This also means it can act as both an acid and a base, known as **amphoteric**. It reacts as both to form a **salt and water** in neutralisation reactions.

Examples:

$$Al_2O_3 + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3H_2O$$

$$Al_2O_3 + 2NaOH + 3H_2O \longrightarrow 2NaAl(OH)_4$$