

2. Periodicity of Period 3 Elements

Trends in the reactions of the elements with water, limited to Na and Mg

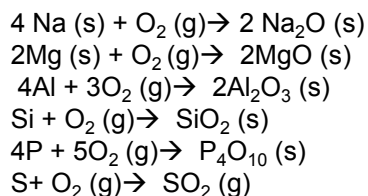
Learn the equations

Sodium reacts with cold water. It fizzes around on surface etc.
 $2\text{Na (s)} + 2\text{H}_2\text{O (l)} \rightarrow 2\text{NaOH (aq)} + \text{H}_2\text{(g)}$

Magnesium reacts very slowly with cold water to form the hydroxide but reacts more readily with **steam** to form the oxide
 $\text{Mg (s)} + \text{H}_2\text{O (g)} \rightarrow \text{MgO (s)} + \text{H}_2\text{(g)}$

Trends in the reactions of the elements Na, Mg, Al, Si, P and S with oxygen

The elements all react with oxygen to form oxides. Sodium burns with a yellow flame. Mg, Al, Si and P burn with a white flame and S with a blue flame.



You should be able to write these equations.

Learn the formulae of the oxides

A survey of the acid-base properties of the oxides of Period 3 elements

Understand the link between the physical properties of the highest oxides of the elements Na → S and their structure and bonding.

Ionic oxides

The metal oxides (Na_2O , MgO , Al_2O_3) are ionic. They have high melting points. They have ionic giant lattice structures: strong forces of attraction between ions : higher mp. They are ionic because of the large electronegativity difference between metal and O

The increased charge on the cation makes the ionic forces stronger going from Na to Al so leading to increasing melting points

Macromolecular oxides

SiO_2 is Macromolecular: very strong covalent bonds between atoms. High energy needed to break the many strong covalent bonds – very high mp +bp

Simple molecular oxides:

P_4O_{10} , SO_2 are simple molecular with weak intermolecular forces between molecules (van der waals + permanent dipoles) so have lower mp's. They are covalent because of the small electronegativity difference between the non-metal and O atoms

The reactions of the oxides of the elements Na → S with water

Metal oxides tend to react with water to form hydroxides which are alkaline

$\text{Na}_2\text{O (s)} + \text{H}_2\text{O (l)} \rightarrow \text{Na}^+\text{(aq)} + 2\text{OH}^-\text{(aq)}$ **pH 13 (This is a vigorous exothermic reaction)**

$\text{MgO (s)} + \text{H}_2\text{O (l)} \rightarrow \text{Mg(OH)}_2\text{(s)}$ **pH 9**

Mg(OH)_2 is only slightly soluble in water as its lattice is stronger so fewer free OH^- ions are produced and so lower pH

know the change in pH of the resulting solutions across the Period.

Al_2O_3 and SiO_2 **do not dissolve** in water because of the high strength of the Al_2O_3 ionic lattice and the SiO_2 macromolecular structure, so they give a neutral **pH 7**

The non-metal, **simple molecular**, covalent, oxides react with water to give acids
 $\text{P}_4\text{O}_{10}\text{(s)} + 6\text{H}_2\text{O (l)} \rightarrow 4\text{H}_3\text{PO}_4\text{(aq)}$ **pH 0 (this is a vigorous exothermic reaction)**
 $\text{SO}_2\text{(g)} + \text{H}_2\text{O (l)} \rightarrow \text{H}_2\text{SO}_3\text{(aq)}$ **pH 3 (weak acid)**
 $\text{SO}_3\text{(g)} + \text{H}_2\text{O (l)} \rightarrow \text{H}_2\text{SO}_4\text{(aq)}$ **pH 0**

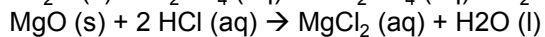
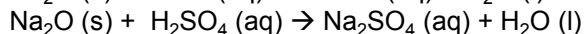
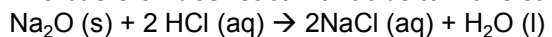
Learn the equations !

The trend is the **ionic metal oxides** show **basic** behaviour and the **non-metal covalent** oxides show **acidic** behaviour.

The slightly intermediate nature of the bonding in Aluminium oxide is reflected in its amphoteric behaviour: it can act as both a base and an acid

Acid base reactions between period 3 oxides and simple acids and bases.

The **basic oxides** react with acids to make salts

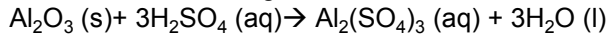


Rather than learning the equations by rote, learn the pattern. Most follow the pattern acid + base = salt + water

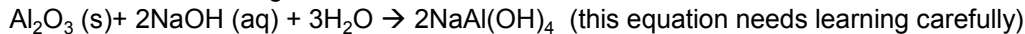
Amphoteric Oxides

Aluminium oxide can act as both an acid and an alkali and is therefore called amphoteric

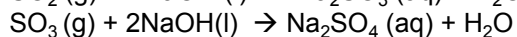
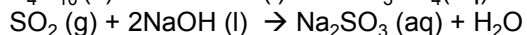
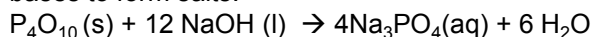
Aluminum oxide acting as a **base**



Aluminum oxide acting as a **acid**



The other simple molecular acidic oxides react with bases to form salts.



SiO_2 has a **giant covalent structure** with very strong bonds. This stops SiO_2 reacting with water and weak solutions of alkali. It will, however, react with very concentrated NaOH

$$2\text{NaOH (l)} + \text{SiO}_2 \text{ (s)} \rightarrow \text{Na}_2\text{SiO}_3 \text{ (aq)} + \text{H}_2\text{O}$$

It is still classed as an acidic oxide