

# CAIE IGCSE Chemistry

## 9.1 Properties of metals

### Notes

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*Compare the general physical properties of metals and non-metals, including:*

(a) Thermal conductivity

- Metals tend to be good conductors of heat, whereas non-metals are not
- This is because metals contain delocalised electrons that are free to move around to carry thermal energy (heat) from one place to another

(b) Electrical conductivity

- Metals tend to be good conductors of electricity, whereas non-metals are poor conductors of electricity and heat.
- This is because metals contain delocalised electrons that are free to move around to carry charge from one place to another

(c) Malleability and ductility

- Metals are malleable (able to be bent and shaped easily) and ductile (stretched and pulling without breaking)
- This is because the positive metal ions are arranged in uniform rows in the structure so are able to slide over one another.

(d) Melting points and boiling points

- Metals generally have high melting and boiling points, whereas non-metals generally have low melting and boiling points.
- This is because metals are giant structures with strong metallic bonding. There is strong electrostatic attraction between the positive metal ions and the negative electrons so require a large amount of energy to break/overcome these bonds to change state.



Describe the general chemical properties of metals, limited to their reactions with:

(a) Dilute acids

- When a metal reacts with a dilute acid, a salt and hydrogen is formed
- This is a displacement reaction as the metal is more reactive than hydrogen in the reactivity series so the metal ions will displace the hydrogen ions in the acid to form the salt
- General equation: Metal + Acid  $\rightarrow$  Salt + Hydrogen
  - E.g. Sodium + Hydrochloric acid  $\rightarrow$  Sodium chloride + Hydrogen  
 $2\text{Na (s)} + 2\text{HCl (aq)} \rightarrow 2\text{NaCl (aq)} + \text{H}_2\text{(g)}$
- Metals that are less reactive than hydrogen will be unable to displace hydrogen so will not form a salt

(b) Cold water and steam

- When a metal reacts with cold water  $\text{H}_2\text{O (l)}$ , a metal hydroxide and hydrogen gas are formed
  - The more reactive metals will react with the water more vigorously and quickly, e.g. when potassium K reacts with water it burns with a lilac flame as it is a very exothermic reaction.
  - Whereas the less reactive metal react with water less violently and more slowly
- General equation: Metal + Water  $\rightarrow$  Metal hydroxide + Hydrogen gas
  - E.g. Potassium + Water  $\rightarrow$  Potassium hydroxide + Hydrogen gas  
 $2\text{K (s)} + 2\text{H}_2\text{O (l)} \rightarrow 2\text{KOH (aq)} + \text{H}_2\text{(g)}$
- When a metal reacts with steam  $\text{H}_2\text{O (g)}$ , a metal oxide and hydrogen gas are formed
  - The less reactive metals, such as magnesium, react with steam more vigorously than with water
- General equation: Metal + Steam  $\rightarrow$  Metal oxide + Hydrogen gas
  - E.g. Magnesium + Water  $\rightarrow$  Magnesium oxide + Hydrogen gas  
 $\text{Mg (s)} + \text{H}_2\text{O (g)} \rightarrow \text{MgO (s)} + \text{H}_2\text{(g)}$

(c) Oxygen

- When a metal reacts with oxygen, a metal oxide is formed
- The speed at which this reaction occurs depends on the reactivity of the metal
- General equation: Metal + Oxygen  $\rightarrow$  Metal oxide
  - E.g. Calcium + Oxygen  $\rightarrow$  Calcium oxide  
 $2\text{Ca (s)} + \text{O}_2\text{(g)} \rightarrow 2\text{CaO (s)}$

