<u>Edexcel Chemistry IGCSE</u>

Practical 1.36: Determining the formula of a metal oxide by combustion (e.g. magnesium oxide) or by reduction (e.g. copper(II) oxide)

Notes

Combustion of magnesium to form magnesium oxide

Aim

To determine the formula of magnesium oxide by combustion.

Equipment list

- Bunsen burner
- Crucible with lid
- Tripod and gauze
- Digital mass balance
- Tongs (optional)

Chemicals required

- Magnesium oxide

Method

1. Measure the mass of the empty crucible and lid.
2. Add a sample of magnesium into the crucible and remeasure the mass of the crucible and lid.
3. Calculate the mass of metal added to the crucible by subtracting the mass of the empty crucible (from step 1) from the total mass of the crucible with the metal added (from step 2).
4. Place the crucible on a tripod and gauze over a bunsen burner and heat strongly with a blue flame for several minutes.
5. Lift the lid of the crucible frequently while heating to allow sufficient air into the crucible. This ensures the magnesium is fully oxidised.
6. After several minutes, check the mass of the crucible. Heat for another minute then check the mass again. If the mass has remained the same, the magnesium has been fully oxidised. If not, continue heating and stop when the mass is constant.
7. Measure the mass of the crucible and its contents. Subtract the mass of the empty crucible (from step 1) to find the mass of magnesium oxide.

Diagram

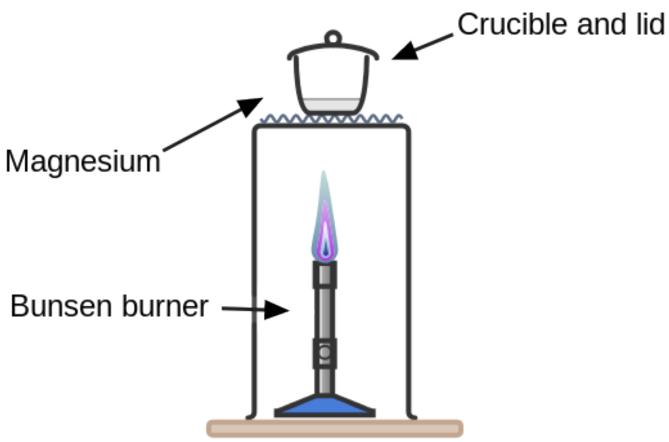

Figure 1 Experiment Setup

[Chemix]

Key points

- The equation for this reaction is: $2Mg + O_2 \rightarrow 2MgO$
- A lid must be used on the crucible so that none of the magnesium oxide escapes. The lid must be lifted regularly to let the oxygen into the crucible and prevent incomplete combustion occurring.

Safety precautions

- Be careful when using the Bunsen burner. When not in use make sure the orange safety flame is on or turn off the gas. Tie back long hair and ensure there are no flammable chemicals in the working area.
- The crucible will be hot when removing it from the tripod. Wait for it to cool or use tongs to pick it up to avoid burns. If the skin is burned, run it under cold water for up to 10 minutes, depending on the severity.

Analysis of results

After calculating the mass of magnesium oxide formed from a known mass of magnesium, it is possible to calculate the empirical formula of the oxide formed.

Mass of magnesium = mass of the magnesium sample and crucible - mass of the empty crucible
Mass of oxygen used in the reaction = mass of magnesium oxide formed - mass of magnesium

When calculating the empirical formula, a layout similar to the table below can be used to calculate the ratio of magnesium to oxygen:

	Magnesium *(Mr = 24)*	Oxygen *(Mr = 16)*
Mass	x	y
Mole	x ÷ 24 = a	y ÷ 16 = b
Ratio	a	b

The ratio of magnesium to oxygen in the empirical formula will be a:b.
Make sure that a and b are whole numbers. For example, if a:b is 1.5:1 then the ratio will be 3:2.

Reduction of copper(II) oxide to form copper

Aim
To determine the formula of copper(II) oxide by reduction.

Equipment list
- Reaction tube with bung and delivery tube (ensure it has a hole at the other end to allow the methane to escape)
- Bunsen burner
- Clamp and stand

Chemical list
- Copper(II) oxide
- Methane gas

Method
1. Measure the mass of the empty reaction tube. Add the copper oxide to the reaction tube and remeasure the mass of the reaction tube. Calculate the mass of copper oxide added to the tube by subtracting the first mass from the second.
2. Clamp the reaction tube horizontally using the clamp and stand.
3. Connect the delivery tube to a supply of methane and secure the bung in the reaction tube.
4. Switch on the methane supply and wait a moment before lighting the methane at the hole where it escapes the reaction tube.
5. Use a bunsen burner to heat the copper oxide from the underside of the horizontal reaction tube.
6. Heat until the metal oxide completely changes colour. This means all the oxygen has been reduced. Turn off the supply of methane.
7. Measure the final mass of the reaction tube. Calculate the mass of copper formed.

Key points
- When copper (II) oxide is heated in a stream of methane, oxygen is removed from the copper (II) oxide. This produces copper, carbon dioxide and water.
- Methane is very explosive if ignited in the presence of oxygen. This is why it is important to leave the methane supply running for a moment before lighting it at the hole in the reaction tube. This allows time for the methane to flush out any oxygen from the tube meaning the gas only burns when it comes into contact with oxygen in the air, once it has left the tube.
- The experiment can also be carried out using hydrogen rather than methane. The two equations for these reactions are:
  $4CuO + CH_4 \rightarrow 4Cu + 2H_2O + CO_2$
  $CuO + H_2 \rightarrow Cu + H_2O$

Safety precautions
- Be careful when using the Bunsen burner. When not in use make sure the orange safety flame is on or turn off the gas. Tie back long hair and ensure there are no flammable chemicals in the working area.

- The reaction tube will be hot when removing it from the clamp. Wait for it to cool or use tongs to pick it up to prevent burns. If the skin is burned, run it under cold water for up to 10 minutes, depending on the severity.
- Take care when using glassware. Clear up broken glass immediately.
- Methane gas is very explosive. Let it run through the reaction tube for 20 seconds to flush out any oxygen before igniting it so that it doesn't ignite within the reaction tube.

Analysis of results

After calculating the mass of copper formed from a known mass of copper oxide, it is possible to calculate the empirical formula of the oxide formed.

Mass of copper oxide = mass of copper oxide sample and reaction tube - mass of the reaction tube
Mass of oxygen used in the reaction = mass of copper oxide used - mass of copper formed

When calculating the empirical formula, a layout similar to the table below can be used to calculate the ratio of copper to oxygen:

	Copper *(Mr = 63.5)*	Oxygen *(Mr = 32)*
Mass	x	y
Mole	x ÷ 63.5 = a	y ÷ 32 = b
Ratio	a	b

The ratio of copper to oxygen in the empirical formula will be a:b.
Make sure that a and b are whole numbers. For example, if a:b is 1.5:1 then the ratio will be 3:2.