Heating copper in air

This investigation is part of the **Nuffield practical collection**, developed by the Nuffield Foundation and the Royal Society of Chemistry. Delve into a wide range of chemical concepts and processes with this collection of over 200 step-by-step practicals: rsc.li/43bjGql

Learning objectives

1 Safely heat copper using a Bunsen burner and record your observations.

2 Describe and explain observations from a chemical reaction.

3 Write word and symbol equations to represent a chemical reaction.

4 Use simple calculations to link mass to reactivity and the availability of oxygen.

Success criteria

The practical allows learners to safely heat copper and record and discuss their observations (LO1 and LO2).

Completion of the follow-up questions using support from the PowerPoint will allow learners to succeed in LO2, LO3 and LO4.

Introduction

In this experiment, learners fold a piece of copper foil into the shape of an envelope, before heating it using a Bunsen burner. When the foil has cooled, learners can open the envelope and discover that where there was no contact with oxygen the copper remains unreacted.

Warn learners that there can be sharp corners on the copper. The copper stays hot for some time and there is a risk of burns.

The experiment will take 20–30 minutes.

Scaffolding

There are two versions of the student worksheet: scaffolded (✪) and unscaffolded (✪✪). The scaffolded sheet offers more support to allow learners to access the questions. For example, longer answer questions and equations are presented as fill-in-the-gap activities. Hints are provided after some of the questions to support learners and guide their answers.

Technician notes

Read our standard health and safety guidance (rsc.li/3zyJLkx) and carry out a risk assessment before running any live practical.

Equipment

Apparatus

- Safety glasses
- Bunsen burner
- Heat resistant mat
- Tongs

Chemicals

- Copper foil, 4 cm x 4 cm

Safety and hazards

- Wear eye protection throughout the experiment
- Copper foil, $\mathrm{Cu(s)}$, not currently classified as hazardous – see CLEAPSS Hazcard HC026

Method

A full method is provided in the student worksheet.

Teaching notes

The outside of the copper envelope will react with oxygen in the air and will turn black. This can confuse learners who think that it is soot which has coated the outside of the copper. To help convince them otherwise, ensure that they use a roaring Bunsen flame and show them that a beaker (containing water) which is heated with the same flame does not get coated in black powder. Inside the envelope, the copper remains as it was at the start.

Copper, like many transition metals, only reacts slowly with oxygen in the air. When heated it forms a layer of black copper oxide on its surface:

$$\text{copper + oxygen} \rightarrow \text{copper oxide}$$

$$2\mathrm{Cu(s)} + \mathrm{O_2(g)} \rightarrow 2\mathrm{CuO(s)}$$

You can use this experiment as an illustration of the likely reactions of other transition metals with oxygen, as they all have similar properties or to provide a contrast to the reactions of group 1 and 2 metals with oxygen.

Answers

1. (a) copper + oxygen → copper oxide
   (b) $2Cu + O_2 \rightarrow CuO$
   (c) copper and oxygen
   (d) copper oxide

2. A black coating of copper oxide was seen on the copper exposed to air.

3. The copper on the outside of the envelope was exposed to oxygen in the air so was able to react.

4. The copper inside the envelope was not exposed to air and therefore wasn't able to react with oxygen.

5. Copper has a **low** reactivity so the **rate** of reaction with oxygen is **slow** at room temperature. Heating it up **increases** the rate of reaction.

6. (a) mass balance *or* top pan balance
   (b) 0.3 g
   (c) The mass has increased.
   (d) **Oxygen** molecules from the air have combined with the **copper** in a chemical reaction so are now present as part of **copper oxide** as a solid on the surface of the copper.

7. (a) 1.26 g
   (b) 0.5 g
   (c) Not all the copper has reacted as some of the copper atoms were not exposed to oxygen.