14–16 years

Extraction of iron on a match head

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Learning objectives

1. Safely investigate heating iron oxide on a match head to reduce iron.
2. Explain why metals need to be extracted from their ores.
3. Explain the process of extracting metals using reduction with carbon.
4. Identify which species are oxidised and which are reduced.

The experiment

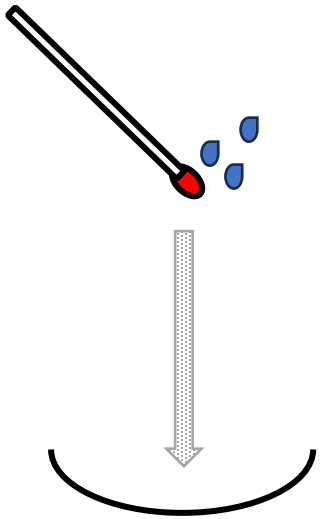
In this experiment, you will reduce iron(III) oxide with carbon on a match head to produce iron.



Method

1. Dip the head of a match in water to moisten it.
2. Roll the damp match head first in sodium carbonate powder, then in iron(III) oxide powder.
3. Hold the match in a pair of tongs. Put the head of the match into a blue Bunsen flame (air-hole open). The match will flare and burn. Do not allow the match to burn more than halfway along its length.
4. Allow the match to cool for about 30 seconds.
5. Use a spatula to crush the charred part of the match into a small plastic weighing boat.
6. Move a magnet around under the weighing boat – some of the small particles will move around in the weighing boat following the track of the magnet. Do not dip the magnet into the particles directly.

❶ Moisten match ❑



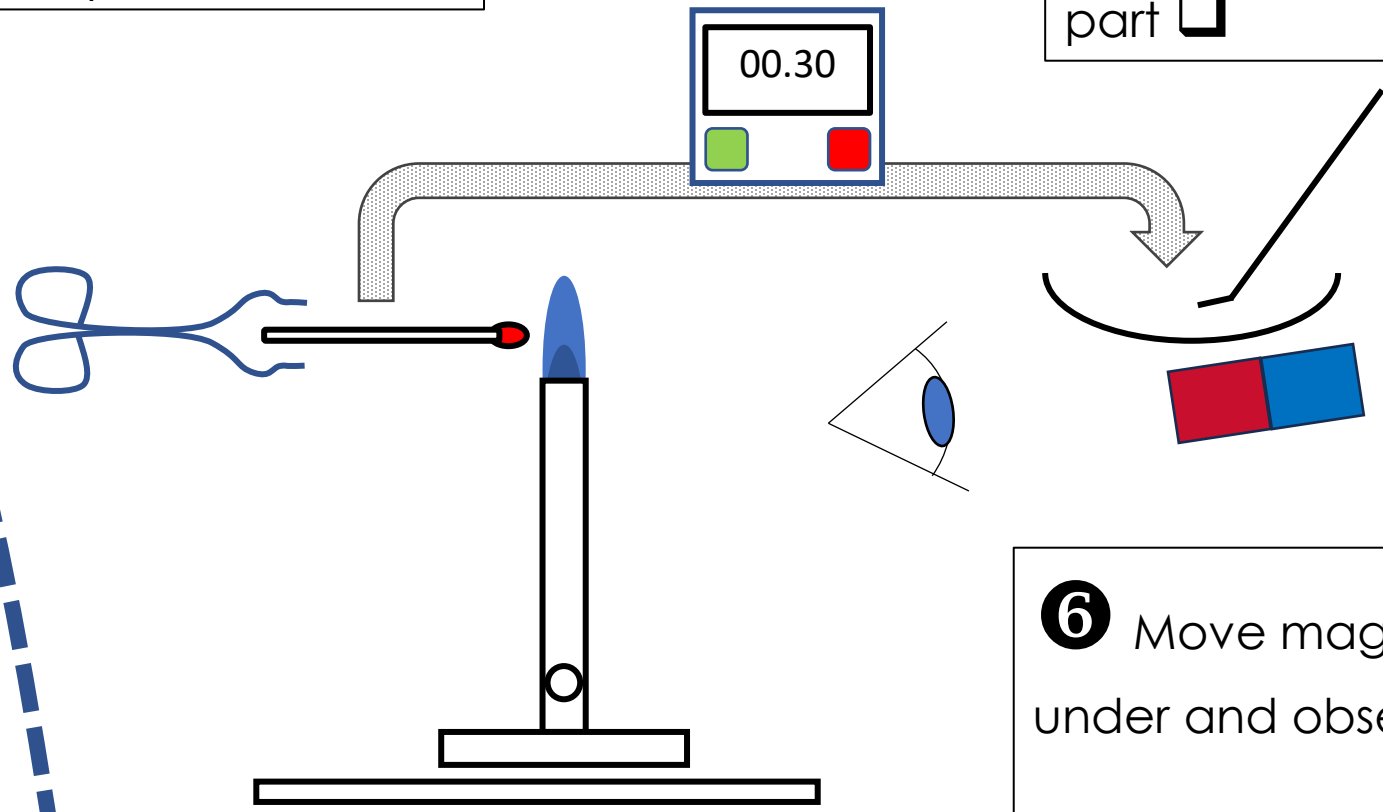
❷ Roll head in:

- sodium carbonate ❑
- iron(III) oxide ❑

❸ Burn no more than halfway ❑

❹ Cool for 30 seconds ❑

❺ Crush charred part ❑



❻ Move magnet under and observe ❑

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Extraction of iron on a match head
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Follow-up questions (scaffolded)

1. In this experiment, iron was produced by reacting the iron(III) oxide with carbon from the matchstick.

   (a) Iron(III) oxide is made up of Fe^{3+} and O^{2-} ions. Write the chemical formula of iron(III) oxide.

   (b) Use the information in the question and your answer to (a) to complete and balance the symbol equation for the reaction.

$$\underset{\text{iron(III)oxide}}{_____} + \underset{\text{carbon}}{____C} \rightarrow \underset{\text{iron}}{_____Fe} + \underset{\text{carbon dioxide}}{____CO_2}$$

Follow-up questions (scaffolded)

(c) Tick the **two** correct boxes to describe oxidation in terms of oxygen and electrons.

- ☐ Oxidation is the loss of oxygen
- ☐ Oxidation is the gain of oxygen
- ☐ Oxidation is the loss of electrons
- ☐ Oxidation is the gain of electrons

(d) Identify which species has been oxidised and which has been reduced.

2. Use the reactivity series to explain why iron can be reduced by carbon in this way.

Follow-up questions (scaffolded)

3. Lead is often extracted from its main ore, galena, which primarily contains lead sulfide, PbS.

   a) Select the correct words to complete the definition of the term ‘ore’.

   Ores are rocks that are found naturally in the Earth’s **atmosphere/crust**. They contain enough **metal/oxygen** to make it **expensive/profitable** to extract.

   b) The first stage of the process involves reacting lead sulfide with oxygen to produce lead oxide. Sulfur dioxide is also produced. Write a word equation for this process.

Follow-up questions (scaffolded)

c) The lead oxide can then be reacted with carbon to produce lead.
Lead oxide is made up of Pb^{2+} and O^{2-} ions.
Use this information to complete and balance the symbol equation for the reaction.

_____	+	____C	→	_____Pb	+ ____CO_2
lead oxide		carbon		lead	carbon dioxide

d) How does this reaction show that lead is **below** carbon on the reactivity series?

Follow-up questions (unscaffolded)

1. In this experiment, iron was produced by reacting the iron(III) oxide with carbon from the matchstick

   a) Write a word equation for the reaction you have carried out.
   b) Write a balanced symbol equation for this reaction.
   c) State and explain whether the iron in iron(III) oxide has been oxidised or reduced in this process. Write a redox half-equation to support your answer.

2. Explain why this method can be used to extract iron. Suggest a metal which could **not** be extracted in this way.

Follow-up questions (unscaffolded)

3. Lead is often extracted from its main ore, galena, which primarily contains lead sulfide, PbS.

   a) Define the term 'ore'.

   b) The first stage of the process involves reacting lead sulfide with oxygen to produce lead oxide. Sulfur dioxide is also produced. Write a word equation for this process.

   c) The lead oxide can then be reacted with carbon to produce lead. Lead oxide is made up of Pb^{2+} and O^{2-} ions.
   Write a balanced symbol equation for this reaction.

   d) What does this tell you about lead's position in the reactivity series relative to carbon?