

Extracting iron from breakfast cereal

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/43bjGqI

Learning objectives

- 1 Extract iron from different breakfast cereals.
- 2 Compare the amounts of iron in different breakfast cereals.
- 3 Explain the importance of iron in our diets.

Learners will complete a practical to extract and compare the amounts of iron contained in different breakfast cereals. The follow-up questions relate to why iron is important for haemoglobin production in the blood and the importance of dietary iron. The final question focusses on genetic conditions which impact haemoglobin production.

This activity and the follow-up questions have cross-curricular links to biology, including nutrition and the role of iron in haemoglobin.

Scaffolding

Scaffolded (★) and unscaffolded (★★) worksheets are provided with varying levels of support in the follow-up questions.

Question 5c is a research-based question which you can differentiate if necessary, (e.g. in the selection of pairings, offering suggested resources such as the NHS website to use when researching and/or completing this as a collaborative discussion task.)

You may need to provide additional support during the practical. Integrated instructions are available on the lesson slides and are available to download from rsc.li/3Qlw7aT.

Technician notes

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

Class practical

Equipment

Apparatus

- Safety glasses
- Pestle and mortar
- Sealable plastic sandwich bag (zip-lock types work best)
- A strong magnet (neodymium magnets are most effective)

Chemicals

- Distilled water
- Breakfast cereals to be tested

Safety and hazards

- Neodymium magnets are available from science education equipment suppliers. Care is required when handling these powerful magnets.

Method

The method for the class experiment can be found in the student sheet with integrated instructions available in the lesson slides (download from: rsc.li/3Qlw7aT).

Teacher demonstration (optional)

You may wish to extend the practical to test the grey deposit to confirm that it is iron.

This optional teacher demonstration explores the reaction of iron with hydrochloric acid and the identification of iron(III) ions using potassium hexacyanoferrate(III), which produces a strong colour change (Prussian Blue). Use a sample of iron(III) ions (e.g. iron(III) sulfate) to show learners the expected outcome of this test in advance.

Equipment

- Hydrochloric acid (1M)
- Potassium hexacyanoferrate(III) solution
- A sample of iron(III) ions (e.g. iron(III) sulfate or similar) to test

Safety and hazards

- Hydrochloric acid (1 M) – LOW HAZARD below 2 M, wear safety glasses. Refer to CLEAPSS Hazcard [HC047a](#) and CLEAPSS Recipe Book [RB043](#), refer to [SSERC](#) or contact your local safety advisory body.
- Potassium hexacyanoferrate(III) solution – LOW HAZARD, wear safety glasses. Do **not** add concentrated acids or heat in contact with acids – toxic gases are produced. Refer to CLEAPSS Hazcard [HC079](#), refer to [SSERC](#) or contact your local safety advisory body.

Disposal

- Neutralise and dilute the hydrochloric acid by adding slowly to 1 M sodium carbonate solution until the mixture is just alkaline. Pour the neutralised mixture down a foul-water drain with further dilution.
- Dilute the potassium hexacyanoferrate(III) solution and pour down a foul-water drain.

Method

Wear safety glasses.

- Collect the iron particles using a magnet covered in cling film
- Place the iron-coated magnet into a small test tube containing hydrochloric acid
- Carefully agitate the mixture to encourage the iron to react. Encourage learners to note down any observations.
- Add a few drops of potassium hexacyanoferrate(III) solution to the test tube – note down any observations.

Answers

- (a) Learners will make a qualitative judgement on which cereal contained the most iron.

(b) This will then be checked against the nutritional information on the cereal boxes.

(c) Answers may include:

 - Not all of the iron will have been separated from the flakes during the practical.
 - Some cereals may have been easier to separate
 - Some groups of learners may have been better at separating the iron.
 - The amount of iron in each individual flake of cereal may vary throughout the same cereal.
 - The method asks for a 'few flakes' but the actual mass of cereal could vary between the different cereals and the different groups of learners.
- (a) Elements are the **simplest** form of a substance. Elements are made up of the same type of **atoms**.

(b) Iron is magnetic. Not all metals are magnetic – only iron, cobalt and nickel.

(c) *Scaffolded*
B and D
Un scaffolded
Any two from: shiny, malleable, ductile, high tensile strength, electrical and thermal conductors etc.
- (a) The iron in fortified breakfast cereal is part of a **mixture**. The method of separating the iron from the cereal did not need a **chemical** change to take place.

(b) Amount of iron in one portion of cereal = $\frac{14}{100} \times 30 = 4.2 \text{ g}$
Number of portions = $\frac{14.8}{4.2} = 3.5$

(c) Answers may refer to:

 - Calorie intake – eating enough cereal to meet the recommended daily intake of iron may result in exceeding the recommended calorie intake.
 - Other ingredients, e.g. sugar - eating enough cereal to meet the recommended daily intake of iron may result in exceeding the recommended daily intake of another ingredient.
 - Balanced diet – consuming one thing in excess is not as healthy as seeking a variety of sources of iron.

(d) Red meat, poultry, fish, legumes (beans, lentils, chickpeas etc.), dark leafy greens, nuts and seeds.
- (a) Haemoglobin helps oxygen to bind to our red blood cells.

(b) Patients with thalassaemia cannot produce haemoglobin – even if they have enough iron in their body.

(c) Iron deficiency and iron overload have many common symptoms, such as dizziness, fatigue, muscle ache etc. This means it is very important to monitor patients and know whether they have too little or too much iron in their bodies.