Choosing a metal extraction route

Student activity • evidence and modelling

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The question

Why can carbon help extract iron but not aluminium?

Use a reactivity map and supplied process cards to choose extraction routes. Follow atoms and electron transfer without heating metal oxides. The cards simplify industrial processes and do not constitute laboratory methods.

Equipment

- Booklet, reactivity cards and periodic table
- Per pair: iron, aluminium and gold process cards; coloured atom counters

Desk activity only; use paper counters. No chemicals, heating, molten materials or electrical supplies.

Course coverage: Chemistry only: 2.22C–2.23C; process evaluation supports 2.24C without requiring detailed industrial memorisation.

Plan, model or apparatus sketch

Draw the reactivity boundary: aluminium / carbon / iron.

Method and reasoning

Read the whole sequence before starting

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1. Place aluminium above carbon and iron below carbon on a reference reactivity map. Gold is near the unreactive end.

2. Read the three process cards. Identify whether the metal is combined in a compound or may occur uncombined.

3. Choose a route for each metal and justify the choice with relative reactivity. A route must recover metal, not merely melt an oxide.

4. Use counters to balance $Fe_2O_3 + CO \rightarrow Fe + CO_2$. Identify the substance losing oxygen and the reducing agent.

5. For aluminium oxide explain why carbon reduction is unsuitable and why electrolysis requires mobile ions. Use the supplied cathode statement to describe electron gain.

6. Evaluate energy use and carbon dioxide production qualitatively from the reference facts. Explain a benefit of recycling and one reason collection or alloy separation can complicate it.

7. Write a short recommendation for each card, including a limitation of this simplified model.

Cleanup

- Return cards and retain explanations. Recycle waste paper.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Process cards: iron oxide is reduced by carbon monoxide derived from coke; aluminium oxide is electrolysed dissolved in a molten electrolyte; sufficiently unreactive gold can occur uncombined. Aluminium cathode: $Al^{3+} + 3e^{-} \rightarrow Al$. Supplied facts are reference material, not class observations or cost measurements. Carbon-based reduction produces carbon dioxide; electrolysis consumes electrical energy. Environmental impact depends partly on how that energy is generated.

Case / condition	Evidence or prediction	Explanation / limitation
Iron oxide + CO: route		
Aluminium oxide: route		
Gold: occurrence / route		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Define an ore and explain why its economic usefulness can change.

2. Choose routes for iron and aluminium and justify the difference.

3. Balance $Fe_2O_3 + CO \rightarrow Fe + CO_2$ and identify reduction.

4. Explain why solid aluminium oxide is unsuitable as the electrolyte.

5. Explain how uncombined gold differs from gold in a compound.

6. Give one benefit and one constraint of recycling, without inventing numerical savings.