Aqueous electrolysis: competing ions

Student activity • observation and reasoning

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The question

Why can water change the predicted products?

Compare the named aqueous electrolytes using inert electrodes. Balance half-equations and distinguish aqueous sodium chloride from molten sodium chloride.

Equipment

- Booklet, pencil, periodic table and optional molecular model kit

Desk activity only; keep small model pieces away from mouths.

Course coverage: Chemistry only: 1.56C, 1.58C–1.59C. Written predictions for NaCl(aq), dilute H_2SO_4 and $CuSO_4$(aq).

Plan, model or apparatus sketch

Draw a labelled structure or model to explain your reasoning for this lesson.

Method and reasoning

Read the whole sequence before starting

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1. List ions from dissolved salt/acid and water, then label cathode/anode signs.

2. For aqueous $CuSO_4$ with inert electrodes, predict copper at the cathode and oxygen at the anode.

3. For dilute sulfuric acid, predict hydrogen and oxygen and write the acidic half-equations.

4. For concentrated aqueous NaCl, predict hydrogen and chlorine; explain why sodium metal is not deposited.

5. Balance $2H_2O+2e^- \rightarrow H_2+2OH^-$ for the aqueous salt cathode and $2Cl^- \rightarrow Cl_2+2e^-$ for the brine anode.

6. Explain why electrode material and chloride concentration must be stated; very dilute chloride may give oxygen or mixed anode products.

Cleanup

- Return shared equipment and retain corrected reasoning.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Use inert carbon electrodes for the comparison. $CuSO_4$: $Cu^{2+}+2e^- \rightarrow Cu$. Acidified water: $2H^+ + 2e^- \rightarrow H_2$ and $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$. Concentrated brine gives chlorine at the anode; do not transfer that prediction to every dilution. No gases are generated in this written lesson.

Electrolyte	Cathode / reduction	Anode / oxidation
$CuSO_4(aq)$		
Dilute $H_2SO_4(aq)$		
Concentrated NaCl(aq)		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Give $CuSO_4$ products with inert electrodes.

2. Give dilute H_2SO_4 products.

3. Why is sodium not deposited from aqueous NaCl?

4. Write the brine cathode equation.

5. Write the chlorine half-equation.

6. Why are inert electrodes specified?