Electrolysis and its products

Pearson Edexcel 1CH0 Separate Chemistry · Foundation and Higher

Show your working where needed. Check the worked answers when you finish.

Name _____ Date _____

1. The solid and the melt

Explain why molten magnesium chloride acts as an electrolyte but solid magnesium chloride does not.

2. Which electrode?

An electrolyte contains Na^+ and Cl^- ions. Give the name and charge of the electrode each type of ion moves towards.

3. A molten salt

Molten zinc bromide contains Zn^{2+} and Br^- ions. Predict the substance that forms at each electrode during electrolysis with inert electrodes.

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4. The effect of water

A sodium sulfate solution is electrolysed with inert electrodes. Name the gases at the cathode and anode. Explain why sodium is not formed.

5. Electrolysis of copper(II) sulfate

Copper(II) sulfate solution is electrolysed with graphite electrodes. Predict which electrode gets a coating and identify the coating. Explain how the blue colour of the solution changes.

6. Compare copper electrodes

Copper(II) sulfate solution is electrolysed using two copper electrodes. Assume only copper is transferred. Predict what happens to the mass of each electrode and to the intensity of the blue colour. Explain your predictions.

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7. Recover pure copper (Higher)

An electrolytic cell contains copper sulfate solution and two copper electrodes. The positive electrode is made from impure copper. Assume only copper is transferred. Write the half equations at each electrode. Explain why solid copper can be collected from the negative electrode.

8. Reactions at inert electrodes (Higher)

Copper(II) sulfate solution is electrolysed with inert electrodes. Predict the products and write a balanced half equation for each electrode. The ions discharged are Cu^{2+} and OH^{-}.

9. Extra challenge · Read the electrode results

Copper sulfate solution is electrolysed twice, once with inert carbon rods and once with copper electrodes. Run X gives a metal coating on one electrode, bubbles on the other and a paler solution. Run Y gives equal metal mass gains and losses with no lasting change in the blue colour. Identify each electrode type and explain the observations.

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Worked answers

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1. The solid and the melt

Ions are free to move and carry charge in the molten compound. In the solid the ions are in fixed positions in the lattice.

2. Which electrode?

Na^+ moves towards the negative cathode. Cl^- moves towards the positive anode. Opposite charges attract.

3. A molten salt

Zinc forms at the cathode from Zn^{2+} ions. Bromine forms at the anode from Br^- ions.

4. The effect of water

Hydrogen forms at the cathode because sodium is more reactive than hydrogen. Oxygen forms at the anode from hydroxide ions. The sulfate ions stay in solution.

5. Electrolysis of copper(II) sulfate

Copper metal coats the cathode. Copper(II) ions are removed from solution as they form the deposit, so the concentration of blue Cu^{2+} ions falls and the solution gets paler.

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Worked answers

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6. Compare copper electrodes

Copper deposits on the cathode, so its mass increases. Copper from the anode enters the solution as Cu^{2+}, so the anode loses mass. The Cu^{2+} entering the solution replaces the Cu^{2+} used at the cathode, so the colour stays about the same.

7. Recover pure copper (Higher)

At the positive electrode: $Cu \rightarrow Cu^{2+} + 2e^{-}$. Copper atoms become ions and enter the solution.

At the negative electrode: $Cu^{2+} + 2e^{-} \rightarrow Cu$. Copper ions gain electrons and deposit solid copper on the electrode.

8. Reactions at inert electrodes (Higher)

Cathode: copper, $Cu^{2+} + 2e^{-} \rightarrow Cu$.

Anode: oxygen, $4OH^{-} \rightarrow O_2 + 2H_2O + 4e^{-}$. Each side has four oxygen atoms, four hydrogen atoms and overall charge −4.

9. Extra challenge · Read the electrode results

X uses inert carbon electrodes. Cu^{2+} is removed from solution as copper plates on the negative electrode, making the liquid paler. The bubbles at the positive electrode are oxygen from the aqueous solution.

Y uses copper electrodes. Copper deposits on the negative electrode while copper from the positive electrode enters the solution as Cu^{2+}. The gains and losses show that removal and replacement are equal, so the blue Cu^{2+} concentration stays the same.

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