AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.3.5

Representation of reactions at electrodes as half equations (HT only)

Past-paper questions

Tier	**Higher**
Question groups	**7**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 01

June 2018 | 8464/C/1H | Original Q8

0 8 This question is about iron.

Iron reacts with dilute hydrochloric acid to produce iron chloride solution and one other product.

0 8 . 1 Name the other product.

[1 mark]

0 8 . 2 Suggest how any unreacted iron can be separated from the mixture.

[1 mark]

Magnesium reacts with iron chloride solution.

$$3\ Mg + 2\ FeCl_3 \rightarrow 2\ Fe + 3\ MgCl_2$$

0 8 . 3 0.120 g of magnesium reacts with excess iron chloride solution.

Relative atomic masses (A_r): Mg = 24 Fe = 56

Calculate the mass of iron produced, in mg

[5 marks]

Mass of iron = _____ mg

Question 8 continues on the next page

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 01 · continued

0 8 . 4 Explain which species is reduced in the reaction between magnesium and iron chloride.

$$3\ Mg + 2\ FeCl_3 \rightarrow 2\ Fe + 3\ MgCl_2$$

Your answer should include the half equation for the reduction.

[3 marks]

10

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 02

June 2019 | 8464/C/1H | Original Q5

0 5 This question is about electrolysis.

0 5 . 1 Some metals are extracted from molten compounds using electrolysis.

Why is electrolysis used to extract some metals?

[1 mark]

_____

_____

0 5 . 2 Aluminium is produced by electrolysis of a molten mixture.

What **two** substances does the molten mixture contain?

[2 marks]

1 _____

2 _____

0 5 . 3 Copper and chlorine are produced when molten copper chloride is electrolysed.

Complete the half equation for the reaction at each electrode.

[2 marks]

Half equation at negative electrode

Cu^{2+} _____ $\rightarrow$ _____

Half equation at positive electrode

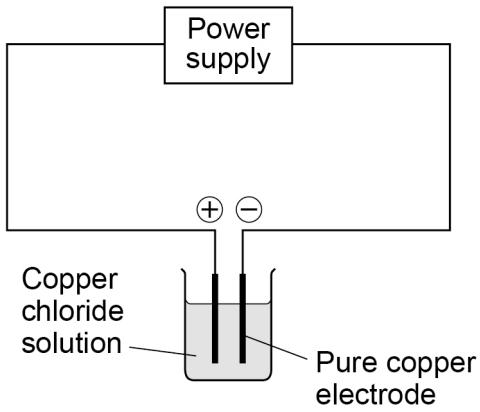
$2\ Cl^{-} \rightarrow$ _____

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 02 · continued

Figure 4 shows the apparatus a student used to electrolyse copper chloride solution.

Figure 4



The student:

- measured the mass of copper deposited on the negative electrode after 60 minutes
- compared the mass deposited with the expected value.

0 5 . 4 Suggest **two** reasons why the mass deposited was different from the expected value.

[2 marks]

1 _____

_____

2 _____

_____

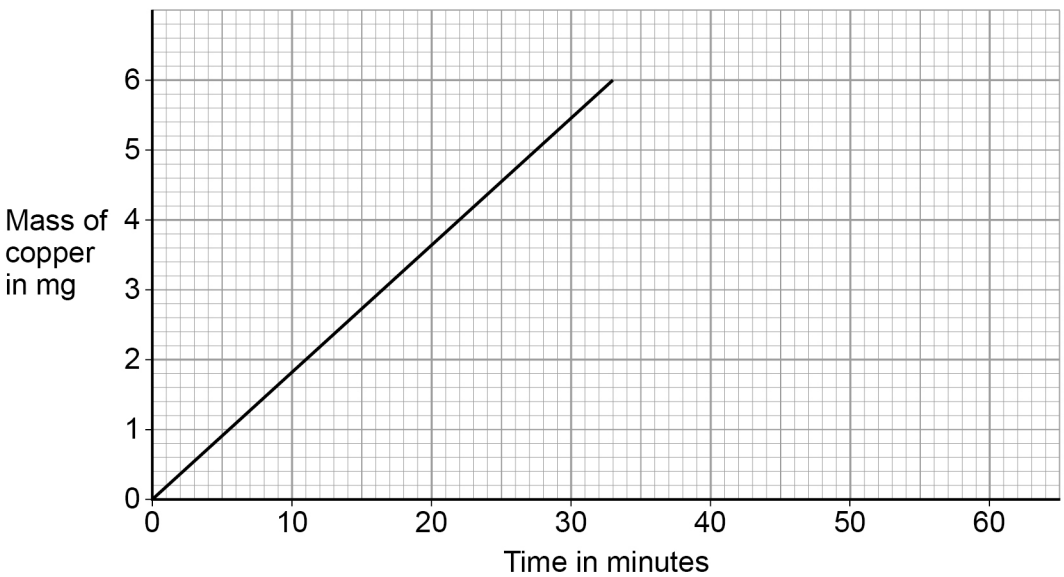
Question 5 continues on the next page

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 02 · continued

0 5 . 5 **Figure 5** shows the expected mass of copper produced each minute.

Figure 5



Determine the expected mass of copper after 24 hours.

Use **Figure 5**.

[3 marks]

Mass = _____ mg

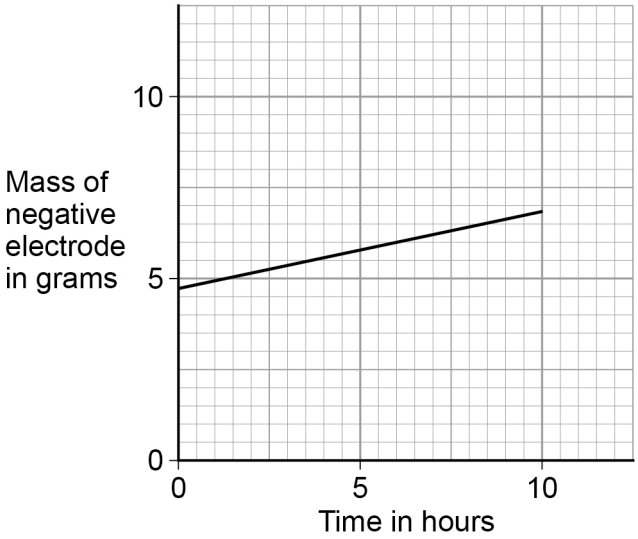
5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 02 · continued

Silver nitrate solution is electrolysed.

Figure 6 shows the change in mass of the negative electrode over 10 hours.

Figure 6



0 5 . 6 Determine the mass of the negative electrode at the start of the experiment.

Use **Figure 6**.

[1 mark]

0 5 . 7 Calculate the gradient of the line in **Figure 6**.

Give the unit.

[3 marks]

Gradient _____

Unit _____

14

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 03

November 2021 | 8464/C/1H | Original Q5

0 5 This question is about the electrolysis of aqueous solutions.

Hydrogen gas and chlorine gas are produced when sodium chloride solution is electrolysed.

0 5 . 1 Hydrogen ions (H^+) are attracted to the negative electrode.

The half equation for the reaction at the negative electrode is:

$$2\,H^+ \quad + \quad 2\,e^- \quad \rightarrow \quad H_2$$

What type of reaction happens at the negative electrode?

Give the reason for your answer.

[2 marks]

Type of reaction _____

Reason _____

_____

0 5 . 2 Chloride ions are attracted to the positive electrode.

Complete the half equation for the production of chlorine gas (Cl_2).

[2 marks]

$$___\ Cl^- \quad \rightarrow \quad _____ \ + \ _____$$

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 03 · continued

0 5 . 3 Hydrogen gas and oxygen gas are produced when sodium sulfate solution is electrolysed.

Explain how oxygen gas is produced in the electrolysis of sodium sulfate solution.

[4 marks]

8

Turn over for the next question

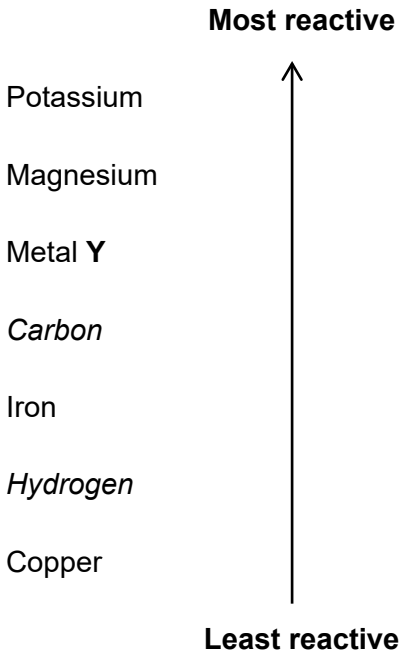
5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 04

0 7 This question is about elements and compounds.

0 7 . 1 **Figure 8** shows a reactivity series.

Figure 8



Give the method and conditions used to extract metal **Y** from a compound of metal **Y**.

[2 marks]

Question 7 continues on the next page

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 04 · continued June 2022 | 8464/C/1H | Original Q7

Sodium reacts with titanium chloride ($TiCl_4$) to produce titanium.

0 7 . 2 Complete the equation.

You should balance the equation.

[2 marks]

____ Na + $TiCl_4$ → _____ + _____

0 7 . 3 The reaction between sodium and titanium chloride is a redox reaction.

Write a half-equation to show that sodium is oxidised in this reaction.

[2 marks]

_____

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 04 · continued June 2022 | 8464/C/1H | Original Q7

0 7 . 4 108 g of aluminum reacts with 1.21 kg of copper chloride to produce copper.

The equation for the reaction is:

$$2\,Al + 3\,CuCl_2 \rightarrow 3\,Cu + 2\,AlCl_3$$

Calculate the maximum mass of copper produced in grams (g).

You should determine the limiting reactant.

Relative atomic masses (A_r): Al = 27 Cu = 63.5

Relative formula masses (M_r): $CuCl_2$ = 134.5 $AlCl_3$ = 133.5

[6 marks]

Limiting reactant is _____

Mass of copper = _____ g

Question 7 continues on the next page

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 04 · continued

Sodium metal and sodium chloride are both able to conduct electricity.

0 7 . 5 Describe how sodium metal conducts electricity.

[2 marks]

0 7 . 6 Explain how sodium chloride can conduct electricity.

[3 marks]

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5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 05

June 2023 | 8464/C/1H | Original Q5

0 5 During electrolysis ions are discharged at the electrodes to produce elements.

A student investigates the electrolysis of sodium chloride.

0 5 . 1 Why does solid sodium chloride **not** conduct electricity?

[1 mark]

_____

_____

0 5 . 2 Sodium chloride solution conducts electricity.

Complete the sentence.

[1 mark]

Sodium chloride **also** conducts electricity when _____ .

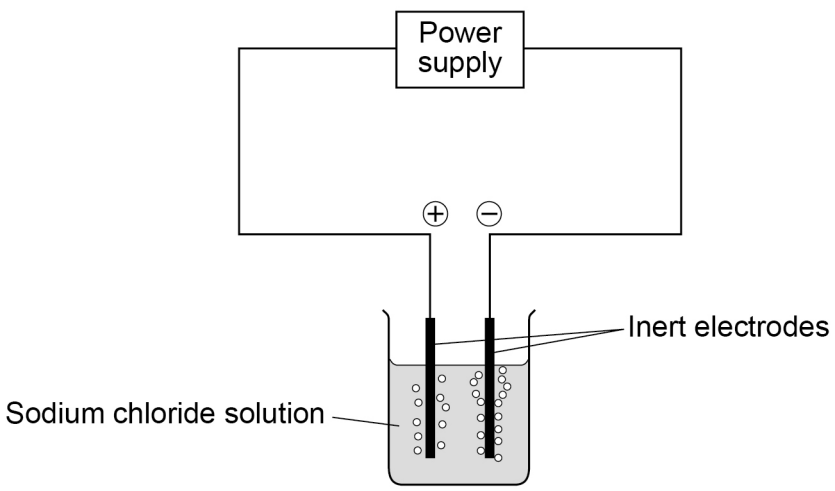
Question 5 continues on the next page

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 05 · continued

Figure 5 shows the apparatus for the electrolysis of sodium chloride solution.

Figure 5



0 5 . 3 Suggest an element that could be used to make the inert electrodes.

[1 mark]

0 5 . 4 Complete the half equation for the production of chlorine (Cl_2) at the positive electrode.

[2 marks]

____ Cl^- → _____ + _____

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 05 · continued

0 5 . 5 Sodium chloride solution has a pH of 7

During the electrolysis of sodium chloride solution:

- hydrogen gas is produced at the negative electrode
- the pH of the solution increases.

Explain why.

[4 marks]

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5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 06

June 2024 | 8464/C/1H | Original Q6

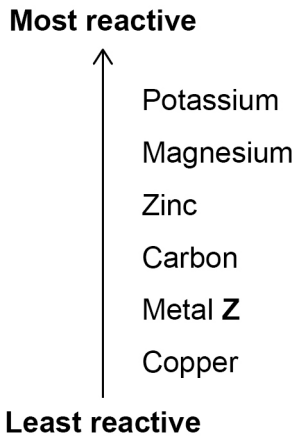
0 6 In the Earth most metals are found as compounds.

0 6 . 1 Name **one** metal that is found in the Earth as the metal itself.

[1 mark]

Figure 9 shows a reactivity series.

Figure 9



0 6 . 2 Suggest the most economical method for extracting metal **Z** from an oxide of metal **Z**.

[1 mark]

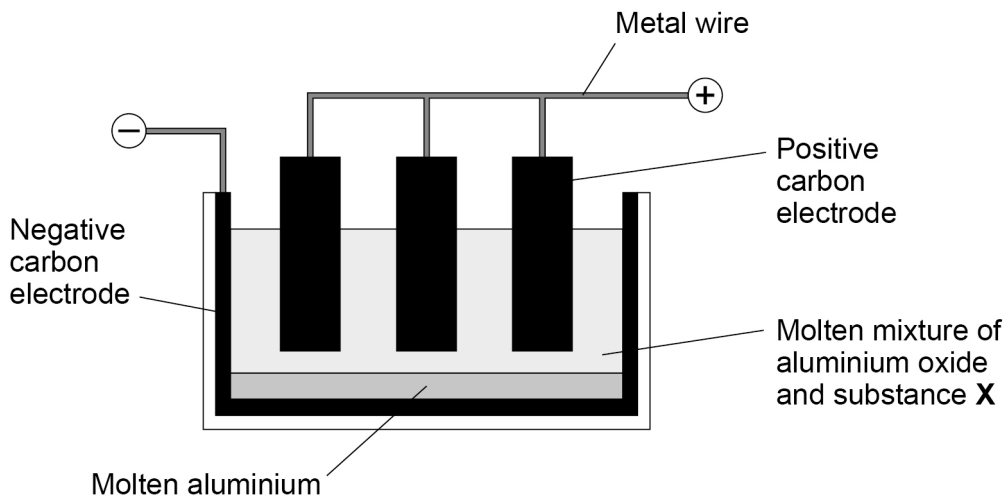
Question 6 continues on the next page

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 06 · continued

Figure 10 shows the electrolysis cell used to extract aluminium from aluminium oxide.

Figure 10



0 6 . 3 Name substance **X** shown in **Figure 10**.

[1 mark]

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 06 · continued

0 6 . 4 Explain what happens to the **positive** carbon electrodes during the extraction of aluminium from aluminium oxide.

[3 marks]

0 6 . 5 The formula of aluminium oxide is Al_2O_3

Write a half equation for the reaction at the **negative** electrode in **Figure 10**.

[2 marks]

_____ + _____ → _____

8

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 07

0 4 This question is about metals.

0 4 . 1 Iron is extracted from iron oxide by reduction with carbon.

Why can iron be extracted by reduction with carbon?

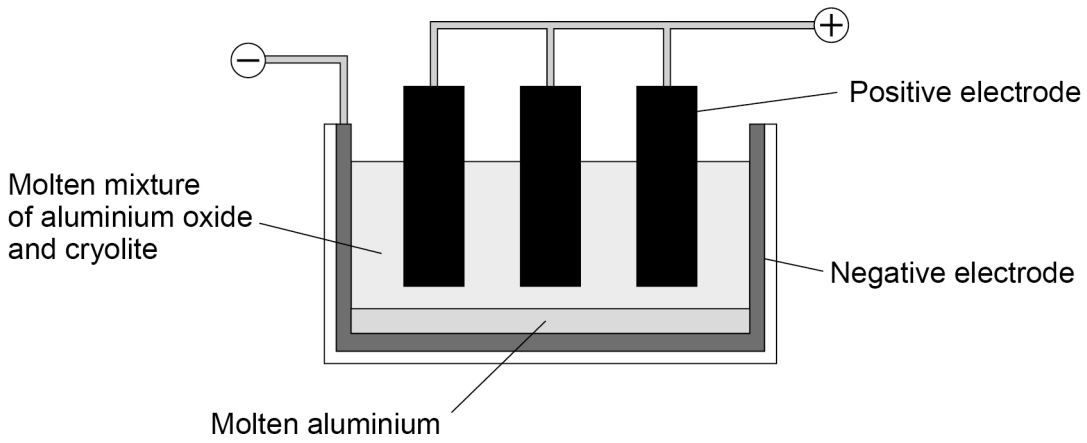
Answer in terms of reactivity.

[1 mark]

Aluminium is extracted by the electrolysis of aluminium oxide.

Figure 4 shows the apparatus used to extract aluminium.

Figure 4



5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 07 · continued

0 4 . 2 Explain why a mixture of aluminium oxide and cryolite is used as the electrolyte instead of only aluminium oxide.

[2 marks]

0 4 . 3 Oxygen gas is produced at the positive electrode.

Write a balanced half equation for the production of oxygen at the positive electrode.

[2 marks]

_____ → _____ + _____

Question 4 continues on the next page

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 07 · continued

Chromium is extracted by reacting chromium oxide with aluminium.

The equation for the reaction is:

$$Cr_2O_3 + 2\,Al \rightarrow Al_2O_3 + 2\,Cr$$

0 4 . 4 Which substance in the equation is reduced?

[1 mark]

Table 3 shows the relative cost of extracting equal masses of aluminium, chromium and iron.

Table 3

Metal	Relative cost of extraction
Aluminium	2
Chromium	20
Iron	1

0 4 . 5 Give **one** reason for the difference in the cost of extracting aluminium and **iron**.

Use **Table 3**.

[1 mark]

5.4.3.5 Representation of reactions at electrodes as half equations (HT only)

Question 07 · continued

0 4 . 6 Give **one** reason for the difference in the cost of extracting aluminium and **chromium**.

Use **Table 3**.

[1 mark]

0 4 . 7 Metals are mixed together to form alloys.

Explain why alloys are harder than pure metals.

[3 marks]

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