AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.3.4

Electrolysis of aqueous solutions

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**6**
Available paper years	**2018–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

5.4.3.4 Electrolysis of aqueous solutions

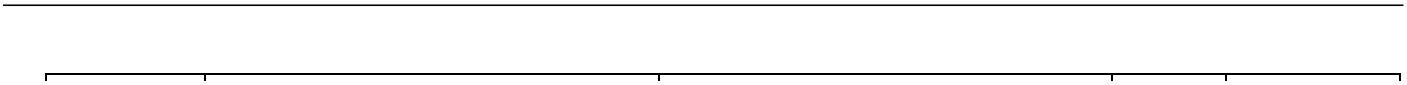
Answer 01 · Mark scheme June 2018 | 8464/C/1F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	chlorine		1	AO2 5.4.3.4
05.2	copper is less reactive than hydrogen		1	AO2 5.4.3.4
05.3	1.8 (mg)	allow an answer in range 1.7–1.9	1	AO3 5.4.3.4
05.4	$\frac{3.02 + 3.01 + x}{3} = 3.06$ 3.15 (mg)	an answer of 3.15 (mg) scores **2** marks allow any other suitable method if no other mark awarded allow 9.18 for **1** mark	1 1	AO2 5.4.3.4
05.5	$\frac{50}{1000}$ **or** $\frac{1}{20}$ **or** 0.05 (0.05) × 300 15 (g) **or** $\frac{300}{1000}$ **or** $\frac{3}{10}$ **or** 0.03 (1) (0.3) × 50 (1) 15 (g) (1)	an answer of 15 (g) scores **3** marks the second mark is dependent on the first mark being scored the second mark is dependent on the first mark being scored if no other mark awarded allow 150 **or** 15 000 for **1** mark	1 1 1	AO2 5.3.2.5
Total			**8**	

5.4.3.4 Electrolysis of aqueous solutions

Answer 01 · Mark scheme

June 2018 | 8464/C/1F | Original Q5



5.4.3.4 Electrolysis of aqueous solutions

Answer 02 · Mark scheme June 2019 | 8464/C/1F | Original Q2

02.1	hydrochloric acid		1	AO1 5.4.2.3
02.2	(black) solid remains (after stirring)	allow copper oxide remains allow no more copper oxide reacts	1	AO1 5.4.2.3
02.3	first stage **B** second stage **A** third stage **C** fourth stage **D**	all 4 correct for **2** marks allow **1** mark if either first stage or fourth stage is correct	2	AO1 5.4.2.3
02.4	(negative electrode) copper (positive electrode) chlorine	allow Cu allow Cl_2 / Cl do **not** accept chloride or Cl^- if no other mark awarded allow **1** mark if elements are reversed	1 1	AO2 5.4.3.2

5.4.3.4 Electrolysis of aqueous solutions

Answer 02 · Mark scheme

02.5	a reading of an increase in mass correct linked reading of the increase in time correct evaluation of gradient	e.g. 4 (mg) in 10 (mins) scores 2 marks e.g. ($\frac{4}{10}$ =) 0.4 (mg per min) allow correct calculation of gradient from incorrectly determined values for mass and/or time	1 1 1	AO2 5.4.3.4
02.6	cryolite oxide	this order only	1 1	AO1 5.4.3.3
Total			**11**	

5.4.3.4 Electrolysis of aqueous solutions

Answer 02 · Mark scheme

June 2019 | 8464/C/1F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec.

5.4.3.4 Electrolysis of aqueous solutions

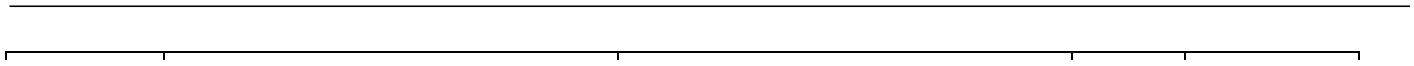
Answer 03 · Mark scheme November 2021 | 8464/C/1F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	molten		1	AO2 5.2.3.2 5.4.3.1 5.4.3.2
02.2	opposite (charges) attract **or** (the ions) are negative(ly charged)		1	AO1 5.4.3.1 5.4.3.4 RPA9
02.3	water		1	AO1 5.4.3.4
02.4	Cu^{2+}		1	AO2 5.4.3.1 5.4.3.4 RPA9
02.5	(positive electrode) bubbles / effervescence / fizzing (negative electrode) (pink / orange / red / brown) solid	 allow gas (is produced) allow copper (plating) allow metal for solid	 1 1	AO3 5.4.3.1 5.4.3.4 RPA9
02.6	$\frac{40.0}{500} \times 6.50$ = 0.52 (g)		1 1	AO2 5.1.2.6 5.3.2.5
Total			**8**	

5.4.3.4 Electrolysis of aqueous solutions

Answer 03 · Mark scheme

November 2021 | 8464/C/1F | Original Q2



5.4.3.4 Electrolysis of aqueous solutions

Answer 04 · Mark scheme

June 2022 | 8464/C/1F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	K_2SO_4		1	AO2 5.1.1.1 5.4.3.4 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(volume of hydrogen) 30 (cm^3) **and** (volume of oxygen) 15 (cm^3)		1	AO2 5.4.3.4 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	(because) the ratio of volume of hydrogen : oxygen is 2 : 1 (and this is the) **same** as the ratio of hydrogen (atoms) : oxygen (atoms) in (formula of) H_2O **OR** (because) the ratio of volume of hydrogen : oxygen is **not** 2 : 1 (1) (and this is) **different** to the ratio of hydrogen (atoms) : oxygen (atoms) in (formula of) H_2O (1)	**must** relate to the volumes given in question **06.2**	1 1	AO3 5.4.3.4 RPA9

Answer 04 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	9 ± 3 cm^3		1	AO2 5.3.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	(conversion) ($\frac{25}{1000}$ =) 0.025 (dm^3)		1	AO2 5.3.2.5 5.4.3.4
	(concentration =) $\frac{0.86}{0.025}$	allow correct use of incorrect / no conversion	1	
	= 34.4 (g per dm^3)	allow 34 (g per dm^3)	1	
	OR			
	(conversion) $\frac{1000}{25}$ (1)			
	= 40 (1)			
	(40 × 0.86) = 34.4 (g per dm^3) (1)	allow correct use of incorrect / no conversion allow 34 (g per dm^3)		
	OR			
	(concentration =) $\frac{0.86}{25}$ (1)			
	= 0.0344 (1)			
	(conversion) (0.0344 × 1000) = 34.4 (g per dm^3) (1)	allow 34 (g per dm^3)		

Total Question 6		8

5.4.3.4 Electrolysis of aqueous solutions

Answer 05 · Mark scheme

June 2023 | 8464/C/1F | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	electrons		1	AO1 5.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	(water →) hydrogen (ion) + hydroxide (ion)	allow for **1** mark hydrogen (ion) allow for **1** mark hydroxide (ion)	2	AO1 5.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	$CuBr_2$		1	AO2 5.1.1.1 5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	(copper ions) are positive(ly charged) (so are) attracted (to the negative electrode)		1 1	AO1 5.4.3.1 5.4.3.4 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	discharged		1	AO1 5.4.3.1 5.4.3.4 RPA9

5.4.3.4 Electrolysis of aqueous solutions

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	increases		1	AO2 5.4.3.1 5.4.3.4 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	bromine		1	AO2 5.4.3.1 5.4.3.4 RPA9

Total Question 4	**9**

5.4.3.4 Electrolysis of aqueous solutions

Answer 06 · Mark scheme

June 2025 | 8464/C/1F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	any **one** from: • do experiment in a fume cupboard • do experiment in a well-ventilated laboratory / room	ignore references to safety glasses or gloves allow use an extractor fan allow descriptions of well-ventilated such as open windows allow use a gas mask	1	AO3 5.4.3.4 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	all 6 points plotted correctly line of best fit	allow a tolerance of ± ½ a small square allow **1** mark for 4 or 5 points plotted correctly	2 1	AO2 5.4.3.4 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	any **one** from: • the increase in mass (for successive 60 second intervals) decreases • after 300 seconds the mass remains constant	allow evidence of two correctly determined changes in mass (for 60 second intervals) from **Table 1** allow the difference in mass (every 60 seconds) is not the same	1	AO3 5.4.3.1 5.4.3.4 RPA9

5.4.3.4 Electrolysis of aqueous solutions

Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(volume conversion 25 cm^3 =) 0.025 (dm^3)		1	AO2 5.3.2.5
	(concentration =) $\frac{5.5}{0.025}$	allow correct use of an incorrect / no conversion of volume	1	
	= 220 (g/dm^3)		1	
	OR			
	(concentration =) $\frac{5.5}{25}$ (1)			
	= 0.22 (g/cm^3) (1)			
	(conversion = 0.22 × 1000) = 220 (g/dm^3) (1)	allow correct use of an incorrectly determined concentration in g/cm^3 using the values in the question		
	OR			
	(ratio of volume $\frac{1000}{25}$ =) 40 (1)			
	(so ratio of mass =) 40 × 5.5 (1)			
	= 220 (g/dm^3) (1)			

5.4.3.4 Electrolysis of aqueous solutions

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	hydrogen is less reactive than potassium		1	AO2 5.4.3.4 RPA9

Total Question 6	**9**

5.4.3.4 Electrolysis of aqueous solutions

Answer 01 · Examiner comments

Question 5 (low & standard demand)

05.1 Halogens are produced at the positive electrode if an aqueous solution contains a halide ion. 27% of students correctly selected chlorine as the gas produced.

05.2 Students could have linked their understanding of the reactivity series, with which ion is discharged when an aqueous solution is electrolysed. In this case, the production of copper at the negative electrode informs students that copper is less reactive than hydrogen. 30% of students were able to correctly deduce this.

05.3 Students needed to look at the data and see that the mass produced at three minutes was missing from the table. Experimental errors account for the trend not being exactly directly proportional. 42% of students noticed the relationship and correctly deduced the mass within the allowed range of 1.7 to 1.9 (mg).

05.4 This question discriminated well. 28% of students achieved full marks for this question giving an answer of 3.15 (mg), however, some did so without showing their working. This was not an issue where they obtained the correct answer, but some did not and therefore gained no credit as it was not possible to see how they had obtained their answer. 15% of students did not attempt to answer this question.

05.5 A unit conversion is essential to make progress in this calculation. A conversion between cm^3 and dm^3 requires a division of either 50 by 1000 to convert cm^3 to dm^3 or 300 by 1000 to convert mass per dm^3 to mass per cm^3. 1% of students understood this concept to achieve the maximum three marks for this question. 28% of students did not attempt to answer this question.

5.4.3.4 Electrolysis of aqueous solutions

Answer 03 · Examiner comments November 2021 | 8464/C/1F | Original Q2

Question 2 (low demand)

02.1 Just over one third of students correctly chose ‘molten’ to complete the sentence.

02.2 Just over one third of students knew that negative ions are attracted to the positive electrode during electrolysis.

02.3 Copper chloride proved to be a more commonly seen response than the correct answer, water. This question was only correctly answered by just over one third of the students.

02.4 More than two thirds of students knew that Cu^{2+} ions produce a metal during electrolysis.

02.5 Investigating what happens when aqueous solutions are electrolysed using inert electrodes is one of the required practical activities. When carrying out these investigations students should observe what happens at the electrodes. The figure was provided to help students answer this question. More than three quarters of students gained one mark for stating that fizzing is observed at the positive electrode. Most students were unable to state the correct observation at the negative electrode.

02.6 Just under one third of students were able to determine the correct mass of copper chloride in 40 cm^3 of solution. Students should be encouraged to think about the magnitude of the numbers and whether their answer is reasonable.

Answer 04 · Examiner comments June 2022 | 8464/C/1F | Original Q6

Question 6 (Standard demand)

06.1 Students were given the formula of the potassium and sulfate ions and asked to deduce the formula of potassium sulfate. Just under 40% of students correctly determined the formula as K_2SO_4. The formula $K(SO_4)_2$ proved to be a good distractor.

5.4.3.4 Electrolysis of aqueous solutions

Answer 04 · Examiner comments June 2022 | 8464/C/1F | Original Q6

06.2 Just under 15% of students were able to correctly read the volumes of hydrogen and oxygen in the measuring cylinders. Most wrote the volumes of solution left in the measuring cylinder, rather than the gas, stating 20 cm^3 for hydrogen and 35 cm^3 for oxygen.

06.3 Students were given a hypothesis linking the ratio of the volumes of gases collected in an electrolysis experiment with the ratio of hydrogen to oxygen atoms in a water molecule. When students deduced that the volumes of hydrogen gas and oxygen gas collected were 30 cm^3 and 15 cm^3, they were able to simplify this ratio to 2:1 which they recognised as the ratio of hydrogen atoms to oxygen atoms in a water molecule and thus able to confirm the hypothesis. When the ratio of their volumes was not 2:1 many did not then go on to state that the hypothesis was incorrect.

06.4 Just over 30% of students identified that the measure of uncertainty in the 4 experiments was 9 ± 3 cm^3. The mean volume was 9 cm^3 and the range of reading was from 6 to 11 cm^3. The option of 9 ± 2 cm^3 proved a good distractor.

06.5 Just over 10% of students gained 2 of the 3 marks, usually following method 3 for dividing the mass of 0.86 g by the volume of 25 cm^3. Few students then went onto carry out the unit conversion of cm^3 into dm^3 which required multiplying their answer (in g/cm^3) by 1000.

5.4.3.4 Electrolysis of aqueous solutions

Answer 05 · Examiner comments

June 2023 | 8464/C/1F | Original Q4

Question 4 (low/standard demand)

04.1 More than two-third of students knew that electrons carry the electrical charge through a metal wire. Protons proved to be the most popular distractor.

04.2 Students were given a symbol equation for the breakdown of a water molecule into hydrogen ions and hydroxide ions and were asked to complete the word equation for the breakdown. Just under 20% of students gained two marks and 60% of students gained one mark, usually for recognising that H^+ is a hydrogen ion. More students thought that OH^- was an oxide rather than a hydroxide ion.

04.3 Just under 20% of students deduced that the formula of copper bromide is $CuBr_2$
The formula Cu_2Br proved to be a good distractor selected by the majority of students.

04.4 Students were asked to explain why the copper ions moved to the negative electrode. A quarter of students gained two marks for stating that the copper ions are positively charged so are attracted to the negative electrode and nearly another 20% of students gained one mark, usually for stating that opposites attract.

04.5 More than 50% of students knew that at the negative electrode copper metal is produced when the copper ions are discharged.

04.6 More than 40% of students knew that mass of the negative electrode increases during the electrolysis of copper bromide solution. Decreases and no change were distractors selected by approximately 30% and 25% of students respectively.

04.7 More than 40% of students knew that bromine is produced at the positive electrode during the electrolysis of copper bromide solution. Hydrogen proved to be a good distractor selected by a large number of students.

Answer 06 · Examiner comments

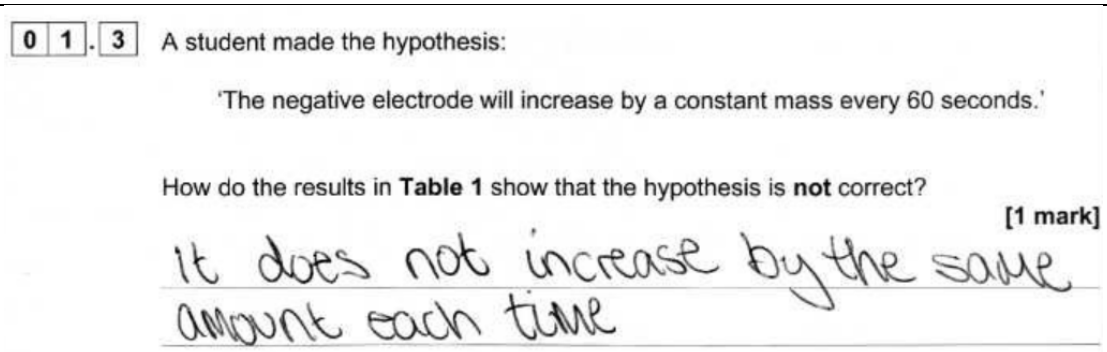
June 2025 | 8464/C/1F | Original Q6

Question 6 (Standard demand)

06.1 The most common response of reducing the risk of harm from chlorine gas was 'wear a mask' which was insufficient to gain credit, as was 'face mask', when what was required was the use of 'a gas mask'. Conducting the experiment 'in a fume cupboard' was a rarely seen correct response as was good ventilation which was well-remembered from the required practical.

06.2 Many students were able to plot the six points. Drawing a curve as a line of best fit remains problematic; lines failed to go through the points, lines between the points were drawn with a ruler or double lines are drawn, lines were stopped and restarted and many were drawn with a thick pen or blunt pencil that was more than half a small square thick. Numerous students drew a straight line, despite the points clearly indicating a curve and some drew both a straight line and a curve.

06.3 This question was poorly answered. Some students referred to the graph for their answer, when the question demanded that they use the results from Table 5. The results show that as time increased in 60 second intervals the mass of the negative electrode increased but at a decreasing rate until 300 seconds when the mass remained constant. Rather than stating 'increase/changes in mass' in their responses, many students referred to 'it'; this was ambiguous and did not gain credit. The most common correct answer was that the mass was constant after 300 seconds. Using two correctly determined changes in mass was creditworthy, but many students simply quoted numbers from the table which was insufficient.


0 1 . 3 A student made the hypothesis:

'The negative electrode will increase by a constant mass every 60 seconds.'

How do the results in **Table 1** show that the hypothesis is **not** correct?

[1 mark]

it does not increase by the same amount each time

An example of a response (from a Higher tier paper) where 'it' was been used; 'it' was ambiguous and not creditworthy.

06.4 The calculation proved difficult for many students with answers achieving all 3 marks rarely seen. A large number did not attempt this question. Many students were able to convert 25 cm^3 to 0.025 dm^3 for 1 mark but were unable to take the calculation further. Others attempted the unit conversion but either divided by 100 or multiplied by 100 or 1000. Numerous students laid out their working clearly, giving units throughout, although few used words e.g. 'concentration ='. Those who didn't quote an equation for concentration very frequently went on to get mass and volume the wrong way up or multiplied them.

06.5 More than half of students knew that when potassium chloride solution is electrolysed hydrogen gas is given off at the negative electrode because hydrogen is less reactive than potassium. The reverse statement hydrogen is more reactive than potassium was the most popular incorrect distractor.

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