AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.3.2

Electrolysis of molten ionic compounds

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**13**
Available paper years	**2010–2025**

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.

4.4.3.2 Electrolysis of molten ionic compounds

Answer 01 · Mark scheme

June 2010 | CHY2H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)(i)	(different) properties	allow ideas of different property / behaviour / element	1
2(a)(ii)	any **one** from: • they had high status **or** they were lecturers / doctors / professors / famous scientists • other scientists repeated experiments • they had proof **or** lots of / strong / conclusive / enough / clear evidence	they = Crawford + Cruikshank allow experiment could be repeated allow other scientists showed they had different properties ignore evidence unqualified	1
2(a)(iii)	other scientists obtained similar results / proved it **or** experiments were repeated		1

Question 2 continues on the next page

4.4.3.2 Electrolysis of molten ionic compounds

CHY 2H

Question 2 continued

question	answers	extra information	mark
2(b)(i)	any **one** from: • mass of solid / strontium (chloride) / barium (chloride) • volume of water • type of container	allow amount / volume allow amount / mass allow initial / starting temperature (of water) ignore room temperature / time / concentration ignore reference to hydrochloric acid	1
2(b)(ii)	2 **and** takes in heat / energy **or** 2 **and** temperature goes down (owtte)		1
2(b)(iii)	temperature increased for one experiment and decreased for the other (owtte) **or** one was exothermic and one was endothermic (owtte)	accept experiment 1 was exothermic	1
2(c)	any **one** from • positive / + (charge) • opposite (charges) attract	do **not** accept incorrect further qualification eg electrons / atoms / electrodes	1
Total			**7**

4.4.3.2 Electrolysis of molten ionic compounds

Answer 01 · Mark scheme June 2010 | CHY2H | Original Q2 | Legacy

CHY 2H

Answer 02 · Mark scheme November 2010 | CHY1AP | Original Q1 | Legacy

Question	Key		
One	**A**	uses another metal	**3**
	B	does **not** use a chemical reaction	**2**
	C	could be done in a blast furnace	**4**
	D	is called electrolysis	**1**

4.4.3.2 Electrolysis of molten ionic compounds

Answer 03 · Mark scheme January 2011 | CHY1H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)(i)	very little / low percentage of metal (in the ore)	accept only 0.5% metal in the ore **or** over 99% waste in the ore **or** nearly 100% waste in the ore ignore reference to percentage of metal in the Earth's crust **or** energy used or pollution	1
1(a)(ii)	any **one** from • iron uses less energy / fuel for extraction • iron has more uses • more demand for iron • iron is stronger • cheaper / costs less • easier to extract	(it = iron) ignore electrolysis / uses electricity / reactivity ignore high abundance in the Earth's crust / high percentage of metal in ore ignore harder	1
1(b)(i)	has melting point lower than 950°C	(it = aluminium) allow has a low melting point ignore boiling point	1
1(b)(ii)	electrode(s) made of carbon oxygen reacts with electrode(s) / carbon	 accept C + O_2 (→ CO_2) NB oxygen reacts with the carbon electrode(s) = **2** marks	1 1

Question 1 continues on the next page

4.4.3.2 Electrolysis of molten ionic compounds

CHY1H

Question 1 contd

question	answers	extra information	mark
1(b)(iii)	any **two** from: • saves resources / non renewable • landfill problem • saves energy / fuel / electricity • less carbon dioxide / carbon emissions or reduces carbon footprint • less quarrying / mining	accept aluminium / ore will run out or conserves aluminium accept aluminium does not corrode ignore global warming ignore consequences of quarrying / mining ignore pollution / harms environment / costs / easy to recycle	2
Total			**7**

4.4.3.2 Electrolysis of molten ionic compounds

Answer 03 · Mark scheme January 2011 | CHY1H | Original Q1 | Legacy

CHY1H

Answer 04 · Mark scheme June 2011 | CHY1AP | Original Q9 | Legacy

Nine	**1**	**2**	**2**	**3**

The AQA UMS Conversion Calculator can be found at the following web address:

http://www.aqa.org.uk/umsconversion

4.4.3.2 Electrolysis of molten ionic compounds

Answer 05 · Mark scheme

June 2013 | CH2HP | Original Q4 | Legacy

Question 4

question	Answers	extra information	Mark
4(a)(i)	current / charge couldn't flow	allow could not conduct (electricity)	1
	because the ions / particles couldn't move **or** (salt) needs to be molten / dissolved (to conduct electricity) (1)	do **not** accept electrons/ molecules / atoms	1
	so that the ions / particles can move (1)	do **not** accept electrons / molecules / atoms	
4(a)(ii)	he had status **or** he had evidence / proof	accept he had authority **or** experience accept the experiment could be repeated	1
4(b)	hydrogen / H_2	do **not** allow hydrogen ions	1
	the ions are positive	accept because opposite (charges) attract	1
	potassium is more reactive (than hydrogen)	accept potassium ions are less easily discharged (than hydrogen) **or** potassium ions are less easily reduced (than hydrogen)	1
4(c)(i)	gain electron(s)	accept fully balanced correct equation for **2** marks	1
	one electron if no other marks awarded allow (potassium ions) reduced for **1** mark		1
4(c)(ii)	$\mathbf{2}Cl^- \rightarrow Cl_2 + \mathbf{2e^-}$	must be completely correct, including charge on electron accept correct multiples	1
4(c)(iii)	2, 8, 8	accept any combination of dots, crosses, "e" or any other relevant symbol ignore any charges if given	1
Total			**10**

4.4.3.2 Electrolysis of molten ionic compounds

Answer 06 · Mark scheme June 2014 | CH2HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
4(a)(i)	so ions can move (and carry charge)	accept so current can flow *allow so it can conduct (electricity)* *allow so charged particles can move* *do **not** accept so electrons can move*	1	1 / 2.7.1a/b	E
4(a)(ii)	because zinc ions gain electrons 2 (electrons) zinc is formed	accept because zinc ions are reduced *accept correct half equation for **3** marks* *if no mark gained allow* *positive ions go to negative electrode **or*** *opposites attract **or*** *reduction (of zinc) **or*** *(zinc) gains electrons for **1** mark*	1 1 1	1 + 2 / 2.7.1b/c/e	E
4(a)(iii)	**2** Cl^- ⟶ Cl_2 + **2** e^-	must be completely correct	1	1 / 2.7.1g	E
4(b)(i)	because the magnesium is *a gas*	*allow magnesium goes from solid to gas*	1	2 / 2.6.1a	E
4(b)(ii)	(a reaction which) takes in energy (from the surroundings)	*accept more energy needed to break bonds than released by forming bonds* *accept correct reference to energy level diagram* *allow (a reaction which) takes in heat (from the surroundings)*	1	1 / 2.5.1a/b	E

4.4.3.2 Electrolysis of molten ionic compounds

Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
4(b)(iii)	*(*M_r MgO =) 40	*accept (2* M_r MgO =) 80	1	2 / 2.3.3c	E
	1.2/24 (x40) **or** 0.05 (x40) **or** 40/24 (x1.2) **or** 1.67 (x1.2)	allow ecf from step 1	1		
	2(.0)	allow ecf carried through from step 1 correct answer with or without working gains **3** marks	1		
4(b)(iv)	75(%)		1	2 / 2.3.3e	E
4(b)(v)	any **one** from: • the reaction is reversible • *some lost /escaped/ released (when* separated) • some of the reactant may react in different ways from the expected reaction • *impure reactant(s)*	*accept incomplete reaction* *ignore equilibrium not reached* *ignore measurement and calculation errors*	1	1 / 2.3.3d/f	E
Total			**12**		

4.4.3.2 Electrolysis of molten ionic compounds

Answer 06 · Mark scheme

June 2014 | CH2HP | Original Q4 | Legacy



4.4.3.2 Electrolysis of molten ionic compounds

Answer 07 · Mark scheme June 2015 | CH2HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)		first 3 marks can be obtained from a suitably labelled diagram incorrect structure or bonding or particle = max 3		AO1 2.1.h,i 2.2.4a
	giant structure / lattice / layers / close packed		1	
	made up of atoms / positive ions		1	
	with delocalized / free electrons		1	
	so electrons can move / flow through the metal	accept so electrons can carry charge through the metal accept so electrons can form a current	1	
3(b)		accept converse for pure metal throughout both marks can be obtained from suitable diagrams		AO1 2,2,4c
	an alloy (is a metal which) has different types / sizes of atoms	allow made of different metals allow mixture of metals / atoms / elements ignore particles ignore properties do **not** accept compound	1	
	alloy has distorted layers	allow layers are unable to slide	1	
3(c)(i)	can return to its original shape	accept shape memory alloy accept smart alloy ignore other properties	1	AO1 2.2.4d

Question 3 continues on the next page

4.4.3.2 Electrolysis of molten ionic compounds

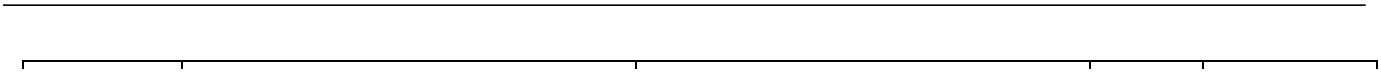
Question 3 continued

3(c)(ii)	(pure copper is too) soft	accept converse accept malleable or bends accept copper is running out ignore references to strength and weakness	1	**AO2** 2.2.4c 2.7.1d
3(c)(iii)	aluminium oxide	accept alumina accept Al_2O_3 ignore bauxite / aluminium ore	1	**AO1** 2.7.1h
3(c)(iv)	any **one** from: • different conditions • different catalyst • different pressure • different temperature	allow different concentration do **not** accept different monomers	1	**AO1** 2.2.5a
3(d)	any **two** from: • accurate • sensitive • rapid • small sample	both needed for 1 mark	1	**AO1** 2.3.2a
Total			**11**	

4.4.3.2 Electrolysis of molten ionic compounds

Answer 07 · Mark scheme

June 2015 | CH2HP | Original Q3 | Legacy



4.4.3.2 Electrolysis of molten ionic compounds

Answer 08 · Mark scheme June 2016 | CH2HP | Original Q5 | Legacy

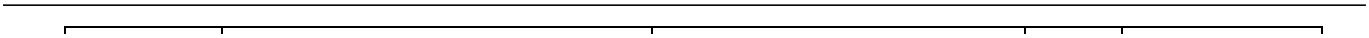
Question	Answers	Extra information	Mark	AO / SpecRe
5(a)		reference to incorrect particles **or** incorrect bonding **or** incorrect structure = **max 3**		AO1/AO2 2.1.1a,b,c,e,f
	magnesium loses two electrons **and** chlorine gains one electron	accept magnesium loses electrons **and** chlorine gains electrons for 1 mark ignore oxidation and reduction	2	
	one magnesium and two chlorines	accept $MgCl_2$	1	
	noble gas structure **or** eight electrons in the outer shell **or** (electrostatic) attraction between ions **or** forms ionic bonds	accept full outer shell (of electrons) do **not** accept covalent bonds	1	
5(b)(i)		accept converse for solid		AO1 2.2.2b,2.7.1a
	because ions can move	ignore ions attracted do **not** accept molecules/ atoms moving do **not** accept incorrect reference to electrons moving	1	
	(and ions move) to the electrodes **or** (and ions) carry charge		1	

5(b)(ii)	magnesium (ions) attracted (to the electrode) so magnesium ions gain electrons 2 electrons	 accept magnesium ions are reduced ignore oxidised accept a correct half equation for 2nd **and** 3rd marking points	1 1 1	2AO1 / 1AO2 2.7.1b,c,d,e
5(b)(iii)	hydrogen	allow H_2	1	AO2 2.7.1f
5(b)(iv)	magnesium is more reactive than hydrogen	accept converse allow magnesium is high in the reactivity series **or** magnesium is very/too reactive. do **not** accept magnesium ions are more reactive than hydrogen ions	1	AO2 2.7.1f
5(b)(v)	**2** Cl^- → Cl_2 + **2e**$^-$	must be completely correct	1	AO1 2.7.1g
5(c)	 layers (of particles/atoms/ions) (particles/atoms/ions/layers) can slide	any mention of intermolecular/ weak bonds/forces = **max 1**	 1 1	AO2 2.2.4b
Total			**14**	

4.4.3.2 Electrolysis of molten ionic compounds

Answer 08 · Mark scheme

June 2016 | CH2HP | Original Q5 | Legacy



4.4.3.2 Electrolysis of molten ionic compounds

Answer 09 · Mark scheme

June 2019 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	mixture has a lower melting point (than aluminium oxide) (so) less energy needed	allow cryolite lowers melting point (of aluminium oxide) ignore boiling point do **not** accept cryolite is a catalyst ignore cost	1 1	AO1 4.4.3.3
07.2	aluminium ions gain electrons		1	AO1 4.4.1.4 4.4.3.3
07.3	$2O^{2-} \rightarrow O_2 + 4e^-$	allow multiples allow **1** mark for an unbalanced equation containing correct species	2	AO2 4.1.1.1 4.4.3.1 4.4.3.3
07.4	the electrode reacts with oxygen the electrode is carbon / graphite (so) carbon dioxide is produced	 allow (so) the electrode / carbon / graphite is used up allow (so) the electrode / carbon / graphite is burned away ignore (so) the electrode / carbon / graphite is worn away ignore (so) the electrode / carbon / graphite is corroded	1 1 1	AO1 4.4.3.3

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5		an answer of 941 (kg) scores **4** marks		AO2 4.3.2.2
	(M_r of Al_2O_3 =) 102		1	
	$\left(\frac{2\,000\,000}{102} =\right)$ 19 608 (mol Al_2O_3)	allow correct calculation using incorrectly calculated value of M_r of Al_2O_3	1	
	$\left(19\,608 \times \frac{3}{2} =\right)$ 29 412 (mol O_2)	allow correct calculation using incorrectly calculated value of moles of Al_2O_3	1	
	$\left(\frac{29\,412 \times 32}{1000} =\right)$ 941 (kg)	allow 941.1764706 (kg) correctly rounded to at least 2 significant figures allow correct answer using incorrectly calculated value of moles of O_2	1	
	alternative approach: (2 M_r of Al_2O_3 =) 204 (1) 204 (kg of Al_2O_3) gives 96 (kg of O_2) (1) (2000 kg of Al_2O_3 gives) $\frac{2000}{204}$ × 96 (kg of O_2) **or** $\frac{2000000}{204}$ × 96 (g of O_2) (1) = 941 (kg) (1)			

4.4.3.2 Electrolysis of molten ionic compounds

Answer 09 · Mark scheme June 2019 | 8462/1H | Original Q7

07.6	hydrogen (gas) would be produced (instead of sodium) (because) sodium is more reactive than hydrogen		1 1	AO3 4.4.1.2 4.4.3.3 4.4.3.4
07.7	$\left(\frac{150\,000}{71} =\right)$ 2113 (mol of Cl_2) **or** (volume of 1 g of $Cl_2 = \frac{24}{71} =$) 0.34 (dm^3) ($\frac{150\,000}{71}$ x 24) = 50700 (dm^3)	an answer of 50700 (dm^3) scores **2** marks an answer of 50.7 (dm^3) scores **1** mark allow 50704.22535 (dm^3) correctly rounded to at least 2 significant figures allow correct calculation using their calculated number of moles and/or calculated volume of 1 g	1 1	AO2 4.3.5
Total			**16**	

4.4.3.2 Electrolysis of molten ionic compounds

Answer 10 · Mark scheme

November 2021 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1		allow voltage for electricity allow potential difference for electricity allow (electrical) current for electricity		AO1 4.4.3.1 4.5.2.1
	electrolysis uses electricity to produce a chemical reaction	allow electrolysis uses electricity to decompose a compound / electrolyte	1	
	(but) cells use a chemical reaction to produce electricity		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$2\,Br^- \rightarrow Br_2 + 2\,e^-$	allow multiples allow **1** mark for Br_2 **and** e^-	2	AO2 4.1.1.1 4.4.3.1 4.4.3.2 4.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3				AO2 4.4.1.2 4.4.3.4 RPA3

Salt solution	Product at positive electrode	Product at negative electrode	Mark
(copper nitrate)	oxygen (1)	(copper)	1
(potassium iodide)	iodine (1)	hydrogen (1)	2

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	filter the mixture wash and dry the copper / residue weigh the copper collected add to the increase in mass of the electrode		1 1 1 1	AO3 4.1.1.2 4.4.3.4 RPA3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	(for given current) straight line through the origin	allow (for given current) when time doubles, mass doubles	1	AO3 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(for given time) when current doubles, mass doubles with supporting data		1	AO3 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.7	copper ions are discharged (from the solution)	allow the solution becomes less concentrated allow copper ions are removed (from the solution) allow copper ions are used up (from the solution)	1	AO3 4.4.3.1

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.8	(number of moles = $\frac{0.24}{63.5}$ =) 3.78×10^{-3} **or** 0.00378		1	AO2 4.3.2.1
	(number of atoms =) $0.00378 \times 6.02 \times 10^{23}$	allow correct use of an incorrectly calculated number of moles	1	
	$= 2.28 \times 10^{21}$	allow a correct evaluation to 3 significant figures of an incorrect expression which involves only a mass from the graph, the A_r of copper and the Avogadro constant	1	

Total			**17**

4.4.3.2 Electrolysis of molten ionic compounds

Answer 11 · Mark scheme

June 2022 | 8462/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$Na^+ + e^- \rightarrow Na$		1	AO2 4.4.3.2 4.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	so the products do not react (to reform sodium chloride)		1	AO3 4.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	ion		1	AO3 4.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	hydrogen / H^+ (ions) hydroxide / OH^- (ions)		1 1	AO1 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	sodium hydroxide	allow NaOH	1	AO2 4.4.3.4

4.4.3.2 Electrolysis of molten ionic compounds

Answer 11 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	sodium ions and hydroxide ions are left (in solution)		1	AO2 4.4.3.4
	(because) hydrogen ions are discharged / reduced (at the negative electrode to form hydrogen)	allow (because) hydrogen ions gain electrons (at the negative electrode to form hydrogen) allow (because at the negative electrode) $2\ H^+ + 2\ e^- \rightarrow H_2$	1	
	(and because) chloride ions are discharged / oxidised (at the positive electrode to form chlorine)	allow (and because) chloride ions lose electrons (at the positive electrode to form chlorine) allow (and because at the positive electrode) $2\ Cl^- \rightarrow Cl_2 + 2\ e^-$	1	

Total Question 6		**9**

4.4.3.2 Electrolysis of molten ionic compounds

Answer 12 · Mark scheme

June 2023 | 8462/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	$Al^{3+} + 3e^- \rightarrow Al$	allow multiples	1	AO2 4.1.1.1 4.4.3.3 4.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	sodium is more reactive than aluminium		1	AO3 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3		allow hydroxide ions for OH^- throughout		AO1 4.4.3.4
	water (molecules) break down		1	
	(to) produce (H^+ and) OH^- (ions)		1	
	(OH^- (ions) are attracted / move to the positive electrode		1	
	(OH^- (ions) are discharged / oxidised to give oxygen (molecules)	allow (OH^- (ions) lose electrons to give oxygen (molecules)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4		allow (inverted) burettes for measuring cylinders allow gas syringes for measuring cylinders		AO3 4.4.3.4
	(change) use measuring cylinders (instead of test tubes)		1	
	(reason) because there is a scale (on the measuring cylinders)	allow measuring cylinder(s) measure volume	1	

4.4.3.2 Electrolysis of molten ionic compounds

Answer 12 · Mark scheme

June 2023 | 8462/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	10 cm^3		1	AO2 4.3.5

Total Question 7	**9**

4.4.3.2 Electrolysis of molten ionic compounds

Answer 13 · Mark scheme

June 2025 | 8462/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	strong electrostatic forces	allow strong forces of attraction ignore strong ionic bonds	1	AO1 4.2.1.3 4.2.2.3
	between oppositely charged ions	allow between (positive) aluminium ions and (negative) oxide ions allow between Al^{3+} (ions) and O^{2-} (ions)	1	
	(which) act in all directions (in the giant structure)		1	
	(so) need a lot of energy to break (the many strong bonds)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	cryolite	allow Na_3AlF_6	1	AO1 4.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	the mixture has a lower melting point than aluminium oxide	allow to lower the melting point (of the mixture) allow to lower the energy demand (of the process)	1	AO1 4.4.3.3

4.4.3.2 Electrolysis of molten ionic compounds

Answer 13 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	$2\,O^{2-} \rightarrow O_2 + 4\,e^-$	allow multiples allow **1** mark for $O^{2-} \rightarrow O_2 + e^-$ with no / incorrect balancing numbers	2	AO2 4.1.1.1 4.4.3.2 4.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	the (positive) electrode is made of carbon / graphite		1	AO1 4.4.3.3
	(so) the carbon / graphite reacts with oxygen (produced in the electrolysis)		1	
	(which) produces carbon dioxide		1	

Total Question 6	**11**

4.4.3.2 Electrolysis of molten ionic compounds

Answer 09 · Examiner comments

June 2019 | 8462/1H | Original Q7

Question 7 (standard, standard / high and high demand)

07.1 The explanation for the use of cryolite in the extraction of aluminium does not appear to be well known. Almost two-thirds of students scored 0 marks.

A common misconception was that cryolite acts as a catalyst.

Common responses seen that were not credited included:

- to melt the aluminium oxide so that it conducts electricity
- so that the ions can move freely
- to reduce costs.

07.2 Almost 60% of students correctly identified that aluminium ions gain electrons as the process occurring at the negative electrode.

07.3 Students found the completion of the half-equation difficult. Almost 70% scored 0 marks.

Common errors included:

- including Al / Al_2O_3
- representing the oxide ion as O^- or O_2^-
- 2 electrons rather than 4 electrons being produced.

07.4 However, only approximately a quarter of students were able to state why the positive electrode needs to be replaced and hence score all 3 marks.

4.4.3.2 Electrolysis of molten ionic compounds

Answer 09 · Examiner comments

June 2019 | 8462/1H | Original Q7

07.5 Most students scored at least 1 mark. Approximately 40% scored all 4 marks.

The most frequently scored mark was for M_r (Al_2O_3) = 102 (or '204' from the alternative approach in the mark scheme).

A common error was M_r (Al_2O_3) = 156 but students were still able to score marks for using this incorrect value in subsequent steps.

A valid variation on the reacting mass method was to calculate the percentage by mass of oxygen in Al_2O_3 and then use this to calculate the mass of oxygen in 2000 kg of Al_2O_3

It was not always clear which approach was being used. A common incorrect final answer was 1412 (kg) where students had applied the 2 : 3 mole ratio (from the main approach) as well as the 96 / 204 mass ratio (from the alternative approach).

07.6 Students found this question difficult. Almost two-thirds of students scored 0 marks.

Even when students realised that reactivity was the key idea, they sometimes compared the reactivity of the wrong species, for example, sodium and chlorine or Na^+ ions and H^+ ions

A common misconception was that sodium chloride solution does not conduct electricity.

07.7 Approximately two-thirds of students scored at least 1 mark for this calculation.

However, the most common final answer was 50.7 dm^3. The error here was the omission of the unit conversion, kg to g.

4.4.3.2 Electrolysis of molten ionic compounds

Answer 10 · Examiner comments November 2021 | 8462/1H | Original Q7

Question 7 (standard, standard / high and high demand)

07.1 Very few students picked up on the link between chemical reactions and electricity given in the question. The idea that electrolysis uses electricity to produce a chemical reaction was poorly understood. Many students believe electrolysis is a method of 'separating' compounds, rather than decomposing a compound. Very few realised that a chemical cell uses a reaction to produce electricity, with many making statements about a cell using electricity.

07.2 Many students were unable to write the formula of bromine. Those who could, often scored at least one mark, although the half-equation was not always balanced.

07.3 Students found difficulty in naming all 3 products. Many students did score the mark for iodine, though iodide was a common response. Very few could work out that in the absence of a halide ion, oxygen must be produced at the positive electrode, with many suggesting nitrogen as the product.

4.4.3.2 Electrolysis of molten ionic compounds

Answer 10 · Examiner comments November 2021 | 8462/1H | Original Q7

07.4 Of the students who recognised that the copper needed to be filtered from the solution, very few then washed and dried the copper, despite that step having been provided in the method for dealing with the electrode itself. Some said the filtered copper would be measured, rather than specifically that the mass would be measured. Some then said incorrectly that the mass would be added to the mass of the electrode, rather than the mass gain of the electrode. Many wasted time describing steps that had already been done, particularly weighing the electrode before and after the experiment.

07.5 The concept of proportionality is poorly understood. Even those who referred to the lines being straight rarely referred to their passing through the origin. Most simply described how the results showed a positive correlation, or a linear relationship.

07.6 The idea of one variable doubling (or trebling) as did the other variable was known by very few students.

07.7 Very few recognised that the blue colour was due to copper ions, which were being removed from the solution. Copper does not dissolve, and is not blue, so the phrase ‘copper is removed from the solution’ has no merit. Many think that the ions are being separated, rather than discharged.

07.8 Many students could make no progress as they had not calculated the number of moles of copper. Some tried to include the current, the time or both in their calculation, instead of using those values to establish the mass of copper formed from the graph.

Answer 11 · Examiner comments June 2022 | 8462/1H | Original Q6

Question 6 (Standard, standard/high and high demand)

06.1 Two thirds of students selected the correct half equation. A significant number chose a distractor in which Na was present at the start rather than formed in the reaction.

06.2 Most students realised the need to prevent the products from reacting together and reforming sodium chloride. However, a significant minority failed to appreciate that the reverse reaction would occur and instead focused on preventing the products from mixing or ensuring product purity.

Answer 11 · Examiner comments June 2022 | 8462/1H | Original Q6

06.3 Only 60% of students recognised that ions must pass through the mesh. Nearly all other responses were 'electrons'. Many students seem to think that an electric current can only be conducted by electrons moving, even through a solution in which there are no free electrons.

06.4 Most students recognised that hydrogen ions would be present in aqueous sodium chloride. However, only just over a half of students also recognised that hydroxide ions were present. Some stated that the fourth ion would be oxygen, showing a lack of understanding of the ionisation of water.

06.5 A majority of students recognised that the alkaline solution must be sodium hydroxide solution.

06.6 This was a high demand question which students found very challenging. The most common mark scored was for the sodium ions and hydroxide ions remaining in solution after the electrode processes. However, many students did not refer to ions. Others thought that hydroxide ions or sodium ions would be made, rather than being in the solution throughout the process. Whilst students often correctly stated the product at each electrode, few described the actual processes occurring at the electrodes as required by the question. Some otherwise creditworthy responses were let down by referring to chlorine ions instead of chloride ions, or by confusing the polarities of anode and cathode, or by confusing oxidation and reduction.

Answer 12 · Examiner comments June 2023 | 8462/1H | Original Q7

Question 7 (standard, standard/high and high demand)

07.1 Nearly all students could balance the ionic equation correctly.

07.2 About a fifth of students answered this high demand question correctly. Some students compared the reactivity of sodium with hydrogen instead of with aluminium. Imprecise language was sometimes a problem; it is elemental sodium which is more reactive, not sodium ions. Aluminium is released at the electrode, not discharged (it is the ion which is discharged, ie loses its charge). There is no displacement occurring.

07.3 The question discriminated well, but very few fully correct answers were seen, with just over a third of students scoring at least one mark. Students were asked to explain how oxygen is produced from water, not why oxygen is produced. Few students described the initial step outlined in the specification; that water molecules break down to form H^+ ions and OH^- ions. Many seem to think that oxide or 'oxygen' ions are responsible, rather than hydroxide ions. The attraction of the hydroxide ions to the positive electrode was reasonably well known, but few students then correctly described the oxidation or discharge of the hydroxide ions to form oxygen. As in the previous question, the term 'discharged' is widely misunderstood – the word means 'loses its charge', so to say that oxygen is discharged is not correct.

4.4.3.2 Electrolysis of molten ionic compounds

Answer 12 · Examiner comments June 2023 | 8462/1H | Original Q7

07.4 Nearly two thirds of students scored at least one mark, but just over half of these also scored the second mark. The easiest change to the apparatus is to change the test tubes to measuring cylinders or inverted burettes. Many students suggested gas syringes; this was allowed, although it would be difficult to set up the apparatus in such a way that this would work. However, a 'gas cylinder' is not a measuring device. One popular misconception is that gas would escape from the apparatus so a lid should be used.

Most students realised that the reason was so that the gas volume could be measured rather than estimated, or that test tubes have no scale; any equivalent way of expressing this idea was allowed. Some students used imprecise language such as 'so the gas could be measured' without referring to volume or a scale.

07.5 The great majority of students gave the correct response, with 20 cm^3 being the most common incorrect choice.

Answer 13 · Examiner comments June 2025 | 8462/1H | Original Q6

Question 6 (standard, standard/high and high demand)

06.1 This was a high demand question which required the use of correct terminology. The question discriminated well, with three fifths of students gaining one mark but very few scoring all four. Many students referred correctly to strong electrostatic forces of attraction and to the large amount of energy needed to break these. Fewer referred correctly to the particles that those forces acted between, i.e. the oppositely charged ions; some referred incorrectly to the forces being between bonds. Some referred to

'oxygen ions' rather than oxide ions. There were very few who stated that the electrostatic forces act in all directions in the giant structure, despite the statement in the specification; this was the mark that most students did not score. Some students ruined their answer by the use of the word 'intermolecular', which is not appropriate as there are no molecules. Most students did recognise that a lot of energy was needed to break bonds but had contradicted this marking point earlier in their response by referring to the bonds as intermolecular forces. Some referred to 'more' energy being needed to break the bonds; this did not gain credit because the question did not require a comparison to anything else, and 'more' does not necessarily imply 'a lot'.

06.2 Only a half of students knew that cryolite was the correct substance. The most common incorrect answer was water.

06.3 Only one in five students scored the mark. Many students missed the point and referred to allowing ions to flow. The idea that the mixture has a lower melting point than pure aluminium oxide so that less energy is required was not well known. It is not correct to say that the melting point of aluminium oxide is lowered, as aluminium oxide has a fixed melting point. Some appear to think incorrectly that cryolite is a catalyst.

06.4 Students had difficulty with this high demand question, but it did discriminate well between the higher achieving students. One in five students scored both marks. Many could not write the formula of the oxide ion, and of those who could, some had the oxygen on the left and the oxide ion on the right. Those who could write the correct formulae could often balance the equation correctly, with the correct number of electrons on the right. An electron must be written with its charge in an ionic equation, as e^-, so that the charge balances as well as the atoms.

06.5 This question discriminated well, with half of students scoring at least one mark and more than a third scoring all three. Those who knew that the positive electrode is made of carbon often went on to score all three marks, although some merely referred to oxidation of the electrode rather than a specific reaction with the oxygen produced. There appeared to be much guesswork, with unspecified corrosion of an electrode made of an unspecified material being fairly common. Some thought that the deterioration of the electrode was due to its gaining electrons, and some thought that the electrode was made of iron and would rust.