AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.3.3

Using electrolysis to extract metals

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**29**
Available paper years	**2007–2025**

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.

4.4.3.3 Using electrolysis to extract metals

Answer 01 · Mark scheme

March 2007 | CHY1A | Original Q9 | Legacy

Nine	**2**	**3**	**4**	**2**

4.4.3.3 Using electrolysis to extract metals

Answer 01 · Mark scheme

March 2007 | CHY1A | Original Q9 | Legacy

CHY1A (Products from Rocks) Higher Tier

Question	Key		
One	**A**	calcium carbonate only	**1**
	B	calcium oxide only	**3**
	C	calcium carbonate and calcium oxide	**2**
	D	carbon dioxide only	**4**
Two	**A**	**2**	
	B	**1**	
	C	**4**	
	D	**3**	

	A	B	C	D
Three	**3**	**2**	**3**	**3**
Four	**2**	**3**	**4**	**2**
Five	**3**	**4**	**3**	**3**
Six	**2**	**3**	**3**	**2**
Seven	**3**	**2**	**3**	**3**
Eight	**3**	**1**	**1**	**3**
Nine	**1**	**4**	**2**	**1**

4.4.3.3 Using electrolysis to extract metals

Answer 02 · Mark scheme

June 2007 | CHY1F | Original Q7 | Legacy

The full source mark scheme begins on page 51. Follow original question 7 in that document.

4.4.3.3 Using electrolysis to extract metals

Answer 03 · Mark scheme

January 2008 | CHY2F | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
(a)(i)	ionic		1
(a)(ii)	elements		1
(b)(i)	chlorine (gas)	allow Cl_2 / Cl / Cl^2 allow chloride	1
(b)(ii)	hydrogen (gas)	allow H / H_2 / H^2	1
(b)(iii)	sodium hydroxide (solution)	allow NaOH allow sodium solution	1
total			5

4.4.3.3 Using electrolysis to extract metals

Answer 03 · Mark scheme January 2008 | CHY2F | Original Q4 | Legacy

CHY2F

Answer 04 · Mark scheme March 2008 | CHY1AP | Original Q5 | Legacy

Five	**A**	iron	**2**
	B	aluminium	**3**
	C	copper	**4**
	D	gold	**1**

Answer 05 · Mark scheme June 2008 | CHY1AP | Original Q8 | Legacy

Eight	**1**	**4**	**3**	**1**

4.4.3.3 Using electrolysis to extract metals

Answer 06 · Mark scheme

June 2008 | CHY2F | Original Q8 | Legacy

question	answers	extra information	mark
8(a)	(propanone) has a low(er) boiling point **or** (propanone) evaporates fast(er) owtte	**or** water has a high(er) boiling point **or** water evaporates slow(er) allow propane / solution / it allow evaporates at lower temperature **or** boils quicker ignore density / reactivity / melting point	1
8(b)(i)	0.29	ignore + **or** – ignore units	1
8(b)(ii)	any **two** sensible suggestions eg: • weighing error • (copper) lost during washing owtte • (copper) lost during electrolysis / reaction owtte • electrodes not completely dry • impurities in the electrode • copper falling off when removing electrode / copper from cell	 accept human error **or** inaccurate measurements allow different washing of electrodes ignore timing errors ignore 'fair test' ignore sludge ignore gases produced	2

Question 8 continued on next page…

COMPONENT NUMBER: CHY2F

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

Question 8 continued…

question	answers	extra information	mark
8(c)	any **four** from: • impure copper is anode / positive (electrode) • pure copper is cathode / negative (electrode) • copper sulfate solution **or** any soluble copper salt in solution • copper loses electrons **or** copper is oxidised • copper forms positive ions / particles • copper gains electrons **or** copper reduced at negative electrode • copper attracts to / collects at negative electrode • sludge / impurities collect at the bottom owtte • impurities not attracted to electrode	as alternative to these two points $Cu \rightarrow Cu^{2+} + 2e^{-}$ = **2** marks **or** $Cu^{2+} + 2e^{-} \rightarrow Cu$ at negative electrode allow sludge left behind **or** sludge left in solution **or** impurities separated from copper ignore get rid of impurities	4
Total			**8**

4.4.3.3 Using electrolysis to extract metals

Answer 07 · Mark scheme

November 2009 | CHY1AP | Original Q9 | Legacy

Nine	**4**	**3**	**2**	**1**

4.4.3.3 Using electrolysis to extract metals

Answer 08 · Mark scheme

June 2010 | CHY2F | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)(i)	(different) properties	allow ideas of different property / behaviour / element	1
7(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
7(a)(iii)	other scientists obtained similar results / proved it **or** experiments were repeated		1

Question 7 continues on the next page

CHY2F

Question 7 continued

question	answers	extra information	mark
7(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
7(b)(ii)	2 **and** takes in heat / energy **or** 2 **and** temperature goes down (owtte)		1
7(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
7(c)	any **one** from • positive / + (charge) • opposite (charges) attract	do **not** accept incorrect further qualification eg electrons / atoms / electrodes	1
Total			**7**

4.4.3.3 Using electrolysis to extract metals

Answer 09 · Mark scheme

November 2010 | CHY1AP | Original Q5 | Legacy

Five	**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**	
	A		**B**	**C**	**D**

Answer 10 · Mark scheme

November 2010 | CHY1AP | Original Q9 | Legacy

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

4.4.3.3 Using electrolysis to extract metals

Answer 11 · Mark scheme

January 2011 | CHY1F | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)(i)	low percentage / very little 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
6(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
6(b)(i)	has melting point lower than 950°C	(it = aluminium) allow has a low melting point ignore boiling point	1
6(b)(ii)	electrode(s) made of carbon oxygen reacts with electrode(s) / carbon	 accept $C + O_2$ ($\rightarrow$ CO_2) NB oxygen reacts with the carbon electrode(s) = **2** marks	1 1

Question 6 continues on the next page

4.4.3.3 Using electrolysis to extract metals

Answer 11 · Mark scheme

CHY1F

Question 6 contd

question	answers	extra information	mark
6(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**

4.4.3.3 Using electrolysis to extract metals

Answer 11 · Mark scheme

January 2011 | CHY1F | Original Q6 | Legacy

CHY1F

4.4.3.3 Using electrolysis to extract metals

Answer 12 · Mark scheme

Question 6

question	answers	extra information	mark
6(a)	the ions can move / travel / flow / are free **or** the ions carry the charge / current	accept particles / they for ions allow delocalised ions ignore delocalised / free electrons ignore references to collisions accept converse with reference to solid ignore ions carry electricity	1
6(b)	any **one** from: • because they are negative / anion • opposite charges / attract	allow Cl^- ignore chlorine	1
6(c)	13		1
6(d)(i)	reasonable attempt at straight line which misses the anomalous point	must touch all five crosses do **not** allow multiple lines	1
6(d)(ii)	40	ignore 2.2	1

Question 6 continues on the next page

CHY2F

Question 6

question	answers	extra information	mark
6(d)(iii)	any **two** sensible errors from: • gas escapes • weighing error • error in measuring (volume / amount) of hydrogen • error in measuring (volume / amount) of water • incorrect concentration • timing error • change in voltage / current • change in temperature • recording / plotting error	ignore systematic / human / apparatus / zero /experimental / random / measurement / reading errors unless qualified allow NaCl not measured correctly allow error in measuring volume / scale for **1** mark if neither hydrogen or water mentioned allow NaCl not fully dissolved **or** spilled **or** impure allow faulty power supply	2
6(d)(iv)	any **one** from: • repeat the experiment • results compared with results from /other students / other groups / other laboratories / internet / literature. • results compared with another method	ignore 'do more tests'	1
6(d)(v)	increases owtte	allow directly proportional or positive correlation allow rate / it is faster / quicker	1
Total			**9**

4.4.3.3 Using electrolysis to extract metals

Answer 12 · Mark scheme

January 2011 | CHY2F | Original Q6 | Legacy

CHY2F

Answer 13 · Mark scheme

November 2011 | CHY1AP | Original Q9 | Legacy

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

4.4.3.3 Using electrolysis to extract metals

Answer 14 · Mark scheme

January 2012 | CH1FP | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)	reduction		1
2(b)	carbon is less reactive than aluminium		1
2(c)	aluminium (ions) / they are positively charged so they are attracted **or** they move towards the negative electrode **OR** aluminium (ions) / they need to gain electrons (1) which come from the negative electrode (1)	they = aluminium ions ignore particle names accept aluminium (ions) / they are cations allow aluminium (ions) / they have an opposite charge if no other marks awarded allow 'opposites attract' for **1** mark	1 1
2(d)	aluminium has a low density aluminium is resistant to corrosion		1 1
2(e)	**advantage** less carbon dioxide is produced **disadvantage** used aluminium cans have to be collected and transported		1 1
Total			**8**

4.4.3.3 Using electrolysis to extract metals

Answer 14 · Mark scheme

January 2012 | CH1FP | Original Q2 | Legacy

CH1FP

4.4.3.3 Using electrolysis to extract metals

Answer 15 · Mark scheme June 2012 | CH2FP | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)(i)	cryolite		1
4(a)(ii)	lower the melting point of the aluminium oxide		1
4(b)(i)	opposite charges **or** oxide ions are negative attract		1 1
4(b)(ii)	carbon		1
4(b)(iii)	reacts with oxygen **or** forms carbon dioxide	accept burns	1
4(c)	**Structure mark**: **either** Al (atoms) in layers / rows **or** alloy (atoms) not in layers / rows **Sliding mark**: **either** so (Al layers) can slide **or** so (alloy) layers cannot slide	 accept Al (atoms) all the same size allow Al (atoms) in lines accept different sizes of atoms in alloy allow alloy (atoms) not in lines	1 1
Total			**8**

4.4.3.3 Using electrolysis to extract metals

Answer 15 · Mark scheme

June 2012 | CH2FP | Original Q4 | Legacy

CH2FP

4.4.3.3 Using electrolysis to extract metals

Answer 16 · Mark scheme

June 2013 | CH1FP | Original Q7 | Legacy

Question 7

question	answers	extra information	Mark
7(a)	any **two** from: • copper / ores are running out / harder to find • there are no / very small amounts of high-grade copper ores left • copper metal is in demand • copper is expensive • now economical to extract copper from low-grade ores	it = copper allow new methods of extraction e.g. bioleaching and phytomining allow high-grade ores are running out for **2** marks	2
7(b)(i)	large amounts / 98% of rock to dispose of as waste **or** waste rock takes up a lot of space	accept contains toxic (metal) compounds / bioleacher	1
7(b)(ii)	(copper sulfide reacts with oxygen to) produce sulfur dioxide / SO_2 that causes acid rain	allow (sulfur reacts with oxygen to) produce sulfur dioxide / SO_2 allow description of effects of acid rain **or** sulfur dioxide if no other mark awarded allow CO_2 produced which causes global warming **or** CO_2 produced by burning fuel or heating the furnace for **1** mark	1 1
7(b)(iii)	any **one** from: • large amounts of fuels / energy used (for the furnace and electrolysis) • (the extraction has) many steps / stages / processes • large amounts of ore / material have to be mined	allow large amounts of electricity needed ignore high temperature / electrolysis unqualified allow (extraction) is a long process / takes a lot of time allow ores contain a low percentage of copper	1

Question 7 continues on the next page

Question 7 continued

question	answers	extra information	Mark
7(b)(iv)	(copper ions move towards) the negative electrode / *cathode* because copper ions / Cu^{2+} are positively charged **or** are oppositely charged **or** copper ions need to gain electrons	 allow because metal ions are positive **or** opposites attract	1 1
7(b)(v)	(growing) plants		1
Total			**9**

4.4.3.3 Using electrolysis to extract metals

Answer 17 · Mark scheme

June 2014 | CH1FP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
5(a)(i)	economical		1	1 / 1.3.1a	A
5(a)(ii)	phytomining		1	1 / 1.3.1g	A
5(a)(iii)	carbon dioxide		1	1 / 1.3.1d/f	A
5(b)(i)	copper / Cu iron sulfate / $FeSO_4$		1 1	2 / 1.3.1h	E
5(b)(ii)	copper/ ions have a positive charge	it = copper ions allow copper ions have a different charge accept copper / ions are free to move accept to gain electrons accept copper / ions are attracted to the negative electrode **or** opposite charges attract	1	1 / 1.3.1h	E
5(c)	any **two** from: • copper ores are limited / running out • copper can be recycled • copper can be reused • copper is expensive • landfill sites are filling up • copper compounds are toxic	ignore not biodegradable or does not decay allow copper is running out allow copper is toxic	2	3 / 1.3.1j	E
Total			**8**		

4.4.3.3 Using electrolysis to extract metals

Answer 17 · Mark scheme

June 2014 | CH1FP | Original Q5 | Legacy



4.4.3.3 Using electrolysis to extract metals

Answer 18 · Mark scheme June 2014 | CH2FP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
5(a)(i)	ions cannot move	*allow only conducts as a liquid*	1	1 / 2.7.1a	E
5(a)(ii)	chlorine		1	2 / 2.7.1b	G
5(a)(iii)	they are positively / oppositely charged **or** they are attracted		1	1 / 2.7.1c	E
5(a)(iv)	2		1	2 / 2.7.1e	G
5(b)(i)	any **one** from: • not all the magnesium was collected • *used less time* ***or*** *lower current* ***or*** *different battery / power pack* ***or*** *different balance* ***or*** *lower voltage* • error in reading balance • error in recording result	*allow some magnesium was lost*	1	3 / 2.7.1	E
5(b)(ii)	1.11	correct answer with or without working gains **2** marks. if answer incorrect, allow **1** mark for 0.99 **or** for 1.13+1.11+1.09	2	2 + 3 / 2.7.1	E
5(c)(i)	*25 – 25.3*	correct answer with or without working gains **2** marks. If answer incorrect, allow **1** mark for 24/95	2	2 / 2.3.3a	E
5(c)(ii)	71		1	2 / 2.3.1f	A
5(d)(i)	reversible reaction		1	1 / 2.3.3f	A
5(d)(ii)	decreases		1	1 / 2.5.1c	A
Total			**12**		

4.4.3.3 Using electrolysis to extract metals

Answer 18 · Mark scheme

June 2014 | CH2FP | Original Q5 | Legacy



4.4.3.3 Using electrolysis to extract metals

Answer 19 · Mark scheme

June 2015 | CH1FP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)	gold		1	1 / 1.3.1c
1(b)	atom (s)		1	1 / 1.1.1a
1(c)(i)	protons neutrons	any order allow proton allow neutron	1 1	1 / 1.1.1c/h
1(c)(ii)	3 / three		1	2 / 1.1.1e/g / 1.1.2a
1(d)(i)	Al	ignore any numbers / charges	1	2 / 1.1.1b
1(d)(ii)	any **two** from: • limited resource • expensive in terms of energy / mining • effects on the environment, such as, landfill, atmospheric pollution, quarrying	allow uses a lot of energy to extract	2	1 / 1.3.1e/i/j
1(e)	resistant to corrosion does not react (with water or food)	allow **one** mark for low density with a suitable reason given	1 1	2+3 / 1.3.3c
Total			**10**	

4.4.3.3 Using electrolysis to extract metals

Answer 19 · Mark scheme

June 2015 | CH1FP | Original Q1 | Legacy



4.4.3.3 Using electrolysis to extract metals

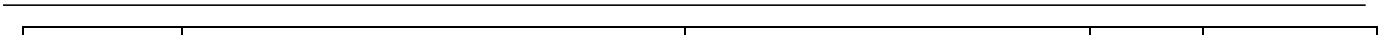
Answer 20 · Mark scheme June 2015 | CH2FP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)	any **one** from: • protection/improve lifespan • improve appearance		1	**AO2** 2.7.1d
4(b)(i)	Bleach		1	**AO1** 2.7.1i
4(b)(ii)	Hydrogen is less reactive than sodium.		1	**AO2** 2.7.1f
4(b)(iii)	1 bonding pair of electrons 6 unbonded electrons on Cl	accept dot, cross or e or – or any combination	1	**AO1** 2.7.1e
4(b)(iv)	Covalent		1	**AO1** 2.7.1f
4(b)(v)	Hydrogen chloride has a low boiling point. Hydrogen chloride is made of simple molecules.		1 1	**AO1** 2.2.1a 2.1.1g
4(c)(i)	oxygen	accept carbon dioxide	1	**AO1** 2.7.1h
4(c)(ii)	aluminium ions are positive so are attracted (to the negative electrode)	allow opposites attract	1 1	**AO1/AO2** 2.7.1h 2.2.2b
4(c)(iii)	Reduction		1	**AO1** 2.7.1e
4(c)(iv)	slide	allow move	1	**AO1** 2.2.4b
4(d)(i)	C		1	**AO1** 2.2.3a,c
4(d)(ii)	strong covalent bonds		1	**AO1** 2.2.3a
Total			**14**	

4.4.3.3 Using electrolysis to extract metals

Answer 20 · Mark scheme

June 2015 | CH2FP | Original Q4 | Legacy



4.4.3.3 Using electrolysis to extract metals

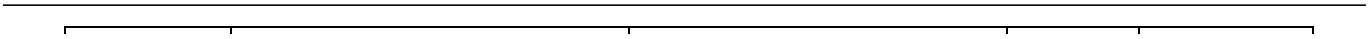
Answer 21 · Mark scheme June 2016 | CH2FP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
3(a)	electricity	allow an electric current	1	AO1 2.7.1a; 2.2.2b
3(b)(i)	chlorine/Cl_2	do **not** accept chloride	1	AO2 2.7.1b
3(b)(ii)	(zinc ions are) positive and (opposite charges) attract	ignore to gain electrons	1 1	AO1/AO2 2.7.1c
3(b)(iii)	reduction		1	AO1 2.7.1e
3(c)(i)	in alloy: different sized atoms/particles **or** no layers/rows so cannot slide	accept converse accept layers distorted	 1 1	AO1/AO2 2.2.4b,c
3(c)(ii)	shape memory (alloys)	accept smart	1	AO1 2.2.4d
Total			**8**	

4.4.3.3 Using electrolysis to extract metals

Answer 21 · Mark scheme

June 2016 | CH2FP | Original Q3 | Legacy



4.4.3.3 Using electrolysis to extract metals

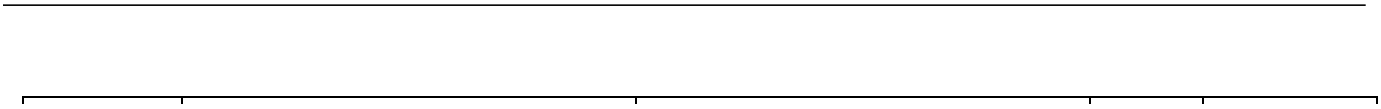
Answer 22 · Mark scheme June 2017 | CH1FP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5(a)(i)	2900	allow with **or** without working If answer is not correct allow one mark for 7000/2 **or** for 3500 (km)	2	**AO2** 1.7.1a
5(a)(ii)	plates speeds currents processes	Must be in this order	1 1 1 1	**AO1** 1.7.1c
5(b)(i)	bar correct (47%)	allow ± ½ a square	1	**AO2** 1.7.1b
5(b)(ii)	9 %		1	**AO2** 1.7.1b
5(b)(iii)	limited / finite resource	allow running out **or** non-renewable ignore cost **or** short supply **or** there is not a lot of it left	1	**AO3** 1.3.1j 1.3.3b
5(b)(iv)	electrolysis		1	**AO1** 1.3.1h
5(b)(v)	copper ions are <u>attracted</u> because they are positive	allow opposite (charges) <u>attract</u> allow because they need to gain electrons (to form copper)	1 1	**AO1** 1.3.1g;h
Total			**12**	

4.4.3.3 Using electrolysis to extract metals

Answer 22 · Mark scheme

June 2017 | CH1FP | Original Q5 | Legacy



4.4.3.3 Using electrolysis to extract metals

Answer 23 · Mark scheme

June 2019 | 8462/1F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$\frac{184}{(232 + 6)} \times 100$ = 77 (%)	an answer of 77 (%) scores **2** marks an answer of 78.63247863 (%) correctly rounded to at least 2 significant figures scores **1** mark allow 77.31092437 (%) correctly rounded to at least 2 significant figures	1 1	AO2 4.3.3.2
06.2	$\frac{38}{100} \times 40$ = 15 (kg)	an answer of 15 (kg) scores **2** marks allow 15.2 (kg)	1 1	AO2 4.4.1.3
06.3	(2 x 27) + (3 x 16) = 102	an answer of 102 scores **2** marks ignore units	1 1	AO2 4.3.1.2
06.4	$\frac{28.4}{31.8} \times 100$ = 89.3081761 (%) = 89.3 (%)	an answer of 89.3 (%) scores **3** marks allow 89.3081761(%) correctly rounded to at least 2 significant figures allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the masses in the question	1 1 1	AO2 4.3.3.1

4.4.3.3 Using electrolysis to extract metals

Answer 23 · Mark scheme

06.5	aluminium is more reactive than carbon (so) carbon cannot displace aluminium **or** (so) carbon cannot reduce aluminium oxide	allow aluminium is above carbon in the reactivity series allow (so) carbon cannot replace aluminium allow (so) carbon cannot remove oxygen from aluminium oxide allow (so) carbon will not react with aluminium oxide	1 1	AO1 4.4.1.1 4.4.1.2 4.4.1.3 4.4.3.3
Total			**11**	

4.4.3.3 Using electrolysis to extract metals

Answer 24 · Mark scheme

November 2020 | 8462/1F | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(negative electrode) solid produced	allow the electrode changes colour ignore metal produced	1	AO3 4.4.3.4 RPA 3
	(positive electrode) bubbles / fizzing / effervescence	ignore gas produced	1	
04.2	potassium nitrate		1	AO3 4.4.3.4 RPA 3
	hydrogen is not a metal	allow hydrogen is a gas allow hydrogen is not a solid allow the products at both electrodes are gases allow the product at the negative electrode is not potassium allow potassium is more reactive than hydrogen	1	
04.3	(graphite) conducts (electricity)	allow (graphite) has delocalised / free electrons	1	AO1 4.2.3.2 4.4.3.4 RPA 3
	(graphite) is inert	allow (graphite) is unreactive	1	
04.4	the ions move towards the positive electrode		1	AO3
	the electrode attracts ions of the opposite charge	allow opposite charges attract	1	AO1 4.4.3.1
Total			**8**	

4.4.3.3 Using electrolysis to extract metals

Answer 25 · Mark scheme

November 2020 | 8462/1F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	Property: Conducts electricity — Reason: Aluminium has delocalised electrons; Aluminium has layers of atoms which can slide Property: High melting point — Reason: Aluminium has strong metallic bonds; Aluminium has weak intermolecular forces Aluminium has a random arrangement of atoms additional line from a box on the left negates the mark from that box		1 1	AO1 4.2.1.5 4.2.2.7 4.2.2.8
05.2	a mixture of metals	allow a mixture of a metal with other elements	1	AO1 4.2.2.7
05.3	bauxite contains a variable percentage of aluminium	allow converse argument allow bauxite does not have a fixed proportion / percentage of aluminium	1	AO3 4.1.1.1
05.4	any **two** from: • danger of dam bursting • leakage of toxic substances from mud to environment • water pollution • damage to habitats • visual pollution • (dam) blocks light • reduces the value of houses	allow the lake (of mud) could overflow allow unpleasant smell	2	AO3 4.4.3.3

Question 5 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	10 / ten		1	AO2 4.1.1.1
05.6	to lower the melting point of the mixture		1	AO1 4.4.3.3
05.7	oxygen carbon	must be in this order	1 1	AO1 4.4.3.3
05.8	$\frac{25}{100}$ × 300 000 =75 000 (kg) = 7.5×10^4 (kg)	 allow correct conversion to standard form of an incorrectly calculated mass	1 1 1	AO2 4.4.3.3
Total			**13**	

4.4.3.3 Using electrolysis to extract metals

Answer 26 · Mark scheme

November 2021 | 8462/1F | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	by filtration		1	AO3 4.1.1.2

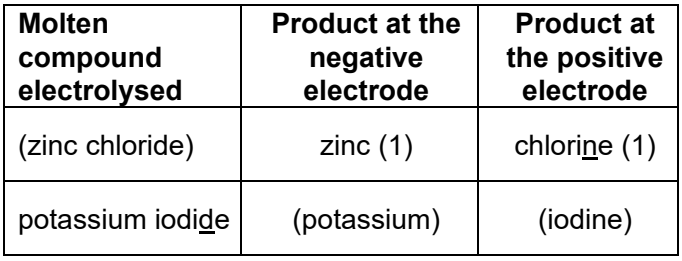
Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	10 minutes per 2 cm on x-axis	allow 5 minutes per 1 cm on x-axis	1	AO2 4.4.3.4
	all points plotted correctly	allow a tolerance of ± ½ a small square allow **1** mark for 3 or 4 points plotted correctly	2	
	line of best fit	allow line of best fit drawn using incorrect plots	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	0.14 (g)	allow ecf from question **07.2** allow a tolerance of ± ½ a small square	1	AO2 4.4.3.4

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	(copper sulfate solution) pink / orange / red / brown solid (sodium chloride solution) bubbles / effervescence / fizzing	 allow copper plating allow metal for solid if no other mark awarded allow **1** mark for copper **and** hydrogen	 1 1	AO2 4.4.1.2 4.4.3.4 RPA3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	toxic / poisonous (fumes)	allow harmful / corrosive (fumes) ignore dangerous / deadly / lethal	1	AO3 4.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6			 2 1	AO2 4.4.3.2

Molten compound electrolysed	Product at the negative electrode	Product at the positive electrode
(zinc chloride)	zinc (1)	chlorine (1)
potassium iodide	(potassium)	(iodine)

allow **1** mark if zinc and chlorine the wrong way round

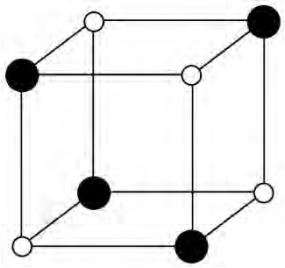
Total			12

4.4.3.3 Using electrolysis to extract metals

Answer 27 · Mark scheme

June 2023 | 8462/1F | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1		allow **1** mark for 2 Na^+ and 2 Cl^-	2	AO1 4.2.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	the ions can move (in the liquid)	do **not** accept reference to moving / delocalised electrons	1	AO1 4.4.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3				AO2 4.4.3.2

Molten compound	Product at the negative electrode	Product at the positive electrode	
Magnesium bromide	Magnesium	**Bromine**	1
Potassium chloride	**Potassium**	Chlorine	1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	the mixture has a lower melting point than pure aluminium oxide		1	AO1 4.4.3.3

4.4.3.3 Using electrolysis to extract metals

Answer 27 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	water		1	AO1 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	hydrogen is less reactive than sodium		1	AO2 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.7	the volume of hydrogen is twice the volume of oxygen	allow the volume of hydrogen is greater than the volume of oxygen allow the volume of hydrogen is (directly) proportional to the volume of oxygen	1	AO3 4.4.3.4

Total Question 7	9

Answer 28 · Mark scheme

June 2024 | 8462/1F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	ions can move through the molten substance to the electrodes		1	AO1 4.4.3.1

Question	Answers	Mark	AO / Spec. Ref.
06.2	<table><tr><th>Molten compound</th><th>Product at negative electrode</th><th>Product at positive electrode</th></tr><tr><td>Lead chloride</td><td>Lead</td><td>Chlorine</td></tr><tr><td>Potassium iodide</td><td>Potassium</td><td>Iodine</td></tr><tr><td>Zinc bromide</td><td>Zinc</td><td>Bromine</td></tr></table>	1 1 1	AO2 4.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	$2Al_2O_3 \rightarrow 4Al + 3O_2$	allow **1** mark for 4 Al allow **1** mark for 3 O_2	2	AO2 4.1.1.1 4.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(M_r =) (27 × 2) + (16 × 3) = 102		1 1	AO2 4.3.1.2

4.4.3.3 Using electrolysis to extract metals

Answer 28 · Mark scheme

June 2024 | 8462/1F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	(by electrolysis) any **one** from: • potassium / K • lithium / Li	allow aluminium / Al allow sodium / Na allow calcium / Ca allow magnesium / Mg	1	AO3 4.4.1.2 4.4.1.3 4.4.3.3
	(by carbon reduction) any **one** from: • zinc / Zn • tin / Sn	allow iron / Fe allow copper / Cu	1	

Total Question 6	10

4.4.3.3 Using electrolysis to extract metals

Answer 29 · Mark scheme

June 2025 | 8462/1F | Original Q5

Question 5

Question	Answers	Mark	AO / Spec. Ref.
05.1	molten compound: copper chloride; product at the negative electrode: **copper**; product at the positive electrode: chlorine — 1 molten compound: potassium bromide; product at the negative electrode: potassium; product at the positive electrode: **bromine** — 1	1 1	AO2 4.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	O_2		1	AO1 4.1.1.1 4.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	aluminium ions are positive(ly charged)		1	AO1 4.4.3.1 4.4.3.2 4.4.3.3
	(so) are attracted to the negative electrode	allow (and) opposite charges attract	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(the mixture) has a lower melting point (than aluminium oxide)		1	AO3
	(so) less energy is required		1	AO1 4.4.3.3

Answer 29 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	carbon reacts with the oxygen produced		1	AO1 4.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	3.4 cm^3		1	AO2 4.4.3.4 RPA3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	hydrogen is less reactive than magnesium		1	AO1 4.4.3.4 RPA3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.8	the volume of hydrogen collected depends on **both** the current and the time		1	AO3 4.4.3.4 RPA3

4.4.3.3 Using electrolysis to extract metals

Answer 29 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.9	(change in volume = 3.8 – 1.9 =) 1.9 (cm^3)	allow any correct matching pairs of values of volume and time for **2** marks	1	AO2 4.4.3.4 RPA3
	(change in time = 5 – 2.5 =) 2.5 (min)		1	
	(gradient =) $\frac{1.9}{2.5}$	allow correct use of incorrectly determined values of volume and / or time	1	
	= 0.76 (cm^3/min)	allow correct use of incorrectly determined values of volume and / or time	1	

Total Question 5	**15**

4.4.3.3 Using electrolysis to extract metals

Version 1.0: 0707

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Science B 4462 / Chemistry 4421

CHY1F Unit Chemistry 1

Mark Scheme

2007 examination - June series

4.4.3.3 Using electrolysis to extract metals

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

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4.4.3.3 Using electrolysis to extract metals

MARK SCHEME

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a candidate writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown.

However if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column;

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

4.4.3.3 Using electrolysis to extract metals

CHY1F Question 1

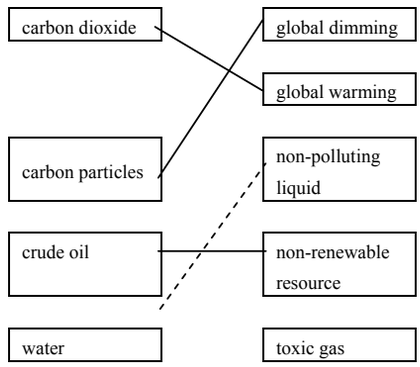
	answers	extra information	mark
(a)	low density unreactive		1 1
(b)	a polymer		1
(c)	any **one** from: • not broken down by (microorganisms) • does not decay (naturally)	ignore cannot recycle / degrade / disintegrate	1
total			4

CHY1F Question 2

	answers	extra information	mark
(a)(i)	additive		1
(b)	any **three** from: • colour 1 is made up of only one colour / dye • colour 2 is made up of only one colour / dye • colour 3 is made up of two colours / dyes **or** more colours (than colours 1 and 2) • colours 1, 2 and 3 are all different • colour 1 is less dark than colour 2	accept colour 3 is a mixture of colours 1 and 2 for **3** marks accept E-number or additive instead of colour ignore comments about height / level	3
total			4

4.4.3.3 Using electrolysis to extract metals

CHY1F Question 3

	answers	extra information	mark
(a)	hydrogen	ignore formulae	1
(b)	any **two** from: • different sized molecules / more or less (carbon) atoms (in molecules) • fuels have <u>different</u> boiling points • fuels condense at <u>different</u> temperatures	ignore different densities	2
(c)		all three correct = **3** marks two correct = **2** marks one correct = **1** mark	3
total			6

4.4.3.3 Using electrolysis to extract metals

CHY1F Question 4

	answers	extra information	mark
(a)(i)	any **one** from: • iron ore is a limited resource / non-renewable • iron is in high demand • provide jobs • economic advantage		1
(ii)	any **two** from: • would damage (wildlife) habitats / countryside / greenfield sites • extra traffic • visual (pollution) / eyesore • noise (pollution) / sound (pollution) • dust (pollution) • river (pollution) • carbon dioxide (from traffic) / adds to greenhouse effect / global warming • damage roads / buildings by <u>vibrations</u> / <u>shockwaves</u>		2
(b)(i)	carbon monoxide / carbon	accept formulae CO / C	1
(ii)	atoms are all the same (size) / type	accept (particles) are all the same (size) / type for one mark	1 1

Continued on next page

4.4.3.3 Using electrolysis to extract metals

Question 4 continued

	answers	extra information	mark
(iii)	any **two** from: • impurities / carbon / different (sized) atoms **or** elements **or** metals • changes the structure / disrupts the pattern or layers • prevents layers sliding over each other • it is an alloy		2
total			8

4.4.3.3 Using electrolysis to extract metals

CHY1F Question 5

	answers	extra information	mark
(a)	core	ignore outer or inner	1
	mantle		1
(b)(i)	carbon dioxide	accept formula CO_2	1
	oxygen	accept formulae O_2 / O	1
(ii)	4%		1
(iii)	carbon dioxide has <u>decreased</u> / from 95% to 0%		1
	oxygen has <u>increased</u> / from 0% to 21%		1
	any **one** from: (carbon dioxide decrease) • carbon dioxide used during photosynthesis / by plants • carbon dioxide dissolves in oceans • carbon dioxide is locked up in rocks / carbonates / fossil fuels (oxygen increase) • oxygen released during photosynthesis / by plants		1
total			8

4.4.3.3 Using electrolysis to extract metals

CHY1F Question 6

	answers	extra information	mark
(a)	any **two** from: • nitrogen • carbon dioxide • water (vapour) / steam	 accept formulae N / N_2 accept formula CO_2 ignore CO accept formula H_2O	2
(b)	any **three** from: <u>limestone</u> • abundant / local • natural material **or** no 'processing' needed • relatively easy to cut • appearance better <u>concrete</u> • <u>raw materials</u> are abundant • can be reinforced (by steel rods) / strong(er) / supported (by steel rods) • concrete mixture can be poured / moulded / constructed on site • less reactive with acid rain / weathering / erosion	no mark for 'limestone' or 'concrete' on first line – mark advantages only ignore ideas of speed of production or easier to use accept 'can build higher' ignore density / extraction / quarrying / pollution / cost	3
total			5

4.4.3.3 Using electrolysis to extract metals

CHY1F Question 7

	answers	extra information	mark
(a)(i)	$Cu_2S + 2O_2 \rightarrow 2CuO + SO_2$	accept fractions and multiples	1
(ii)	any **two** from: • sulfur dioxide • causes acid rain • consequence of acid rain eg kills fish / plants	 accept sulphur dioxide / sulphur oxide / SO_2 ignore other comments eg global warming / ozone / global dimming / greenhouse effect	2
(b)	any **two** from: • heat (copper oxide with carbon) • oxygen is removed by carbon **or** carbon monoxide / carbon dioxide is produced **or** carbon displaces copper • because carbon is more reactive than copper	 accept copper (oxide) loses oxygen **or** carbon gains oxygen accept carbon oxide accept a correct word or balanced symbol equation allow a correct comparison of reactivity	2
(c)(i)	electrolysis	accept electroplating	1
(ii)	(electrical) wiring / appliances / coins / pipes / cladding for buildings / jewellery / making alloys **or** named alloys		1

Continued on next page

4.4.3.3 Using electrolysis to extract metals

Question 7 continued

	answers	extra information	mark
(d)	any **three** explanations from: <u>for recycling</u> • less acid rain (pollution) • copper reserves last longer / conserved **or** do not run out • energy for extraction (saved) **or** less energy required • less mining / quarrying • less waste (copper) / electrical appliances dumped **or** less landfill <u>against recycling</u> • collection problems • transport problems • difficult to separate copper from appliances • energy used to melt the collected copper	ignore electrolysis / pollution ignore ideas about less machinery / plant ignore idea of cost	3
total			10

4.4.3.3 Using electrolysis to extract metals

Answer 23 · Examiner comments

June 2019 | 8462/1F | Original Q6

Question 6 (low and standard demand)

06.1 Approximately 60% of students calculated the percentage atom economy correctly.

A final answer of 77.3 with a dot over the 3 signifying a recurring 3 was a common error.

06.2 Approximately two-thirds of students performed the percentage calculation correctly.

06.3 Approximately 70% of students calculated the relative formula mass correctly.

06.4 The requirement to give the answer to 3 significant figures made this calculation more challenging. However, approximately a half of students scored all 3 marks.

A final answer of 89.3 with a dot over the 3 signifying a recurring 3 was a common error.

06.5 Students found this question difficult. Almost three-quarters of students scored 0 marks.

For those students who scored 1 mark, it was almost always for the relative reactivity of aluminium and carbon.

Answer 27 · Examiner comments

June 2023 | 8462/1F | Original Q7

Question 7 (low and standard demand)

07.1 This question was answered by fewer than half of the students showing that many students do not read the entire question, but focus only on the sentence above an answer line. As there was no answer line, the instruction to complete Figure 8 was missed. Of those who did respond, most scored at least one mark.

Most of those who did answer realised that two of each ion should be drawn, but many placed the ions directly under the same type of ion, instead of in the alternate positions.

07.2 This standard demand question proved to be difficult even with the prompt to refer to ions. There were few references to electrons, showing that students had taken note of this prompt; however, the idea that ions can move in the liquid state was not given by many students.

07.3 This question was well answered, with more than three quarters of students scoring both marks. Potassium was nearly always correct, but bromine was often incorrectly described as bromide.

07.4 Only a half of the students knew that the mixture has a lower melting point than pure aluminium oxide, with the majority of the rest opting for a higher melting point.

4.4.3.3 Using electrolysis to extract metals

Answer 27 · Examiner comments June 2023 | 8462/1F | Original Q7

07.5 Only a half of students knew that the source of the hydrogen and oxygen is water. Most of the other chose sulfate ions.

07.6 Again, roughly a half of students knew the reason for the production of hydrogen rather than sodium, with nearly as many choosing the incorrect statement that hydrogen is more reactive than sodium.

07.7 Some students were not specific enough about the relationship of the volumes, merely stating that as one increased, so did the other. However, many gave excellent descriptions of the volume of hydrogen being twice that of oxygen. Just over a half of students scored the mark.

Answer 28 · Examiner comments June 2024 | 8462/1F | Original Q6

Question 6 (low and standard demand)

06.1 Fewer than a half of students identified the reason why molten substances can be electrolysed. The incorrect distractor that electrons can move through the substance was almost as popular.

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Answer 28 · Examiner comments June 2024 | 8462/1F | Original Q6

06.2 Nearly three quarters of students could name all three substances correctly. The most common errors were iodide instead of iodine and zinc bromine instead of zinc bromide.

06.3 Nearly a half of students gave a completely balanced equation. The oxygen was correctly balanced more often than the aluminium.

06.4 Nearly three fifths of students set out their work clearly and obtained the correct answer. The most common incorrect answers were 27 + 16 = 43 and 27 × 16 = 432.

06.5 Fewer than two thirds of students scored one or two marks, with fewer than one third scoring both marks. It was expected that students would chose appropriate metals from the list provided, but other correct answers were accepted. Gold was not given credit, since students should know that gold is found in the Earth as the metal itself, so does not need chemical extraction. Carbon was often given as a response.

Answer 29 · Examiner comments

June 2025 | 8462/1F | Original Q5

Question 5 (low and standard demand)

05.1 This was very well answered, although a few said bromide rather than bromine. Four fifths of students scored both marks.

05.2 Three quarters of students chose the correct formula. The most popular distractor was O^2.

05.3 Students found this question difficult and one in ten did not attempt it. Many stated that aluminium, rather than aluminium ions, is positive. The attraction between the positive ions and the negative electrode was better expressed.

05.4 Again, students found this difficult despite the data provided as a prompt, and again one in ten made no attempt. Few students stated clearly that the mixture has a lower melting point, and even fewer that less energy is therefore required. Some stated that the melting point is lowered by cryolite, which was not accepted; the melting point of aluminium oxide is a fixed value. Some did not make a clear reference to energy, referring to fuel or heat instead. Many referred to boiling points instead of melting points, despite also quoting the given values of melting point. Just over a quarter of students scored 1 mark but only one in 20 scored both.

05.5 About half of students gave the correct answer, with the two distractors both being very popular.

05.6 Three quarters of students gave the correct value, with 2.7 cm^3 being the more popular distractor.

05.7 Three fifths of students gave the correct reason, though a surprising number thought that hydrogen is more reactive than magnesium.

05.8 Only a half of students gave the correct answer, with nearly as many thinking that the volume did not depend on the time.

05.9 There were very many fully correct answers, with a half of students scoring full marks. A few measured the change in volume as 1.8 cm^3 instead of 1.9 cm^3, and some inverted

Answer 29 · Examiner comments

June 2025 | 8462/1F | Original Q5

the expression for gradient even though it was provided. Any matching pairs of change in volume and change in time were accepted. Even those who read incorrectly from the graph were able to gain partial credit for showing how to manipulate their values correctly.