AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.1.1.6

Relative atomic mass

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**16**
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.

5.1.1.6 Relative atomic mass

Answer 01 · Mark scheme June 2018 | 8464/C/1H | Original Q6

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>06.1</td><td>CaO

CO_2</td><td>either order
ignore names</td><td>1

1</td><td>AO1
5.3.1.3</td></tr>
<tr><td>06.2</td><td>

[12 + (3 × 16)]
or 60

(197 − 60 =) 137

barium or Ba</td><td>an answer of 137 scores the 2 calculation marks

barium or Ba without working scores this mark</td><td>

1

1

1</td><td>AO2
5.3.1.2
5.3.1.3
5.1.1.5</td></tr>
<tr><td>06.3</td><td>

(working) Y increase <u>and</u> X increase measured from graph <u>and</u> substitution into $\frac{\Delta Y}{\Delta X}$

(answer) 167

(units) cm^3/g</td><td>an answer of 160–174 scores the 2 calculation marks

<table><tr><td>y-axis</td><td>80–85</td><td>162–170</td><td>248–252</td><td>330–335</td></tr><tr><td>x-axis</td><td>0.5</td><td>1.0</td><td>1.5</td><td>2.0</td></tr><tr><td>=</td><td>160–170</td><td>162–170</td><td>165–168</td><td>165–168</td></tr></table>
allow answer in range 160–174

allow $cm^3\ g^{-1}$

if no other mark awarded allow 1 mark for the inverse ($\frac{\Delta X}{\Delta Y}$)
or 0.006</td><td>

1

1

1</td><td>AO2
5.3.1.2
5.3.1.3</td></tr>
</table>

5.1.1.6 Relative atomic mass

Answer 01 · Mark scheme

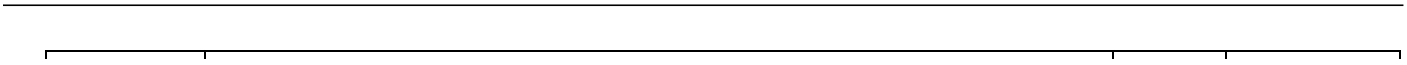
June 2018 | 8464/C/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4		an answer of 140–150 scores **4** marks an answer of 0.14–0.15 scores **3** marks		AO3 5.3.1.2 5.3.1.3
	(from graph) volume to 240 cm^3 mass = 1.45 g	allow answer based on any reading from the graph (eg 250 cm^3 = 1.5 g)	1	
	ratio is $\frac{1}{100}$ (ie $\frac{24\,000}{240}$)	allow ratio from their volume eg $\frac{24\,000}{250}$	1	
	100×1.45	$\left(\frac{24\,000}{250}\right) \times 1.5$	1	
	145	allow range 140–150	1	
	or allow method using answer from question **06.3**			
	$x = \frac{y}{m}$ (1)	(rearrangement of y = mx where m = answer from question **06.3**)		
	24 (dm^3) to 24 000 (cm^3) (1)			
	$\frac{24\,000}{\text{answer from question 06.3}}$ (1)			
	144 (1)	allow range 140–150		
Total			**12**	

5.1.1.6 Relative atomic mass

Answer 01 · Mark scheme

June 2018 | 8464/C/1H | Original Q6



5.1.1.6 Relative atomic mass

Answer 02 · Mark scheme June 2018 | 8464/C/1H | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	hydrogen **or** H_2	allow hydrogen gas ignore H without the 2 subscript	1	AO1 5.4.2.1
08.2	filtration / filter	allow magnet **or** decant ignore heating	1	AO1 5.1.1.2
08.3		an answer of 185–190 (mg) scores **5** marks an answer of 0.185–0.19 scores **4** marks		AO2 5.3.2.2
	(Mg) $\frac{0.12}{24}$ or 0.005 (moles)	mark is for ÷ by 24	1	
	(Fe) $\frac{2}{3} \times 0.005 = 0.00333$(moles)	mark is for × $\frac{2}{3}$	1	
	(mass Fe) = 0.00333 × 56	mark is for × 56	1	
	= 0.1866 (g)		1	
	= 187 (mg)		1	
		an answer of 280 (mg) scores **4** marks an answer of 0.280 scores **3** marks (no ratio from equation) 184 scores **0** [=(3×24) + (2×56)]		
	OR (Mg) = $\frac{0.12}{(3 \times 24 =)\ 72}$ (1) = 0.00166 **or** $\frac{1}{600}$ (moles) (1) (mass of Fe) = 0.00166 **or** $\frac{1}{600} \times 112\ (2 \times 56)$ (1) = 0.1866 (g) (1) 187 (mg) (1)			

5.1.1.6 Relative atomic mass

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3 cont.	**OR** 72 g Mg → 112g Fe (1) 1 g Mg → $\frac{112}{72}$ **or** 1.56 g Fe (1) 0.12 g Mg → $\frac{112}{72}$ × 0.12 (1) = 0.1866 (g) (1) = 187 (mg) (1)			
08.4	Fe^{3+} (because) reduction is gain <u>of electrons</u> $Fe^{3+} + 3e^{(-)}$ ➔ Fe	allow change in oxidation state / (+)3 to 0	1 1 1	AO2 AO1 AO2 5.4.1.2 5.4.1.4
Total			**10**	

5.1.1.6 Relative atomic mass

Answer 03 · Mark scheme June 2019 | 8464/C/1H | Original Q2

02.1	(aq)	allow aq ignore aqueous ignore formulae	1	AO1 5.2.2.2
02.2	HNO_3		1	AO1 5.1.1.1 5.4.2.2
02.3	red purple **or** blue	allow orange or yellow do **not** accept green allow shades of purple eg violet	1 1	AO1 5.4.2.4
02.4	D		1	AO3 5.4.2.4
02.5	3 × 16 **or** 48 $\frac{48}{80}$ (×100) 60 (%)	an answer of 60 (%) scores **3** marks an answer of 20 (%) scores **2** marks for: $\frac{16}{80}$ (× 100) (1) = 20 (%) (1)	1 1 1	AO2 5.3.1.2

Question	Answers	Mark	AO/ Spec. Ref
02.6	**Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 AO2
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	5.5.1.1
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content **Steps** • use a suitable container eg test tube • use insulation • add water • measure the initial water temperature (with a thermometer) • add stated mass eg 1g **or** 1 spatula • stir (to dissolve the solid) • measure the final (allow lowest or highest) temperature of the solution • calculate the temperature difference **or** determine graphically • repeat with different masses • repeat with the same volume of water to access level 3 there must be an indication of how the temperature change is determined using different masses dissolved in the same quantity of water		

Total			14

5.1.1.6 Relative atomic mass

Answer 03 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.1.1.6 Relative atomic mass

Answer 04 · Mark scheme June 2019 | 8464/C/1H | Original Q4

04.1	atomic weight	do **not** accept atomic mass or A_r	1	AO1 5.1.2.2

04.2	left gaps / spaces **or** changed the order based on atomic weights	 allow placed them in correct groups according to properties do **not** accept reference to atomic number	1	AO1 5.1.2.2

04.3	weak forces between the molecules **or** weak intermolecular forces	allow weak intermolecular bonds do **not** accept incorrect references to covalent bonds	1	AO1 AO3 5.1.2.6 5.2.2.4
	(so) little energy required to overcome / break the forces between molecules **or** (so) little energy required to overcome / break the intermolecular forces	allow (so) little energy required to separate the molecules allow (so) little energy required to overcome / break the intermolecular bonds ignore less energy	1	

04.4	(the) molecules get larger going down the group (so the) forces between the molecules increase **or** (so the) intermolecular forces increase (so the) boiling points increase going down the group **or** (so the) boiling points increase with increasing relative atomic mass	allow converse explanation in terms of boiling point allow (so) more energy is needed to separate the molecules	1 1 1	AO1 AO3 5.1.2.6 5.2.2.4

04.5	2,8 (so) stable arrangement of electrons **or** (so) full outer shell	allow diagram or description	1 1	AO1 5.1.2.4

04.6	$\frac{1}{40} \times 6.02 \times 10^{23}$ **or** $0.025 \times 6.02 \times 10^{23}$ 1.51×10^{22}	an answer of 1.51×10^{22} scores **2** marks allow 1.505×10^{22}	 1 1	AO2 5.3.2.1

Total			**11**

5.1.1.6 Relative atomic mass

Answer 04 · Mark scheme

June 2019 | 8464/C/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.1.1.6 Relative atomic mass

Answer 05 · Mark scheme June 2019 | 8464/C/2H | Original Q4

04.1	growing plants (on low-grade ore) plants are burnt (to produce ash) (ash dissolved in acid to produce) solution of a copper compound electrolysis (of solution of a copper compound) **or** displacement (by adding scrap iron to a solution of a copper compound)	allow named plant allow named copper compound allow addition of scrap iron (to a solution of a copper compound)	1 1 1 1	AO1 5.10.1.4
04.2	 M_r $CuSO_4$ = 159.5 $\frac{0.319}{159.5}$ = 0.002 (mol)	an answer of 0.002 **or** 2×10^{-3} (mol) scores **3** marks allow correct use of incorrectly calculated value for M_r allow 2×10^{-3} (mol)	 1 1 1	AO2 5.3.2.1 5.3.2.5
04.3	both reaction profiles start at the same energy level and end at the same energy level.		1	AO3 5.6.1.4

5.1.1.6 Relative atomic mass

Answer 05 · Mark scheme

04.4	the amount of carbon dioxide used to produce the ethanol is the same as the amount of carbon dioxide given off when the ethanol is burned	**alternative approach** there is sufficient carbon dioxide (in the atmosphere) (1) because carbon dioxide is constantly produced from burning fossil fuels (1) if no other mark awarded allow for **1** mark burning ethanol produces carbon dioxide	1 1	AO3 5.9.2.2 5.9.3.1

5.1.1.6 Relative atomic mass

Answer 05 · Mark scheme

June 2019 | 8464/C/2H | Original Q4

04.5	meets needs of current generation without compromising needs of future generations	 allow so there are enough resources for future generations ignore references to harming / damaging planet / environment	1 1	AO1 5.10.1.1

Total			**12**

5.1.1.6 Relative atomic mass

Answer 05 · Mark scheme

June 2019 | 8464/C/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.1.1.6 Relative atomic mass

Answer 06 · Mark scheme

June 2019 | 8464/C/2H | Original Q6

06.1	glowing splint relights		1 1	AO1 5.8.2.2

06.2	equilibrium shifts to right-hand side (because) concentration of SO_3 decreases	allow towards the products allow in favour of the forward reaction this marking point is dependent on first marking point being awarded allow pressure decreases allow to increase the concentration of SO_3 allow to re-establish equilibrium	1 1	AO3 AO2 5.6.2.5 5.6.2.7

06.3	(M_r CaO =) 56 (M_r $CaSO_3$ =) 120 $\frac{7}{56} \times 120$ = 15(.0 g)	an answer of 15(.0 g) scores **4** marks in all approaches allow a correct calculation using an incorrectly calculated M_r **alternative approach A** (M_r CaO =) 56 (1) $\frac{7}{56}$ = 0.125 (moles) (1) (mass $CaSO_3$ =) 0.125 × 120 (1) = 15(.0 g) (1)	1 1 1 1	AO2 5.3.1.2 5.3.2.1 5.3.2.2

5.1.1.6 Relative atomic mass

		alternative approach B (M_r CaO =) 56 (1) $\frac{56}{7}$ = 8 (factor) (1) (M_r $CaSO_3$ =) 120 (1) $\frac{120}{8}$ = 15(.0 g) (1) **alternative approach C** (M_r CaO =) 56 (1) (M_r $CaSO_3$ =) 120 (1) $\frac{120}{56}$ = 2.14235714 (factor) (1) 2.14235714 × 7 = 15(.0 g) (1)		

Total			**8**

5.1.1.6 Relative atomic mass

Answer 06 · Mark scheme

June 2019 | 8464/C/2H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.1.1.6 Relative atomic mass

Answer 07 · Mark scheme November 2020 | 8464/C/1H | Original Q6

06.1	atoms have a positively charged nucleus. mass is concentrated in the nucleus in the centre of atoms.		1 1	AO1 5.1.1.3

06.2	$\frac{4 \times 10^{-7}}{2400}$ $= 1.66666 \times 10^{-10}$ $= 1.67 \times 10^{-10}$ (m)	 allow 0.000 000 000 167 (m) allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question	1 1 1	AO2 5.1.1.5

06.3	(moles Au = $\frac{0.175}{197}$ =) 0.000888 (moles Cl_2 = 0.000888 × $\frac{3}{2}$ =) 0.00133 (mass Cl_2 =) 0.00133 × 71 = 0.0946 (g) = 94.6 (mg)	 allow a correct calculation using an incorrectly calculated value of moles of gold allow a correct calculation using an incorrectly calculated value of moles of chlorine allow a correct conversion using an incorrectly calculated mass of chlorine	1 1 1 1 1	AO2 5.3.1.1 5.3.2.2

	alternative approach: (from equation 2 moles of Au reacts with 3 moles of Cl_2) (so) 394 g Au reacts with 213 g Cl_2 (1) 1 g Au reacts with ($\frac{213}{394}$ =) 0.54 g Cl_2 (1) 0.175 g Au reacts with 0.54 × 0.175 g Cl_2 (1) = 0.0946 (g) (1) = 94.6 (mg) (1)	 allow a correct calculation using an incorrectly calculated value of mass of gold and / or chlorine allow a correct calculation using an incorrectly calculated value of mass of gold and / or chlorine allow a correct conversion using an incorrectly calculated mass of chlorine		

Total			**10**

5.1.1.6 Relative atomic mass

Answer 07 · Mark scheme

November 2020 | 8464/C/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.1.1.6 Relative atomic mass

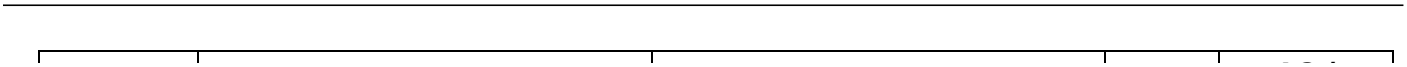
Answer 08 · Mark scheme November 2021 | 8464/C/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	(Group) 0 **or** noble gases		1	AO2 5.1.2.2
01.2	B		1	AO2 5.1.1.3
01.3	A		1	AO3 5.1.1.3
01.4	(atoms with the) same number of protons	allow atoms with the same atomic number allow atoms of the same element ignore the same number of electrons	1	AO1 5.1.1.5
	(but with) different numbers of neutrons	ignore (but with) different mass numbers do **not** accept (but with) different relative atomic mass	1	
01.5	$\frac{(39 \times 93.1) + (41 \times 6.9)}{100}$ = 39.138 = 39.1	 allow correctly rounded answer to **1** decimal place from an incorrect calculation using all the values given in the question	1 1 1	AO2 5.1.1.6
Total			**8**	

5.1.1.6 Relative atomic mass

Answer 08 · Mark scheme

November 2021 | 8464/C/1H | Original Q1



5.1.1.6 Relative atomic mass

Answer 09 · Mark scheme November 2021 | 8464/C/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(mass of oxygen = 0.20 – 0.12) = 0.08 (g)		1	AO2 5.1.1.1 5.3.1.1 5.3.1.3 5.3.2.1 5.4.1.1
	(moles of oxygen) = $\frac{0.08}{32}$	allow **1** mark for 0.005 if derived from $\frac{0.08}{16}$	1	
	= 0.0025		1	
06.2	(without a lid the) mass of magnesium oxide was less		1	AO3 5.4.1.1
	(because) products escaped	allow magnesium oxide escaped	1	
06.3	(mass of copper oxide =) $\frac{79.5}{63.5} \times 0.5$		1	AO2 5.1.1.1 5.3.1.1 5.3.1.3 5.3.2.1 5.3.2.2 5.3.2.3 5.4.1.1
	= 0.62598 (g)		1	
	= 0.626 (g)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all the values in the question	1	

5.1.1.6 Relative atomic mass

Answer 09 · Mark scheme

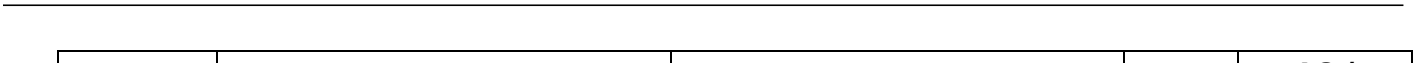
November 2021 | 8464/C/1H | Original Q6

06.4	3:2 ratio Fe : O_2 (molecules) **or** 3:4 ratio Fe : O (atoms)		1	AO2 5.1.1.1 5.3.1.1 5.3.1.3 5.3.2.1
	(formula) Fe_3O_4	allow **1** mark for Fe_3O_2 from 3:2 ratio Fe : O (atoms) (MP2 but not MP1)	1	5.3.2.2 5.3.2.3 5.4.1.1
	$3\,Fe + 2\,O_2 \rightarrow Fe_3O_4$	allow multiples allow correct use of incorrectly determined formula allow **1** mark for Fe, O_2 and Fe_3O_4 **or** allow **1** mark for Fe, O_2 and incorrectly determined formula	2	
Total			**12**	

5.1.1.6 Relative atomic mass

Answer 09 · Mark scheme

November 2021 | 8464/C/1H | Original Q6



5.1.1.6 Relative atomic mass

Answer 10 · Mark scheme

June 2022 | 8464/C/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	electrolysis of molten compound (of metal **Y**) **OR** displacement (1) by heating with a more reactive metal **or** by heating with potassium / magnesium (1)	 allow liquid for molten	1 1	AO3 5.4.1.3 5.4.3.2 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	4 Na + $TiCl_4$ → 4 NaCl + Ti	allow multiples allow **1** mark for NaCl **and** Ti with incorrect / no balancing	2	AO2 5.1.1.1 5.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	$Na \rightarrow Na^+ + e^-$	ignore state symbols allow multiples allow **1** mark for $Na \rightarrow Na^+ + e^-$ with incorrect balancing	2	AO2 5.4.1.2 5.4.1.4

5.1.1.6 Relative atomic mass

Answer 10 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	**method 1:** (moles of Al = $\frac{108}{27}$ =) 4		1	AO2 5.3.2.2 5.3.2.4
	(moles $CuCl_2$ = $\frac{1210}{134.5}$ =) 8.996	allow 9	1	
	(identifying limiting reactant) 4 moles Al gives 6 moles Cu 8.996 moles $CuCl_2$ gives 8.996 moles Cu	allow correct use of an incorrectly calculated value(s) for moles of Al and / or $CuCl_2$	1	
	therefore aluminium is the limiting reactant	must follow on from MP3	1	
	(mass of Cu = 2 × 3 × 63.5) = 6 × 63.5		1	
	= 381 (g)		1	

5.1.1.6 Relative atomic mass

Answer 10 · Mark scheme

June 2022 | 8464/C/1H | Original Q7

07.4 cont.	**method 2:** $2\,Al + 3\,CuCl_2 \rightarrow 3\,Cu + 2\,AlCl_3$ (2×27) (3×134.5) (3×63.5) 54 (g) 403.5 (g) 190.5 (g) (1) (1) (1) (so) 108 g Al (reacts with 807 g $CuCl_2$) to produce 381 g Cu (1) (so) there is excess $CuCl_2$ **or** 807 g $CuCl_2$ is less than 1210 g $CuCl_2$ (1) therefore aluminium is limiting reactant (1) **method 3:** 134.5 g $CuCl_2$ produces 63.5 g Cu (1) (mass conversion 1.21 kg $CuCl_2$ =) 1210 (g) (1) 1210 g $CuCl_2$ produces ($\frac{63.5}{134.5}$ × 1210 =) 571 g Cu (1) 54 g Al produces 190.5 g Cu (1) 108 g Al produces ($\frac{190.5}{54}$ × 108 =) 381 (g) (1) (therefore) aluminium is the limiting reactant (1)	allow correct use of an incorrect calculation of mass for Al / $CuCl_2$ / Cu must follow on from MP4 / MP5 allow correct use of an incorrect / no conversion of mass of $CuCl_2$ must follow on from MP3 and MP5		

5.1.1.6 Relative atomic mass

Answer 10 · Mark scheme

June 2022 | 8464/C/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	delocalised electrons carry (electrical) charge through the metal / sodium	allow free electrons ignore throughout for through ignore current / electricity MP2 is dependent upon MP1	1 1	AO1 5.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(conducts electricity) when liquid / molten **or** (conducts electricity) in (aqueous) solution (because) <u>ions</u> (ions) are free to move **or** (ions) allow charge to flow	allow (conducts electricity) when dissolved in water	1 1 1	AO1 5.2.2.3

Total Question 7		17

5.1.1.6 Relative atomic mass

Answer 11 · Mark scheme

June 2023 | 8464/C/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	neutralisation	allow exothermic	1	AO1 5.4.2.2 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	(M_r =) (1 × 2) + 32 + (4 × 16) = 98		1 1	AO2 5.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	(A_r O × 4 =) 4 × 16 **or** 64 (percentage of oxygen =) $\frac{64}{110} \times 100$ = 58.18 = 58 (%)	 allow correct use of incorrectly determined mass of oxygen allow a correctly calculated answer to 2 significant figures from an incorrect calculation which uses the values in the question	1 1 1 1	AO2 5.3.1.2

5.1.1.6 Relative atomic mass

Answer 11 · Mark scheme

June 2023 | 8464/C/1H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	(unit conversion) (25 cm^3 ÷ 1000) = 0.025 dm^3		1	AO2 5.3.2.5
	(conc =) $\frac{0.30}{0.025}$ (g/dm^3)	allow correct use of incorrect / no unit conversion	1	
	= 12 (g/dm^3)		1	
	alternative approach: $\frac{0.30}{25}$ (g/cm^3) (1)			
	= 0.012 (g/cm^3) (1)			
	(unit conversion) (0.012 × 1000) = 12 (g/dm^3) (1)	allow correct conversion of an incorrect concentration calculation		

Total Question 2	10

5.1.1.6 Relative atomic mass

Answer 12 · Mark scheme

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

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	electron → proton → neutron		1	AO1 5.1.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	(times heavier =) $\frac{1.673 \times 10^{-27}}{9.109 \times 10^{-31}}$ = 1837	 allow 1836.645076 correctly rounded to at least 3 significant figures	1 1	AO2 5.1.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	46		1	AO2 5.1.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	36		1	AO2 5.1.1.4 5.1.1.5

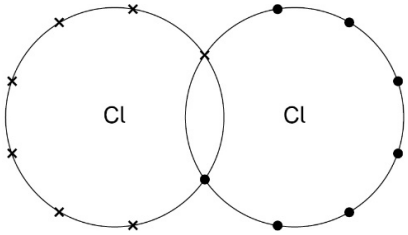
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(A_r =) $\frac{(35 \times 75.77) + (37 \times 24.23)}{100}$ = 35.4846 = 35.48	 allow an answer correctly calculated to 2 decimal places from an incorrect calculation which uses the values in the question	1 1 1	AO2 5.1.1.6

5.1.1.6 Relative atomic mass

Answer 12 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6		allow any combination of circles, dots, crosses, $e^{(-)}$ for electrons		AO1 5.1.2.6 5.2.1.1
	one shared pair in overlap		1	5.2.1.4
	each chlorine atom with 6 non-bonded electrons (on outer shell)	ignore any inner shell electrons	1	
		the diagram below scores 2 marks		



Total Question 4	10

5.1.1.6 Relative atomic mass

Answer 13 · Mark scheme

June 2023 | 8464/C/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	filter (to remove excess magnesium) (then) crystallisation (of magnesium chloride solution)	 allow (then) evaporation (of water from magnesium chloride solution)	1 1	AO1 5.1.1.2 5.4.2.1 5.4.2.3 RPA8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(magnesium atoms are) oxidised (because the atoms) lose (two) electrons		1 1	AO2 5.4.1.4 5.4.2.1 5.4.2.3 RPA8

5.1.1.6 Relative atomic mass

Answer 13 · Mark scheme

June 2023 | 8464/C/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	(moles Mg =) $\frac{0.72}{24}$		1	AO2 5.3.1.1 5.3.2.2 5.4.2.1 5.4.2.3 RPA8
	= 0.03		1	
	(moles Mg = moles $MgCl_2$) (so mass $MgCl_2$ =) 0.03 × 95	allow a correct calculation using an incorrectly calculated value of moles of magnesium allow a correct calculation using an incorrectly calculated value of moles of magnesium chloride	1	
	= 2.85 (g)		1	
	(100.0 cm^3 = 0.100 dm^3 concentration = $\frac{\text{mass}}{\text{volume}}$)			
	= $\frac{2.85}{0.100}$	allow correct use of incorrectly calculated mass of magnesium chloride	1	
	= 28.5 (g/dm^3)		1	

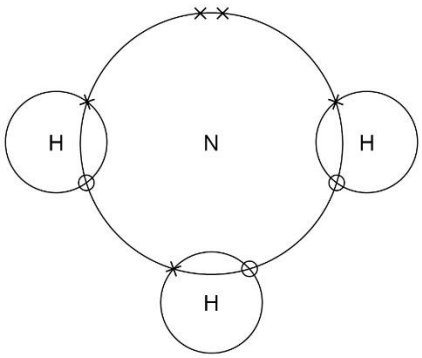
Total Question 6	10

5.1.1.6 Relative atomic mass

Answer 14 · Mark scheme

June 2024 | 8464/C/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1		allow any combination of circles, dots, crosses or $e^{(-)}$ ignore any inner shell electrons on nitrogen		AO1 5.2.1.4
	one shared pair of electrons in each overlap		1	
	2 non-bonding electrons on the outer shell of nitrogen	do **not** accept non-bonding electrons on hydrogen an answer of  scores **2** marks	1	

5.1.1.6 Relative atomic mass

Answer 14 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(M_r NH_3 = 14 + (3 × 1) =) 17		1	AO2 5.3.1.1 5.3.2.2
	$\left(\text{moles } NH_3 = \frac{25}{17}\right)$ = 1.47 (mols)	allow correct use of incorrectly determined M_r of NH_3	1	
	(moles H_2 = 1.47 × $\frac{3}{2}$) = 2.205 (mols)	allow correct use of an incorrectly calculated value of moles of NH_3	1	
	(mass H_2 = 2.205 × 2) = 4.41 (g)	allow 4.4117647 (g) correctly rounded to at least 2 significant figures allow correct use of an incorrectly calculated value of moles of H_2	1	
	alternative approach (2 × M_r NH_3 = 17 × 2 =) 34 (1)			
	6 g H_2 → 34 g NH_3 (1)	allow correct use of an incorrectly calculated value of 2 × M_r NH_3		
	$\frac{6}{34}$ × 25 (g) H_2 → 25 g NH_3 (1)			
	4.41 (g H_2 → 25 g NH_3) (1)			

5.1.1.6 Relative atomic mass

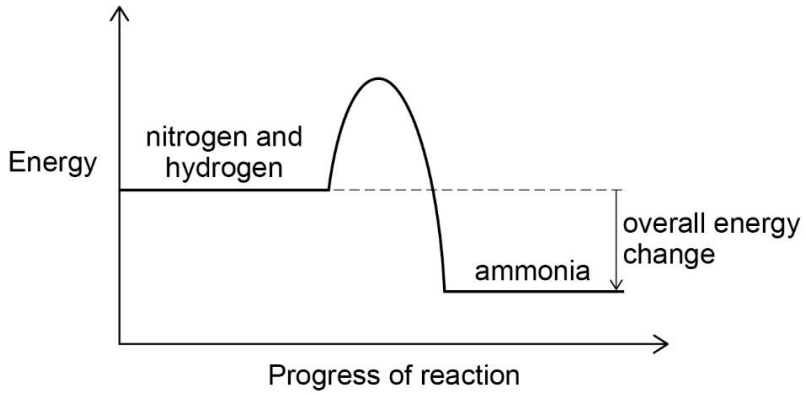
Answer 14 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(bonds broken =) 945 + 3**X**		1	AO2 5.5.1.1 5.5.1.3
	(bonds made = 6 × 391 =) 2346		1	
	(energy released = bonds made – bonds broken =) 93 = 2346 – [945 + 3**X**]	allow correct use of incorrectly determined value(s) of bonds broken and/or bonds formed	1	
	(3**X** =) 1308 (kJ/mol)		1	
	(**X** =) 436 (kJ/mol)	allow correct use of an incorrectly determined value for 3**X**	1	

5.1.1.6 Relative atomic mass

Answer 14 · Mark scheme

June 2024 | 8464/C/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	correct shape for exothermic reaction with the product line below the level of the reactants line		1	AO2
	labelled horizontal lines for reactants and product	labelled horizontal lines for nitrogen and hydrogen and ammonia	1	AO1
	labelled overall energy change		1	AO1 5.5.1.2
	an answer of  scores **3** marks			

Total Question 5	14

5.1.1.6 Relative atomic mass

Answer 15 · Mark scheme

June 2025 | 8464/C/1H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(a reaction) which transfers energy to the surroundings	allow heat for energy allow (a reaction) which releases energy (to the surroundings)	1	AO1 5.5.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	(mass of oxygen = 2 × 16 =) 32		1	AO2 5.3.1.2
	(percentage =) $\frac{32}{74}$ × 100	allow correct use of an incorrectly determined mass of oxygen	1	
	= 43.2 (%)	allow 43.2432 (%) correctly rounded to at least 2 significant figures	1	

5.1.1.6 Relative atomic mass

Answer 15 · Mark scheme

June 2025 | 8464/C/1H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.3	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 5.5.1.1 RPA10
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	

	Indicative content
	• measure volume of water
	  ○ using a measuring cylinder
	  ○ pour into a suitable container eg insulated cup
	• measure initial temperature of water
	  ○ using a thermometer
	• add known mass of calcium oxide
	  ○ measured with a balance
	  ○ stir
	• measure the highest temperature reached by the mixture
	or
	measure temperature reached after set time period
	  ○ determine the temperature change
	• repeat with different masses of calcium oxide
	or
	add successive masses to the same mixture
	• use the same volume of water
	  ○ use the same initial temperature of water
	
	for **Level 3** all key steps should be described and the control variable the same volume of water must be given		

Total Question 2	10

5.1.1.6 Relative atomic mass

Answer 16 · Mark scheme

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(mass in one phone =) $1.73 \times 10^{-4} \times 197$		1	AO2 5.3.2.1 5.10.1.1
	= 0.034081 (g)		1	
	(total mass =) $0.034081 \times 2.48 \times 10^{6}$	allow (total mass =) $0.034081 \times 2\,480\,000$ allow correct use of an incorrectly determined mass in one phone	1	
	= 84520.88 (g)		1	
	(conversion 84520.88 g =) 84.5 (kg)	allow 84.52088 (kg) correctly rounded to at least 2 significant figures allow conversion at MP2, MP3 allow correct conversion of an incorrectly determined mass using all numbers from the question	1	
	alternative approach			
	(total moles =) $1.73 \times 10^{-4} \times 2.48 \times 10^{6}$ (1)	allow (total moles =) $1.73 \times 10^{-4} \times 2\,480\,000$		
	= 429.04 (1)			
	(total mass =) 429.04 × 197 (1)	allow correct use of an incorrectly determined total moles		
	= 84520.88 (g) (1)			
	(conversion 84520.88 g =) 84.5 (kg) (1)	allow 84.52088 (kg) correctly rounded to at least 2 significant figures allow correct conversion of an incorrectly determined mass using all numbers from the question		

5.1.1.6 Relative atomic mass

Answer 16 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	1.04×10^{20}		1	AO2 5.3.2.1 5.10.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	uses bacteria		1	AO1 5.10.1.4 5.10.2.2
	to produce leachate / solutions containing gold compounds		1	
	from which gold is obtained by displacement / electrolysis		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	any **two** from: • high-grade ores still available • land not available • phytomining takes a long time • very small yields produced • new technology		2	AO3 5.10.1.4

Total Question 6	**11**

5.1.1.6 Relative atomic mass

Answer 01 · Examiner comments

June 2018 | 8464/C/1H | Original Q6

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

06.1 The question was not answered well, with large numbers of students missing the key word 'formula' in the question stem. As a result, lots of responses included the names of a wide range of chemicals. Quite a few knew the formula for carbon dioxide.

06.2 Those students who were aware that carbonate had a formula of CO_3 usually came up with the correct answer. Many opted for more well-known Group 2 carbonates such as calcium and magnesium, usually with little justification.

06.3 A good number of students could successfully calculate the gradient. Most students knew the method but could not get the correct figures from the graph. Students seemed to make their life very difficult when selecting values from the graph to calculate the gradient.

The easiest methods would have been to:

- use the increase in mass from 0 g to 1 g, with the equivalent volume increase of 167 cm^3, to give a simple calculation of 167 ÷ 1
- increase in mass from 0 g to 0.5 g, or 0 g to 2 g would have also given relatively easy calculations.

There were very few inverted equations but very few correct units, these were invariably inverted as g/cm^3

When determining a gradient students should be encouraged to draw the sides of their triangle as large as possible, as this reduces the error in reading the *x* and *y* values from the graph.

06.4 This question was answered well by only the highest-attaining students with 4% achieving full marks. Their working followed those methods in the mark scheme or routes based upon these, which also achieved full credit. These students could either see the link from the graph, where 240 cm^3 had a mass of 1.45 g, and the subsequent conversion from 240 cm^3 to 24 dm^3 or they divided the volume (in cm^3) by their gradient.

Some students used a volume on the *y*-axis of 24 cm^3, which gave a mass of approximately 0.15 g on the *x*-axis, which scaled up to (a correct answer of) 150. However, because their scale was so small, some got the mass as 0.16 g. As this is within half a small square and scaled up to 160, these students were also awarded full credit.

Students should be aware that when larger values are taken from the *x* and *y*-axes, errors in subsequent calculations are minimised.

5.1.1.6 Relative atomic mass

Answer 02 · Examiner comments

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

Question 8 (standard, standard / high & high demand)

08.1 66% of students answered this question correctly. The most common incorrect answer was water.

08.2 47% of students appreciated the need for filtration or the use of a magnet. The most common incorrect responses were electrolysis, distillation, heating / evaporation or displacement using carbon.

Students need to understand the list principle. If they give two answers (one correct and one incorrect) when only one is required, no mark can be awarded. This was the case with those students who gave filter and another method that was incorrect eg simple distillation.

08.3 Students found this question tough, but it discriminated well with higher-attaining students being able to achieve four or five marks (10%). 74% of students scored zero marks.

The most common mistake found in correct calculation methods was the absence of a conversion from g to mg. Some got to 0.185 g and then stopped or converted g to mg incorrectly. Common errors were dividing by 1000 rather than multiplying by 1000 or using a factor of 10 or 100 to convert g to mg.

Stoichiometry was not well understood which resulted in students obtaining an answers of:

- 280 mg or 0.280 g due to the omission of the stoichiometric ratio (× 2/3) or
- 124 mg or 0.124 g where they had divided by 72 and multiplied by 112, and had multiplied by 2/3 as well, so they had taken the ratio into account twice.

Some students got as far as 0.12/24 or 0.12/72 and then no further. Others tried to calculate RFMs for the compounds involved and got no further and gained no marks.

08.4 The most common mark achieved was for stating that reduction was the gaining of electrons. Many students quoted OILRIG but gave an incomplete answer of ‘reduction was gain’, without stating what it was that was being gained.

Few students specifically identified the ‘reduced species’ being reduced. Some did identify iron was reduced but didn’t say which ion of iron, others gave magnesium or iron chloride.

Only a small number of students correctly wrote the half equation. 1% of students achieved two or three marks.

5.1.1.6 Relative atomic mass

Answer 02 · Examiner comments

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

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

5.1.1.6 Relative atomic mass

Answer 03 · Examiner comments — June 2019 | 8464/C/1H | Original Q2

Question 2

This question was common with the Foundation paper and included an extended response question based around Required Practical Activity 10. Each item was at standard demand.

02.1 This question was poorly answered where only a quarter of students gained the mark. A wide range of incorrect responses were seen. Many students wrote a chemical formula of ammonium nitrate instead of the state symbol. Students should know that state symbols are lower case only which are written in brackets.

02.2 Around two-thirds of students identified the correct formula of nitric acid. The next most common response was the alkali NH_4OH

02.3 This recall question was generally well answered with more than half the students gaining both marks. Two colours were often listed eg red/orange or blue/purple when only one colour was required. The most common incorrect responses included green, black and colourless.

Answer 03 · Examiner comments — June 2019 | 8464/C/1H | Original Q2

02.4 Approximately one-third of students identified the correct pH change when nitric acid was added to ammonia solution. The three incorrect responses were selected in approximately equal amounts. A large number of students did not follow the rubric of the question which required them to tick one box only.

02.5 This question discriminated well. Two-thirds of students gained all three marks for an answer of 60%. A very common error was to carry out the calculation for only one oxygen atom, leading to an answer of 20%, which gained two marks. Some students started the calculation correctly by calculating 48 for three oxygen atoms, but then subtracted that from the given relative formula mass to give 32, which was then used in a percentage calculation.

02.6 Most students had a good understanding of the requirements of this question which was based upon Required Practical Activity 10. They could appreciate the need to control variables, although the most common errors were to not mention a constant volume of water when starting each experiment or not taking the temperature of the water before the ammonium nitrate was added. The descriptions were often poorly organised with statements relating to a constant volume of water or measuring the starting temperature appearing at the end of the response. Some students carried out the experiment in one container, adding successive masses to the same beaker in the same way they could have done a heat of neutralisation experiment. This question discriminated well with approximately a fifth of students achieving level 3 and a half achieving level 2.

5.1.1.6 Relative atomic mass

Answer 04 · Examiner comments

June 2019 | 8464/C/1H | Original Q4

Question 4

Most of this question was at standard/high demand.

04.1 Scientists' use of atomic weight to arrange elements in early periodic tables was not well known. Far too many students did not fully appreciate the historical nature of the question and provided concepts that were not known at the time, such as atomic number and electrons.

04.2 Over half the entry gave a correct reason. Large numbers of students appreciated that Mendeleev left gaps or grouped elements with similar properties. Changing the order based upon atomic weights was correct but less common.

04.3 Only the higher-attaining students were able to explain that halogens have low boiling points because of weak intermolecular forces. It is these forces that are overcome when a 'little energy' is applied; less energy did not gain this mark, as less does not necessarily equate to little. Many students answered this question incorrectly in terms of the covalent bonds within the halogens. A lot of students linked the listed values to reactivity within group 7.

5.1.1.6 Relative atomic mass

Answer 04 · Examiner comments June 2019 | 8464/C/1H | Original Q4

04.4 The concept of intermolecular forces and the fact that the intermolecular forces increase because the molecules got larger was rarely seen in explanations. Many students gained a mark for stating that the boiling points increased down the group; down the table or periodic table did not gain this mark. Students commonly tried to explain a trend in reactivity down the group and attempted to link that to boiling points. Some struggled with negative temperatures.

04.5 Most students were able to state that neon's outer shell was full. Many did not gain the second mark by not giving the electronic structure of neon.

04.6 A third of students calculated the correct answer for 2 marks. Many were confused by standard form, with only a few students making slight calculation errors.
Most wrong answers came from either dividing the Avogadro number by 0.025 (the number of moles) or from multiplying by 40; they did not appreciate that 1g of argon is less than 1 mole of argon so the answer to this question must be less than 6×10^{23}

Answer 05 · Examiner comments June 2019 | 8464/C/2H | Original Q4

Question 4 (standard/high demand)

04.1 The majority of students who obtained marks on this question did so from the first 2 marking points, although then many continued to describe the next process incorrectly as 'electrolysing the copper metal from the ash'. Converting the copper compounds found in the ash into a suitable copper solution or electrolyte, was rarely seen in the student responses. A significant minority of students who gained no marks on this question did not seem familiar with the process of phytomining, and gave answers based around normal mining, or heating the rock until the copper melted.

04.2 Around 73% of students gained some credit on this question, predominantly for correctly calculating the M_r of copper sulfate (159.5), although 111.5 (addition of all the A_r given in the question) was given regularly. The most common mistake was to multiply the figures (0.319 x 159.5) rather than divide ($\frac{0.319}{159.5}$). 15% of students scored all three marks, many giving their answers in standard form (2×10^{-3}), which, although not asked for, was accepted.

04.3 About 84% of students gained this mark with no pattern seen in the incorrect responses.

04.4 Only a few students achieved both marks by correctly linking the idea that the amount of CO_2 used to produce ethanol would be the same as would be released when the ethanol was burned. The vast majority of correct answers for both marks were based on the large amount of CO_2 in the air, and its regular replacement by burning fossil fuels. About 23% of students achieved 1 mark for highlighting that there was sufficient carbon dioxide in the atmosphere or that it is produced from the combustion of ethanol.

04.5 Around 17% of students gained credit on this question by recalling the definition of sustainability from the specification or were able to give an equivalent statement. Most students answered in terms of environmental issues or renewable routes, including 'long lasting' and 'won't run out'.

5.1.1.6 Relative atomic mass

Answer 06 · Examiner comments — June 2019 | 8464/C/2H | Original Q6

Question 6 (standard/high demand)

06.1 The correct test and result for oxygen gas was known by about 54% of students. Using a splint (not glowing) or a 'blown-out splint' to test for oxygen were the most frequently seen incorrect answers.

06.2 Less than a quarter of students achieved credit on this question, with around 4% of students achieving both marks. Students were able to suggest a shift in the equilibrium but often in the wrong direction. Few of the students who correctly answered the directional shift were able to explain why. Many students simply suggested 'to counteract the change'. The most common correct response was 'to re-establish equilibrium'.

06.3 Over a quarter of students gained full marks and around 80% of students gained some credit for their calculation. The most common answers that gained either 1 or 2 marks were for correctly calculating the M_r for calcium oxide (56) and/or calcium sulfite (120). The

Answer 06 · Examiner comments — June 2019 | 8464/C/2H | Original Q6

highest-attaining students were able, through a variety of approaches, to successfully calculate the mass of $CaSO_3$ produced (15.0g). Using a ratio approach was more popular than using moles as a method to arrive at the answer.

The most common mistake seen was to multiply the mass of CaO by the M_r of $CaSO_3$ ($7 \times 120 = 840$).

Answer 08 · Examiner comments — November 2021 | 8464/C/1H | Original Q1

Question 1 (standard demand)

01.1 More than two thirds of students knew that Group 0, the noble gases, had not been discovered when Mendeleev's version of the periodic table was published.

01.2 The plum pudding model was identified by more than four fifths of students.

01.3 Chadwick discovered the neutron. Just under half of students were able to make the link between this discovery and the figure which represented an atom containing neutrons.

01.4 The question required students to answer in terms of 'subatomic particles'; the answer was that isotopes are atoms with the same number of protons but different numbers of neutrons. Just over one third of students gained two marks.

01.5 Many students gained the first mark by showing that the weighted average had to be divided by 100. The evaluation of this gained the second mark which then needed to be correctly rounded to one decimal place. Approximately one third of students gained all three marks.

5.1.1.6 Relative atomic mass

Answer 09 · Examiner comments November 2021 | 8464/C/1H | Original Q6

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

06.1 Just over one-tenth of students gained full marks in this calculation. Having correctly calculated the mass of oxygen the most common error was to incorrectly calculate the number of moles by dividing by the relative atomic mass of oxygen (16) rather than the relative formula mass of oxygen molecules (32).

06.2 Few students realised that without a lid the mass of products would decrease as magnesium oxide would escape during the reaction.

06.3 This calculation was answered correctly by approximately one fifth of students. A small number were not able to round their answer correctly to three significant figures.

06.4 Students found this question challenging. Very few students were able to make the link between the moles of reagents that reacted and the formula of the product. Just under one sixth of students were able to correctly write a balanced chemical equation using their iron oxide product from the earlier part of the question.

Answer 10 · Examiner comments June 2022 | 8464/C/1H | Original Q7

Question 7 (Standard/high and high demand)

07.1 Students had to recognise the relative position of a metal in a reactivity series and to deduce the method and conditions used to extract the metal from a compound of the metal. Over 50% of students gained 1 mark. Electrolysis was the most common answer. However, many students then went on to talk about electrolysis of a solution rather than the molten compound. The displacement route was less common and those who chose this method often only scored 1 mark as they failed to mention ‘heating’ when talking about potassium or magnesium.

07.2 Students had to complete an equation for the displacement reaction between sodium and titanium chloride. Some students were not able to identify the products. Titanium was usually identified, but sodium chloride was often written as $NaCl_4$. Without the correct formulae balancing was not possible. Generally, element symbols were written well with upper and lower case letters in the appropriate place. Nearly 20% of students gained both marks.

5.1.1.6 Relative atomic mass

Answer 10 · Examiner comments June 2022 | 8464/C/1H | Original Q7

07.3 Students were asked to write the half equation to show the oxidation of sodium. This proved very challenging. Approximately 5% gained two marks with about a fifth of students not attempting the question. One mark was infrequently scored, since identifying the equation and not the balancing proved to be the problem.

07.4 This reacting mass calculation where students had to identify the limiting reagent proved very challenging. Only a small percentage of students were able to show that aluminium was the limiting factor. Although there were several methods available to students, many attempted to use more than one method to get to the answer. Many students could work out the number of moles of aluminium and copper chloride or the ratio of masses that reacted together, but then were unable to use these numbers further. 30% of students scored 3 marks in this calculation but few scored any further marks..

07.5 Students had to describe how sodium metal conducts electricity. More than 50% of students gained 1 mark for stating that delocalised electrons or free electrons were responsible for electrical conduction in metals. The idea that these delocalised electrons carry the charge through the metal was infrequently given (the second marking point). Many students suggested throughout or around, which did not give direction to their answer.

07.6 Students had to explain how sodium chloride conducts electricity. Many students gave the impression that sodium chloride is a liquid or (to a lesser extent) aqueous solution, rather than conveying that conductivity is restricted to when sodium choride is in these states. Many incorrectly described the electrons as the particles that were able to move. 10% of students gained all 3 marks for stating that sodium chloride needed to be either molten or in aqueous solution in order to conduct electricity and went on to mention ions that are free to move.

5.1.1.6 Relative atomic mass

Answer 10 · Examiner comments

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

5.1.1.6 Relative atomic mass

Answer 11 · Examiner comments June 2023 | 8464/C/1H | Original Q2

Question 2 (standard demand)

02.1 More than a third of students knew that the reaction was either neutralisation or exothermic. Displacement and endothermic were common incorrect responses.

02.2 Over 80% of students correctly calculated the relative formula mass of sulfuric acid from the given formula.

02.3 This question was a good discriminator. Just under half of students answered this correctly. A further 20% gained 3 marks; either failing to recognise that there are four oxygen atoms in lithium sulphate or for not giving their answer to 2 significant figures.

02.4 This question was a good discriminator. A third of students gained all 3 marks. The most common method was to start by evaluating the mass of 0.30 g divided by the volume of 25 cm^3. A third of students failed to then carry out the unit conversion of cm^3 into dm^3.

Answer 12 · Examiner comments June 2023 | 8464/C/1H | Original Q4

Question 4 (standard and standard/high demand)

04.1 Nearly half of the students correctly selected the order of discovery of the electron, proton and neutron. A third of students thought that the proton was discovered before the electron and chose the fourth option.

04.2 Just over a third of students calculated the number of times a proton is heavier than an electron. Most students were able to correctly round their answers to 3 significant figures although those who gained 1 mark invariably evaluated the ratio correctly but then incorrectly rounded the answer (1836.645076) usually by 'truncating' this to 1836. The most common error here was to invert the mathematical expression.

04.3 More than three-quarters of students deduced the number of neutrons in the bromine $^{81}_{35}Br$ atom.

04.4 Only 20% of students deduced the number of electrons in the bromide $^{81}_{35}Br^-$ ion. The majority gain the number of electrons in a bromine atom.

04.5 This question was a good discriminator. Just under a third of students gained all 3 marks with a few students gaining 2 of the 3 marks for not giving their answer to 2 decimal places.

04.6 More than three-quarters of students correctly drew a dot and cross diagram for chlorine. When only one mark was gained this was usually for the two shared electrons in the overlap between the atoms. Some failed to show that there are six unshared electrons on each chlorine atom.

5.1.1.6 Relative atomic mass

Answer 13 · Examiner comments June 2023 | 8464/C/1H | Original Q6

Question 6 (standard/high and high demand)

06.1 Students found difficulty in describing how to obtain magnesium chloride from the reaction solution. Just over one third of students gained at least one mark. A number of students did not filter out the excess magnesium before crystallising the solution and many referred to magnesium displacing hydrogen.

06.2 A common response was that magnesium displaces the hydrogen without any explanation; many students did not appreciate that this is a redox reaction. Students should realise that metals always undergo oxidation which can be related to dot and cross diagrams in ionic bonding. In this question identifying what is oxidised (ie the metal) is easier than identifying what is reduced ie H+ ion (not hydrogen). Magnesium is oxidised during the reaction with hydrochloric acid as magnesium atoms lose two electrons. Students found it challenging to describe what happens to the magnesium atoms with only a quarter gaining more than one mark. Many students who stated that magnesium atoms were oxidised then went on to state it was because they gained oxygen. A common mistake was to say that atoms (not electrons) were lost.

06.3 Students found this calculation challenging but the question proved to be a good discriminator. A third of students gained at least one mark for initially calculating the number of moles of magnesium. About 20% went on to calculate the mass of magnesium chloride produced as 2.85 grams. Only a small percentage of students then went on to determine the concentration of the magnesium chloride solution produced; students struggled with the conversion of 100 cm^3 into dm^3 so a wide variety of answers were seen where a mass of 2.85 grams had been multiplied by ‘some factor of 10’.

Answer 14 · Examiner comments

Question 5 (standard/high & high demand)

05.1 Around two-thirds of students were able to complete the dot and cross diagram for an ammonia molecule.

Some students gained just 1 mark for correctly adding either three shared pairs of electrons or two non-bonding electrons on the outer shell of nitrogen, or included non-bonding electrons on hydrogen, so were not able to access mark point 2.

05.2 In this reacting mass calculation students were asked to calculate the mass of hydrogen needed to produce 25 g of ammonia. As always, a number of approaches were taken and students who showed their working often gained credit even after making errors. More than half of students scored at least 1 mark.

Those who answered with a moles method usually scored 4 marks for the correct answer, 3 marks for 2.94 g (because they missed the molar ratio) or 1 mark for determining the M_r of ammonia.

Those who used a ratio method usually either scored 4 marks for the correct answer or 1 mark for $2 \times M_r$ of ammonia; few showed clear working to gain either marking point 2 or marking point 3.

05.3 In this question students were asked to calculate the bond energy for the H—H bond. The working for breaking bonds needed to show that the values 945 and 3*X* have been added together.

Many students were good at calculating the energy changes for bonds broken but went on to simply subtract the bond breaking value from the bond making value without taking into account the H—H bond energy. In the reaction more energy was released than was needed to break existing bonds so this value, 93 kJ/mol, needed to be correctly used in the next stage of the calculation before the H—H bond energy was determined by dividing by 3.

This question differentiated well, with higher-attaining students showing clear working where they equated the energy released to the difference between the bonds made and the bonds broken.

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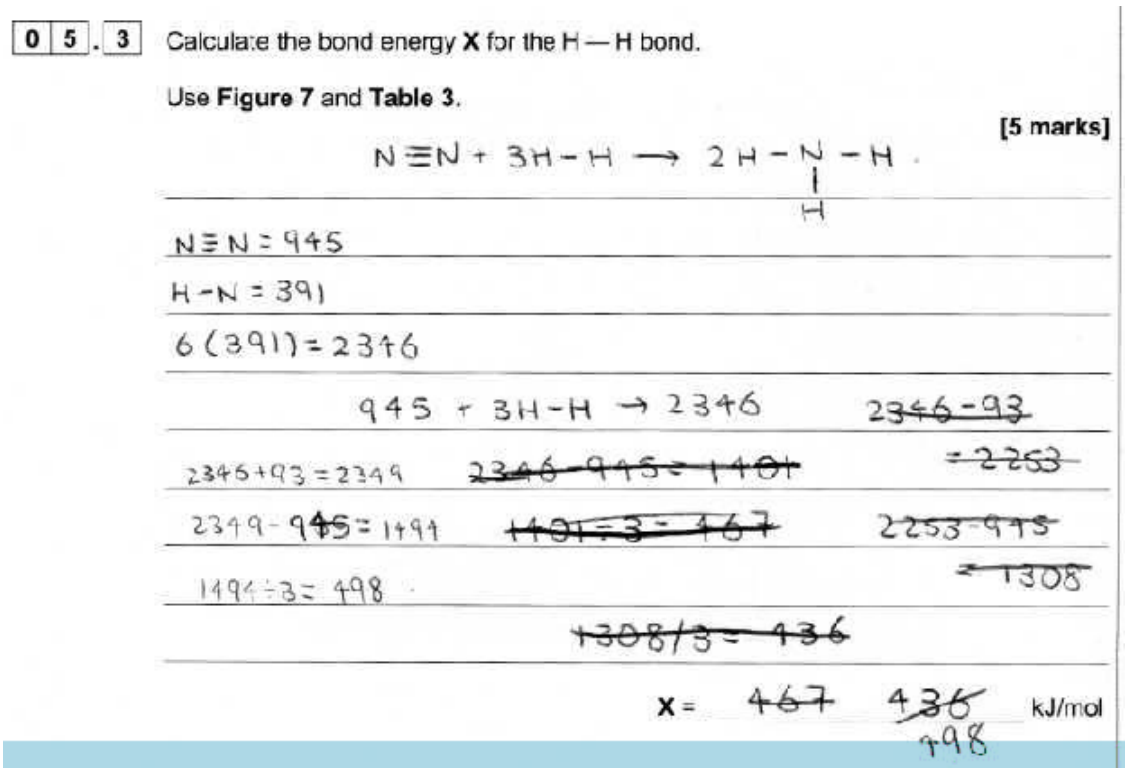
5.1.1.6 Relative atomic mass

Answer 14 · Examiner comments June 2024 | 8464/C/1H | Original Q5

0 5 . 3 Calculate the bond energy **X** for the H — H bond.

Use **Figure 7** and **Table 3**.

[5 marks]



This student gained 3 marks for 498 kJ/mol. They gained the first 2 marks for calculating the energy to break bonds and the energy released when bonds are made but did not then include the value of 93 so were unable to gain the next 2 marks. They then correctly divided 1494 by 3 to determine the average H—H bond energy so gained the final mark.

The student has made three attempts at the calculation, two of which they have crossed out. In the middle they did not use the value of 93, which gave a common incorrect answer of 436; this answer would have also scored 3 marks. On the right (also crossed out) they used the value of 93 correctly to give the correct answer of 436, which would have scored all 5 marks.

05.4 This question was well answered with approximately 20% of students gaining 3 marks, 40% gaining 2 marks and 20% of students gaining 1 mark.

Those students who gained 2 marks usually either drew the arrow indicating the overall energy change incorrectly or completed a correct profile for an endothermic reaction.

When 1 mark was scored this was usually for the correct shape for an exothermic reaction but labels for reactants and/or product were omitted and the arrow indicating the overall energy change was incorrect. On this occasion any sort of arrow was allowed accompanied with the label for the overall energy change, and ΔH is an equivalent response for the label.

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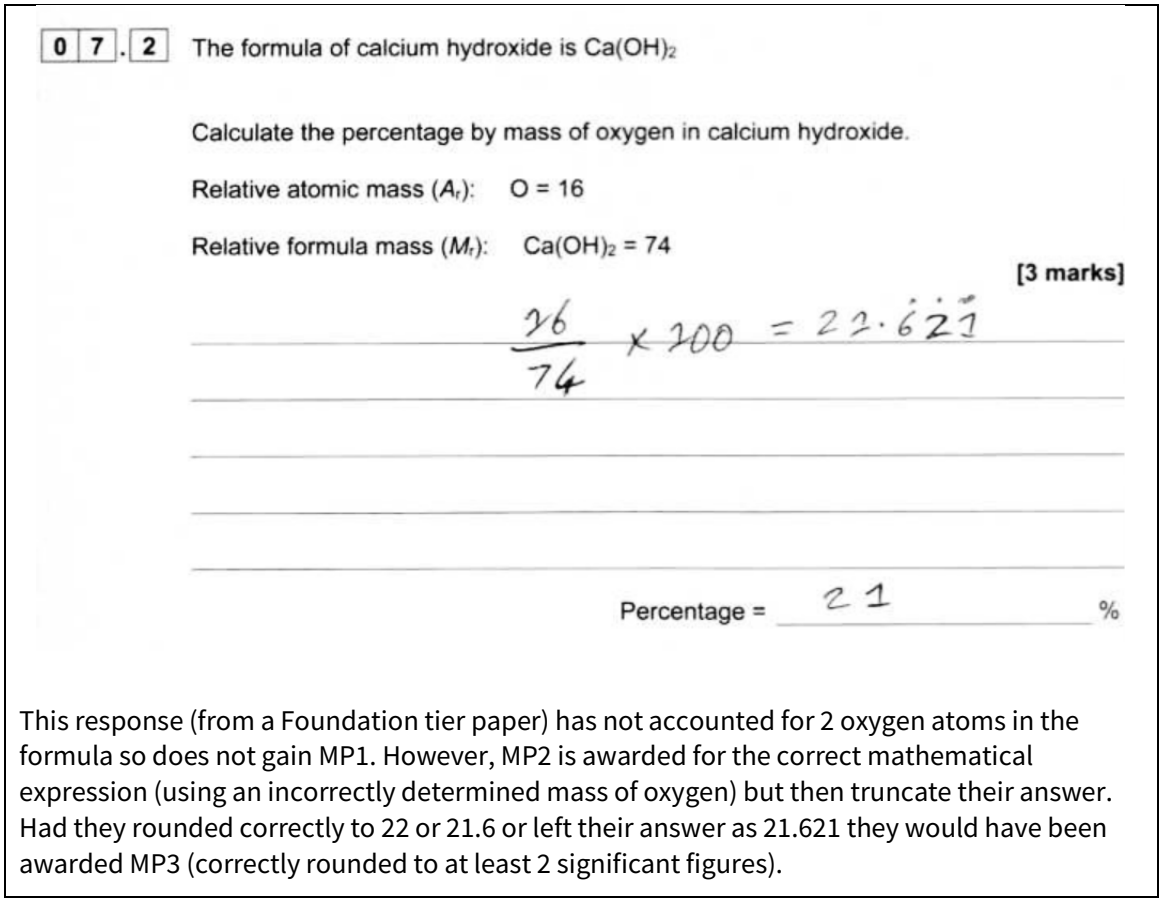
Answer 15 · Examiner comments

June 2025 | 8464/C/1H | Original Q2

Question 2 (Standard demand)

02.1 The specification definition for an 'exothermic' reaction was not well known as students rarely stated that energy or heat was released or transferred '*to the surroundings*'. However, more than three-quarters of students gained this mark. Answers were mostly general explanations, describing how energy or heat were 'given off' or 'released'. Common non-creditworthy responses referred to energy or heat being 'produced', the idea of heat or energy being 'lost' or references to an increase in temperature. Some answers stated that 'oxygen' or 'a gas' was given off by the reaction.

02.2 This question was well answered. The majority of students understood the use of brackets in a formula and used the subscript 2 correctly so evidence of 32 was common. There were some different variations on the use of 16 and 74 such as 74+16, 74-16 or 74÷16.



0 7 . 2 The formula of calcium hydroxide is $Ca(OH)_2$

Calculate the percentage by mass of oxygen in calcium hydroxide.

Relative atomic mass (A_r): O = 16

Relative formula mass (M_r): $Ca(OH)_2$ = 74

[3 marks]

$\frac{16}{74} \times 100 = 22.\dot{6}\dot{2}\dot{1}$

Percentage = 21 %

This response (from a Foundation tier paper) has not accounted for 2 oxygen atoms in the formula so does not gain MP1. However, MP2 is awarded for the correct mathematical expression (using an incorrectly determined mass of oxygen) but then truncate their answer. Had they rounded correctly to 22 or 21.6 or left their answer as 21.621 they would have been awarded MP3 (correctly rounded to at least 2 significant figures).

02.3 This was an 'extended response' style of question. Such questions are marked holistically. There are overall generic descriptions for the three levels of response at the top of the mark scheme, giving a hierarchy of response. Within each level there are 2 marks.

Students were asked to plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction when calcium oxide is added to water. The indicative content includes 5 key steps and the control variable, along with some additional information.

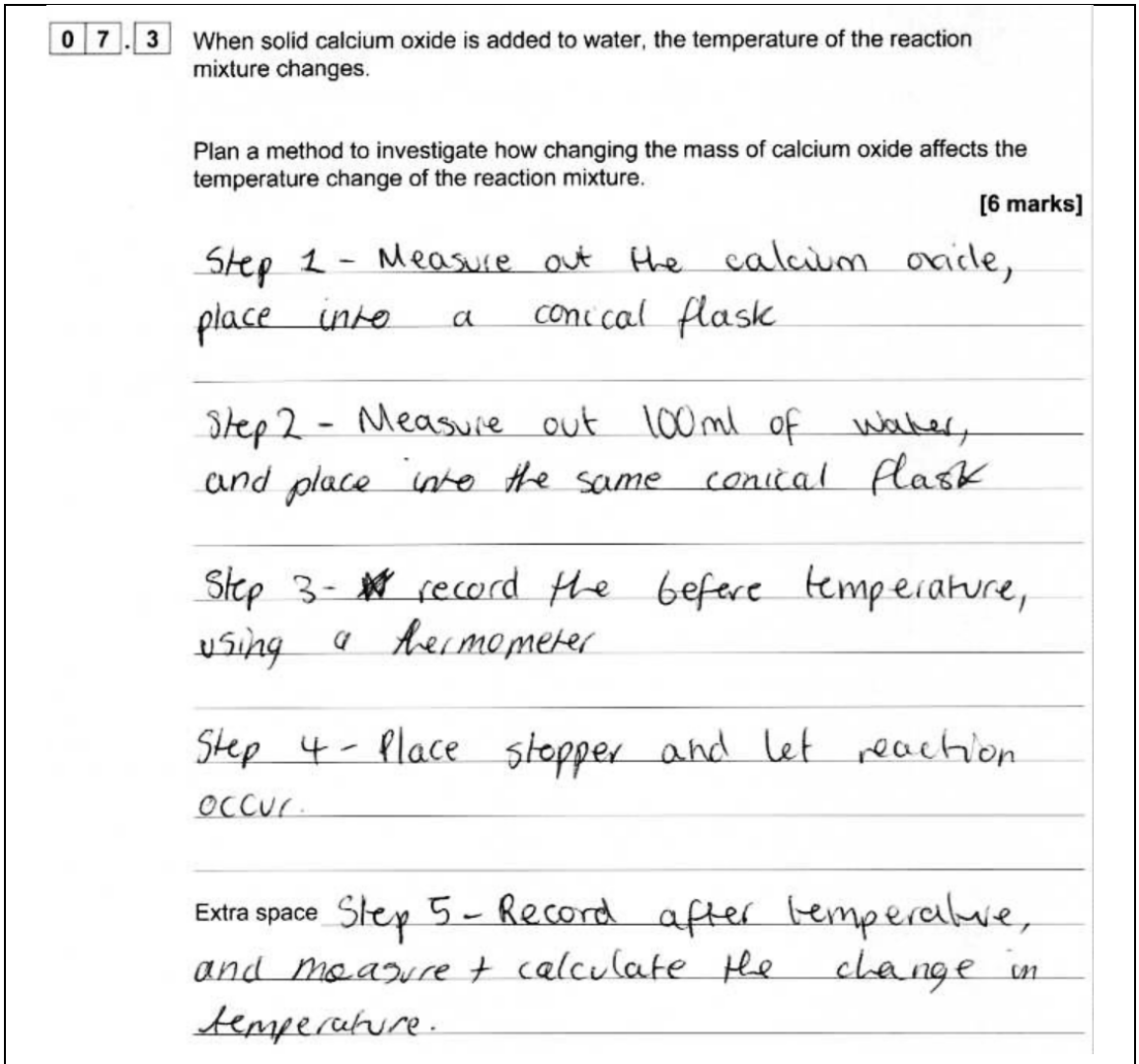
At Level 1, students needed to identify some relevant steps. To enter Level 2, three key steps, or two with the control variable, were required. To achieve marks in Level 3, all 5 key steps and the control variable were needed. Only a minority of students were able to obtain 6 marks.

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5.1.1.6 Relative atomic mass

Answer 15 · Examiner comments June 2025 | 8464/C/1H | Original Q2

Most students added calcium oxide to water but many omitted either volume (of water) or mass (of solid) although 'amount' was creditworthy for both here. Numerous students then took the 'initial' temperature (but this was often after they had added solid to water). Many were less clear on when and how the subsequent temperature or temperatures were to be taken. Too frequently it was stated that the 'temperature change' was to be measured which is not creditworthy, as this requires a calculation. The need for a control variable, whilst rarely stated as such, was often found in a Level 2 response due to the students realising that the volume of water needed to be fixed along with the experiment being repeated in some way. An indication of how the temperature change was to be determined was rarely seen.



0 7 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]

Step 1 - Measure out the calcium oxide, place into a conical flask

Step 2 - Measure out 100ml of water, and place into the same conical flask

Step 3 - record the before temperature, using a thermometer

Step 4 - Place stopper and let reaction occur.

Extra space Step 5 - Record after temperature, and measure + calculate the change in temperature.

In this response (from a Foundation tier paper) the student has stated a valid volume of water but omitted 'mass' of calcium oxide. In step 3 they record the 'before' temperature but this is after both reactants have been added to the conical flask so is not credited with taking the initial temperature. They have not stated when the subsequent temperature is measured nor described how the temperature change is determined. Had the student 'repeated the experiment with different masses of calcium oxide' they would have been credited with the control variable as this would imply fixing the volume stated. The student uses a thermometer which is a valid point in the mark scheme.

Only one key step is stated with some additional information (correct use of a thermometer) so this is a Level 1 response and is awarded 1 mark.

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5.1.1.6 Relative atomic mass

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0 7 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]

- Place water in a polystegrene cup with a thermometer and lid
- ~~Add in~~ measure out different masses of calcium oxide
- add smallest mass to cup, place lid on top and measure maximum temperature and temperature change
- repeat with increasing masses of calcium oxide
- repeat previous steps to make sure investigation is accurate
- ~~measure~~ find the mean temperature of each reaction of increasing calcium oxide mass and water.

Extra space

In this response (from a Foundation tier paper) the student has omitted volume of water but stated mass of calcium oxide. The initial temperature is not recorded but the maximum temperature is. They repeat for accuracy and then repeat with different masses of calcium oxide. They have not stated how the temperature change is determined nor that they need to use the same volume of water when repeating. The student uses a suitable container (an insulated cup) and a thermometer which are valid ideas from the mark scheme.

There are three key steps with some additional information (thermometer and insulated cup) so this is a Level 2 response and is awarded 3 marks.

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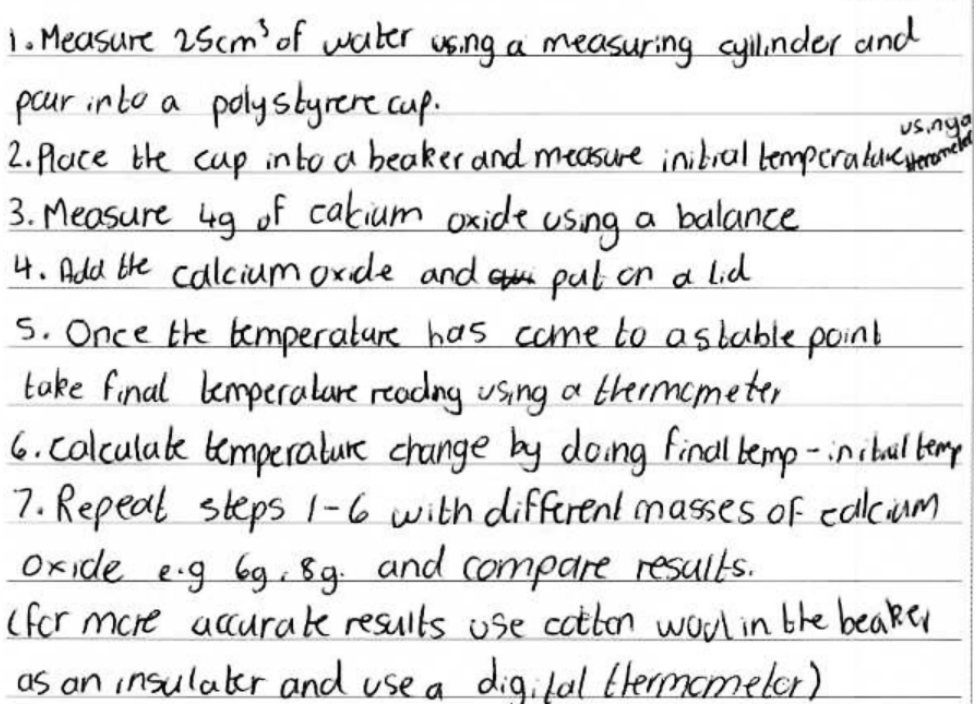
5.1.1.6 Relative atomic mass

Answer 15 · Examiner comments June 2025 | 8464/C/1H | Original Q2

0 2 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]



In this response, the student has stated a valid volume of water and mass of calcium oxide. The initial temperature (before the solid is added) and final temperature are recorded. They repeat with different masses of calcium oxide and are using the same volume of water so are credited with having a control variable. They have shown how the temperature change is determined. The student uses a measuring cylinder, suitable container (an insulated cup), balance and a thermometer which are additional valid points in the mark scheme.

There are all five key steps, a control variable, how the temperature change is determined with lots of additional information, so this is a Level 3 response and is awarded 6 marks.

5.1.1.6 Relative atomic mass

Answer 16 · Examiner comments

June 2025 | 8464/C/2H | Original Q6

Question 6 (Standard/High and High demand)

06.1 Students found the format the numbers were presented in difficult, and often incorrectly used figures such as 1.73 and 2.48, rather than 1.73×10^{-4} and 2 480 000
Many students were unable to carry out the full calculation, but most gained some credit for successfully multiplying by 2.48 million.
Of the students who successfully carried out the calculation many did not complete the correct conversion from grams to kilograms correctly, often using a factor of 100, rather than 1000.

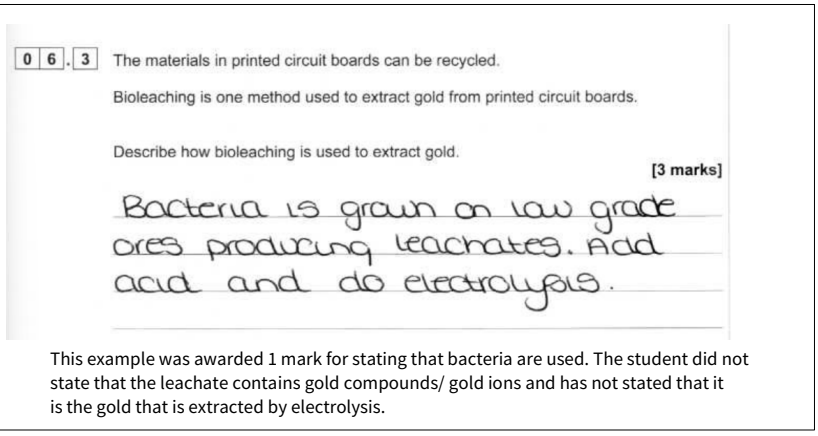
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5.1.1.6 Relative atomic mass

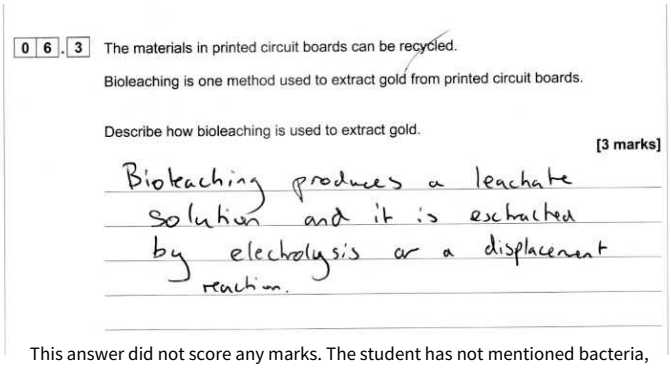
Answer 16 · Examiner comments June 2025 | 8464/C/2H | Original Q6

06.2 By selecting 1.04 x 10^{20}, the majority of students answered correctly.

06.3 The process of bioleaching was not well known.
Of the students that gained credit in this question many did so as they were able to identify that bacteria were involved.
Although some students were able to make a link to the idea of a leachate or solution, very few were able to explain that the leachate or solution contained gold compounds or gold ions.
When methods of extraction were included in a response they were often correctly identified.



This example was awarded 1 mark for stating that bacteria are used. The student did not state that the leachate contains gold compounds/ gold ions and has not stated that it is the gold that is extracted by electrolysis.



This answer did not score any marks. The student has not mentioned bacteria, does not state that the leachate solution contains gold compounds/gold ions, and the 'it' actually refers to the leachate solution not gold.

06.4 Many students understood that phytomining is a time-consuming process and when marks were credited this was by far the most common correct response.

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5.1.1.6 Relative atomic mass

Answer 16 · Examiner comments June 2025 | 8464/C/2H | Original Q6

Some students were aware that only small yields were produced and that a lot of land is needed but these ideas were not always clearly expressed using the correct terminology. Amount is not equivalent to yield, and lots of space is not equivalent to lots of land, for example.
Many students gave the answer of being expensive or damaging to the environment which are not specific to the process of phytomining.

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5.1.1.6 Relative atomic mass

Answer 16 · Examiner comments

Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

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