AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.1.2

The reactivity series

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**8**
Available paper years	**2018–2025**

Using this booklet

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

Name: _____ **Date:** _____

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

5.4.1.2 The reactivity series

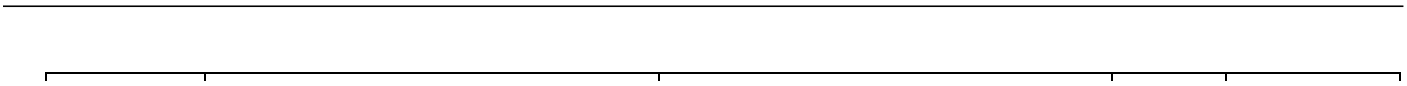
Answer 01 · Mark scheme June 2018 | 8464/C/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	chlorine		1	AO2 5.4.3.4
01.2	copper is less reactive than hydrogen		1	AO2 5.4.3.4
01.3	1.8 (mg)	allow an answer in range 1.7–1.9	1	AO3 5.4.3.4
01.4	$\frac{3.02 + 3.01 + x}{3} = 3.06$ 3.15 (mg)	an answer of 3.15 (mg) scores **2** marks allow any other suitable method if no other mark awarded allow 9.18 for **1** mark	1 1	AO2 5.4.3.4
01.5	$\frac{50}{1000}$ **or** $\frac{1}{20}$ **or** 0.05 (0.05) × 300 15 (g) **or** $\frac{300}{1000}$ **or** $\frac{3}{10}$ **or** 0.03 (1) (0.3) × 50 (1) 15 (g) (1)	an answer of 15 (g) scores **3** marks the second mark is dependent on the first mark being scored the second mark is dependent on the first mark being scored if no other mark awarded allow 150 **or** 15 000 for **1** mark	1 1 1	AO2 5.3.2.5
Total			**8**	

5.4.1.2 The reactivity series

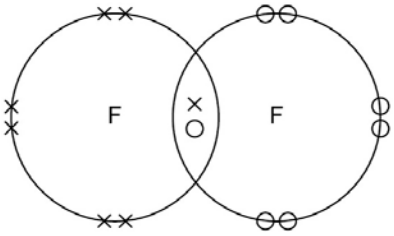
Answer 01 · Mark scheme

June 2018 | 8464/C/1H | Original Q1



5.4.1.2 The reactivity series

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	g	do **not** accept upper case (G) do **not** accept gas	1	AO1 5.1.2.6
04.2		one shared pair anywhere in overlap between two circles **or** on intersection 6 other electrons on each atom allow dots **or** crosses **or** mixture for all marks ignore any inner shell electrons	1 1	AO1 5.1.2.6 5.2.1.4 AO2 5.1.2.6 5.2.1.4
04.3	18		1	AO2 5.1.1.5 5.1.2.6
04.4	$AlBr_3$ **2** Al + **3** Br_2 (→ 2 $AlBr_3$)	ignore state symbols ignore charges ignore brackets as eg $Al(Br)_3$ allow **1** mark for balancing their equation with an incorrect product	 1 1	AO2 5.1.1.1 5.1.2.6

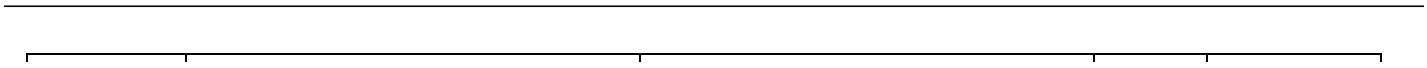
04.5		**max 2** if outer shell / level not mentioned 'it' refers to chlorine allow converse reasons for bromine being less reactive		
	chlorine is a smaller atom **or** has fewer energy levels **or** outer shell closer to nucleus	ignore chlorine has fewer electrons	1	AO1 5.1.2.6
	chlorine has less shielding **or** has the greater attraction between the nucleus and the outer shell **or** incoming electron		1	AO1 5.1.2.6
	therefore chlorine can gain an electron (into the outer shell) more easily		1	AO2 5.1.2.6
		if no other marks awarded allow **1** mark for correct trend in reactivity in Group 7 do **not** accept reference to incorrect particles eg chloride atom		

Total			**9**

5.4.1.2 The reactivity series

Answer 02 · Mark scheme

June 2018 | 8464/C/1H | Original Q4



5.4.1.2 The reactivity series

Answer 03 · Mark scheme June 2019 | 8464/C/1H | Original Q1

01.1	Ca Mg Zn Cu		1	AO3 5.4.1.2

01.2	any **two** from: • mass (of metal / element) • surface area (of metal / element) • concentration (of acid) • volume (of acid) • temperature (of acid)	 allow weight ignore size ignore length ignore pH ignore strength ignore room temperature	2	AO3 5.4.1.2

01.3	(type of) metal / element		1	AO2 5.4.1.2

5.4.1.2 The reactivity series

Answer 03 · Mark scheme

01.4	(beryllium is) less reactive any **one** from: • greater attraction between nucleus and outer electrons • more energy is needed to remove electrons • loss of electrons is more difficult • outer electrons closer to nucleus • less shielding	allow converse answers for magnesium MP2 only if MP1 is correct allow higher in group allow reactivity increases down the group ignore reactivity series	1 1	AO3 5.1.2.3 5.1.2.5 5.4.1.2

Answer 03 · Mark scheme

01.5	$\frac{50}{1000}$ (dm^3) = 0.05 (dm^3) ($\frac{3.2}{0.05}$) = 64 (g per dm^3) **alternative approach:** $\frac{3.2}{50}$ (1) = 0.064 (1) (× 1000) = 64 (g per dm^3) (1) **alternative approach**: $\frac{1000}{50}$ (1) = 20 (1) (× 3.2) = 64 (g per dm^3) (1)	an answer of 64 (g per dm^3) scores **3** marks an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps an answer of 0.16 / 0.064 / 0.64 / 6.4 / 6.4 × 10^{-5} (g per dm^3) gains **2** marks	1 1 1	AO2 5.3.2.5
Total			**9**	

5.4.1.2 The reactivity series

Answer 03 · Mark scheme

June 2019 | 8464/C/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.4.1.2 The reactivity series

Answer 04 · Mark scheme June 2019 | 8464/C/1H | Original Q6

06.1	$2\ Na + Cl_2 \rightarrow 2\ NaCl$		1	AO2 5.1.1.1 5.1.2.5

06.2	(before) silver solid / liquid / metal **or** green (gas) (during) yellow flame **or** white smoke **or** green colour fades / disappears (after) white solid / powder	 allow grey solid / metal allow yellow (gas) allow orange / white flame allow vigorous reaction	 1 1 1	AO1 5.1.2.5

5.4.1.2 The reactivity series

Answer 04 · Mark scheme

06.3	(sodium has) fewer energy levels / shells	allow converse for potassium allow diagrams of electron structure	 1	AO1 5.1.2.5
	<u>outer</u> electron / shell is closer to nucleus **or** <u>outer</u> electron / shell is less shielded		1	
	(so) greater attraction between nucleus and outer electron / shell		1	
	(so) outer electron is less easily lost	allow (so) loses an / one electron less easily allow (so) more energy needed to remove an / one electron	1	

5.4.1.2 The reactivity series

Answer 04 · Mark scheme

June 2019 | 8464/C/1H | Original Q6

Question	Answers	Mark	AO/ Spec. Ref
06.4	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4–6	AO1 AO2
	Level 1: Relevant features are identified and differences noted.	1–3	
	No relevant content	0	

Indicative content

	sodium chloride	hydrogen chloride
differences in bonding	ionic	covalent
	metal & non-metal	two non-metals
	transferring electrons	sharing electrons
	ions (Na^+ and Cl^-)	molecules
	charged particles	neutral **or** no overall charge
differences in structure	**giant** structure or lattice	**small** / **simple** / **discrete** molecules
	electrostatic	intermolecular forces
	(electrostatic forces) are **strong**	(intermolecular forces) are **weak**
	act in all directions	random **or** between the molecules
	regular	irregular / random
similarities in bonding	full shells **or** stability	full shells **or** stability
	(transferring) electrons	(sharing) electrons
	strong bonds	**strong** (covalent) bonds
similarities in structure	(electrostatic) forces	(intermolecular) forces

ignore properties eg melting points, conduct electricity

to access level 2 there must be a comparison of the structure **and** bonding **and** magnitude of both sodium chloride **and** hydrogen chloride.

5.4.1.2 The reactivity series

Answer 04 · Mark scheme

June 2019 | 8464/C/1H | Original Q6

Total			**14**

Answer 05 · Mark scheme

Question 3

Question	Answers	Mark	AO / Spec. Ref.
03	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3
	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	AO3
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1
	No relevant content.	0	
	Indicative Content • measure volume of (hydrochloric) acid • into a suitable container eg polystyrene cup • measure the initial temperature (of hydrochloric acid) • with a thermometer • add stated mass of one metal • stir • measure the highest temperature reached of the solution **or** measure temperature reached after a set time period • determine the temperature difference • repeat • repeat for each metal • with same mass • in same physical state (powder, lump, etc) • with the same volume and / or concentration of (hydrochloric) acid • use results to arrange metals in order of reactivity • most reactive metal has the largest temperature change to access level 3 there must be an indication of how the temperature change is determined with the same mass of the 3 different metals reacted with the same volume of (hydrochloric) acid		5.1.4.2 RPA2

Total Question 3		**6**

5.4.1.2 The reactivity series

Answer 06 · 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	$4\ Na + TiCl_4 \rightarrow 4\ NaCl + Ti$	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

Answer 06 · 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	

Answer 06 · Mark scheme

07.4 cont.	**method 2:** $2Al + 3CuCl_2 \rightarrow 3Cu + 2AlCl_3$ (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		

5.4.1.2 The reactivity series

Answer 06 · 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

5.4.1.2 The reactivity series

Answer 07 · Mark scheme

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

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	gold	allow Au allow silver / Ag allow platinum / Pt allow copper / Cu	1	AO1 5.4.1.2 5.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	reduction by carbon	allow heating / reacting with carbon	1	AO3 5.4.1.2 5.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	cryolite		1	AO1 5.4.3.1 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	oxygen is produced		1	AO1 5.4.3.1
	(which) reacts with the carbon / electrode / anode to form carbon dioxide		1	5.4.3.2 5.4.3.3
	(so the electrode) has to be continually replaced	allow (so) the electrode is used up allow (so) the electrode burns away	1	

5.4.1.2 The reactivity series

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	$Al^{3+} + 3e^- \rightarrow Al$	allow **1** mark for $Al^{3+} + e^- \rightarrow Al$ with no / incorrect balancing numbers	2	AO2 5.4.3.1 5.4.3.2 5.4.3.3 5.4.3.5

Total Question 6	**8**

5.4.1.2 The reactivity series

Answer 08 · Mark scheme

June 2025 | 8464/C/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	iron is less reactive than carbon		1	AO1 5.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	the **mixture** has a lower melting point (than aluminium oxide) (so) less energy is used (to melt the electrolyte)		1 1	AO1 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	$2\ O^{2-} \rightarrow O_2 + 4\ e^-$	allow multiples allow **1** mark for $O^{2-} \rightarrow O_2 + e^-$ with no / incorrect balancing numbers	2	AO2 5.4.3.3 5.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	Cr_2O_3 **or** chromium oxide	allow Cr^{3+} ions	1	AO2 5.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	extracting aluminium uses more energy (so costs more)		1	AO3 5.4.1.3 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(extracting chromium costs more because) aluminium is used in the extraction of chromium		1	AO3 5.4.1.3 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	alloys contain different sized atoms	allow alloys contain different sized (positive) ions	1	AO1 5.2.2.7
	(so the) layers are distorted		1	
	(so the) layers (of atoms) slide less easily	allow (so the) atoms cannot slide over each other	1	

Total Question 4	11

5.4.1.2 The reactivity series

Answer 01 · Examiner comments

June 2018 | 8464/C/1H | Original Q1

Question 1 (standard demand)

01.1 Halogens are produced at the positive electrode if the solution contains a halide ion. 51% of students correctly selected chlorine as the gas produced.

01.2 Students could have linked their knowledge of the reactivity series, with which ion is discharged when an aqueous solution is electrolysed. In this case, the production of copper at the negative electrode informs students that copper is less reactive than hydrogen. 46% of students were able to correctly deduce this.

01.3 Students needed to look at the data and see that the mass produced at three minutes was missing from the table. Experimental errors account for the trend not being exactly directly proportional. In this instance 63% of students noticed the relationship and correctly deduced the mass. The mark scheme did allow a small range around the expected answer.

01.4 68% of students achieved full marks for this question giving an answer of 3.15 (mg), however, a significant number did so without showing their working. This was not an issue where they obtained the correct answer, but some didn't and therefore gained no credit as it was not possible to see how they had obtained their answer.

A working mark was available and showing 9.18 (mg) was the most likely way that this was gained by students.

5.4.1.2 The reactivity series

Answer 01 · Examiner comments

June 2018 | 8464/C/1H | Original Q1

01.5 A unit conversion between cm^3 and dm^3 in this question requires a division of either:

- 50 by 1000 to convert cm^3 to dm^3 or
- 300 by 1000 to convert mass per dm^3 to mass per cm^3

This conversion is essential to make progress in this calculation. 14% of students understood this concept and achieved the maximum three marks for this question.

A significant number either divided 300 by 50 with an answer of 6 or multiplied 300 by 50. The latter led to a compensatory mark for 15 000.

Answer 02 · Examiner comments

June 2018 | 8464/C/1H | Original Q4

Question 4 (standard, standard / high & high demand)

04.1 Students did not answer this question as well as expected. They were either not aware that chlorine was a gas or were not familiar with state symbols, as answers other than (s), (l) (g) or (aq) were frequently seen. Some wrote the word 'gas' in the space. 36% of students answered correctly.

04.2 This question was very well answered with 64% of students achieving full marks. Students showed a good understanding of the number of electrons involved in this example of covalent bonding, by ensuring that they had two electrons in the overlap area and six other electrons in the energy level of each fluorine.

A common mistake was to include two electrons in the overlap, but still included the seven electrons each fluorine originally contained in the level outside the overlap.

04.3 48% of students selected the correct answer to this question. The question followed the diagram of a fluorine (F_2) molecule in question **04.2** and focussed on this species.

A significant number of students incorrectly selected '9' as their response, which is the number of electrons in one fluorine atom.

04.4 Students are expected to represent the electronic structures of the first 20 elements of the periodic table and to predict and explain reactions of elements from their position in the periodic table.

A small number of students were able to state the correct formula, $AlBr_3$, with AlBr and $AlBr_2$ being the most common incorrect formulae. But, students did show a good understanding of balancing equations, in this case based upon their wrong formula for aluminium bromide. 68% of students achieved a single mark.

04.5 This question was not answered well, with 8% of students achieving three marks for the explanation that included:

- comparative size of atoms
- comparative difference in attraction
- the ease of which an electron was gained.

This last point was the one that was seen the least and the word 'outer' (shell or level) was omitted in a lot of answers.

Often students would repeat the question stem in terms of chlorine and bromine's reactivity without relating it to the whole of Group 7 and in many instances referring to the reactivity series (of metals).

5.4.1.2 The reactivity series

Answer 03 · Examiner comments

June 2019 | 8464/C/1H | Original Q1

Question 1

This question was common with the Foundation paper and each item was at standard demand.

01.1 The decreasing reactivity of the metals was deduced from the amount of effervescence in each reaction. Most students selected the correct order.

01.2 Although most students had a good understanding of the control variables in this situation, the way they described the variable sometimes lacked the correct terminology. 'Amount of acid' was often used instead of 'volume of acid'.

01.3 This question to identify the independent variable was well answered, although it was common to see other incorrect variables mentioned, such as reactivity of the metals or number of bubbles.

01.4 This question comparing the reactivity of beryllium to magnesium was reasonably well answered. A number of students gained no credit as they stated that beryllium was more reactive. Some students stated that magnesium has more 'outer shells'; all elements only have one outer shell. Trends in reactivity had to refer to the group (as the question stated to use the periodic table) and not the periodic table or reactivity series. The word 'outer' was frequently omitted, so responses such as the electrons in magnesium are further from the nucleus were insufficient.

01.5 A quarter of students used a variety of methods to correctly calculate the concentration. Just under a half of the students scored 2 of the 3 marks, usually failing to correctly convert cm^3 to dm^3

5.4.1.2 The reactivity series

Answer 04 · Examiner comments

June 2019 | 8464/C/1H | Original Q6

Question 6

This question was mostly high demand.

06.1 Approximately one-third of students identified the balanced equation for the reaction. The first two responses proved to be good distractors.

06.2 A large proportion of students failed to gain any marks on this question. Students need to ensure they consider the command words at the beginning of questions; many described how sodium reacted with chlorine in terms of electron transfer. Very few described what they would actually see. Some students answered the 'before section' by stating that nothing happened. Few students stated chlorine was a green gas or sodium a silvery metal. For marking point 2 students often mentioned the rate of the reaction and formation of gas rather than considering actual observations. The most common observation mentioned in this section was fizzing. It gave the impression with other comments that students were talking about the reaction between sodium and water. For marking point 3 many students described cloudiness, without identifying that a white solid was involved.

06.3 This question achieved a spread of marks and discriminated very well. 'More outer shells' and references to intermolecular forces were often seen; only molecules can have intermolecular forces. References to potassium 'having a higher melting or boiling point' or 'bigger atomic mass or atomic number' were also given as reasons for it being more reactive; these answers displayed confusion in the difference between chemical and physical properties.

There were many vague statements about the trend in reactivity down Group 1, but these did not gain any credit. Students often made statements about electrons and shells but did not specifically mention electrons in the outer shell. Many students understood that there was a force holding the outer shell electron, but it was a common error to not mention the nucleus or that it was a force of attraction. Those students who mentioned that there was a force of attraction often omitted to mention that it decreased down the group. Marking point 4 was the most commonly awarded mark, with students explaining the ease of losing an electron in terms of sodium and potassium.

06.4 This question discriminated very well with only the most able students accessing level 2. Students had an excellent understanding of bonding, covering types of bonding, transfer or sharing of electrons, full shell stability and ion formation. However, the question asked for information on bonding and structure for sodium chloride and hydrogen chloride. Only a

5.4.1.2 The reactivity series

Answer 04 · Examiner comments

small proportion included comments about the structure, and even fewer made comments that compared the magnitude of forces/bonding within both substances.

Many responses had incorrect or vague statements. Although many students understood the formation of sodium and chloride ions, very few appeared to appreciate the consequence of this in the formation of an ionic lattice. Some students stated both sodium chloride and hydrogen chloride had the same type of bonding. There was also a lot of confusion over types of bonding and forces, with students often contradicting themselves during their response.

5.4.1.2 The reactivity series

Answer 04 · 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.

5.4.1.2 The reactivity series

Answer 05 · Examiner comments — June 2022 | 8464/C/1H | Original Q3

Question 3 (Standard demand)

03 This question discriminated well with nearly 60% of students achieving level two or above. It was based upon Required Practical Activity 10. Students needed to plan an investigation to find the order of reactivity of three metals using the temperature change recorded when each metal reacts with hydrochloric acid.

To access level 3, the method would lead to a valid outcome. This required students controlling variables such as the mass of metal and the volume of acid reacting, determining a temperature change having recorded the initial and final temperatures and repeating the method for each metal.

To access level 2 the method would not necessarily lead to a valid outcome. Students were generally good at providing practical details. The main oversights that prevented a valid outcome were the measurement of starting temperature and/or controlling the mass of metal. Students should be encouraged to state volumes and masses as most creditworthy

Answer 05 · Examiner comments — June 2022 | 8464/C/1H | Original Q3

responses regarding the control of volume and mass did so by stating a value and then repeating with the other metals. Weaker responses gained credit for either correctly identifying apparatus or for explaining the link between expected results and the reactivity of the metal.

Answer 06 · 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.

5.4.1.2 The reactivity series

Answer 06 · 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.

5.4.1.2 The reactivity series

Answer 06 · Examiner comments

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

Use of statistics

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Mark Ranges and Award of Grades

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

Answer 07 · Examiner comments

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

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

06.1 Many students correctly named a metal that is found in the Earth as the metal itself. The most common answer was gold.

06.2 Students were given a reactivity series and asked to suggest the most economical method for extracting a metal from its metal oxide. 18% of students answered this correctly. Electrolysis was a common incorrect response as this would not be the most economical method.

Many students used 'it' in their response but 'it' refers to the metal so heating 'it' with carbon was not creditworthy but displacing 'it' with carbon was.

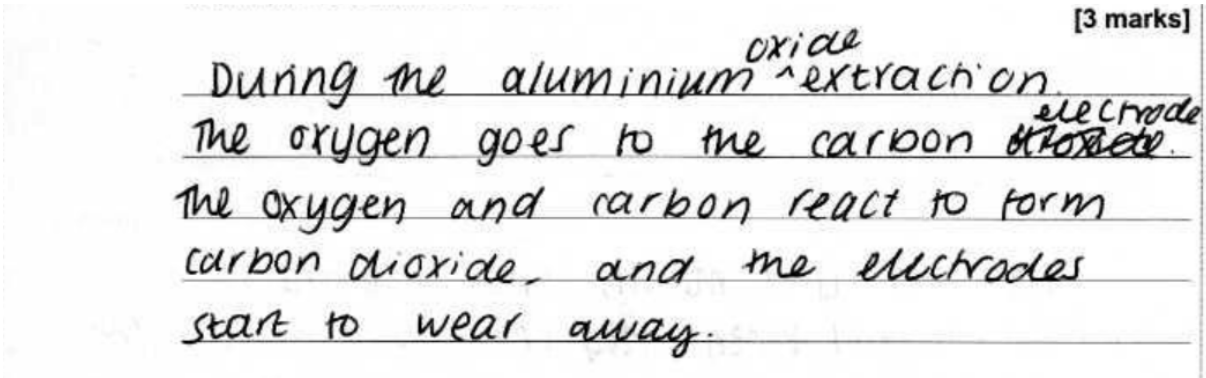
06.3 Few students were able to identify that cryolite was the unknown substance in the molten mixture used in electrolysis to extract aluminium from aluminium oxide.

06.4 This question proved challenging with just under 10% gaining 2 or 3 marks. It was common for students to refer to oxygen being attracted to the electrode or oxide ions reacting with carbon. Some answers focused on explaining why oxygen gas was produced, suggesting that oxide ions were discharged because of the absence of halide ions but not then describing what further happens to the oxygen and the electrode whilst others described the production of aluminium by the reduction of aluminium ions. Thus, oxygen being produced at the positive electrode was frequently omitted.

When students gained 1 mark it was either for saying that carbon dioxide is produced or that the electrode has to be continually replaced.

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

[3 marks]



This response does not state that oxygen is produced at the positive electrode but 2 marks are awarded for oxygen reacting with the carbon electrode to form carbon dioxide (so the electrode) has to be continually replaced.

06.5 Students found writing the half equation at the negative electrode to show the reduction of aluminium ions very challenging. A number did not attempt the question and few gained 2 marks. One mark was infrequently scored, since identifying the correct reactants and not the balancing appeared to be the problem.

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Answer 08 · Examiner comments

June 2025 | 8464/C/1H | Original Q4

Question 4 (Standard, Standard/High and High demand)

04.1 Many correctly stated iron can be extracted by reduction with carbon because iron is less reactive than carbon. The converse statement was the most common incorrect response.

04.2 Very few students were able to achieve both marks on this question as the idea that the melting point of the mixture is lower, was rarely seen. Many responses incorrectly stated that it is the melting point of the aluminium oxide or aluminium that is lowered. A large majority of students gained marking point 2 by stating that less energy is used. However, those who qualified this by saying that less energy is needed for the 'reaction' were not awarded the mark. Many students thought that cryolite was a catalyst.

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

[2 marks]

Aluminium oxide has a very high melting point · Cryolite is added to reduce the melting point · This makes it cheaper and means less energy is needed ·

This response gained 1 mark. MP1 was not awarded as it is the melting point of the mixture is lower not the melting point of the aluminium oxide. MP2 was credited.

04.3 Students found writing the half equation at the positive electrode to show the oxidation of oxide ions very challenging. Many students could not give the formula for the oxide ion (O_2^- was common), oxygen or electron (e either with a + charge or no charge was common). One mark was infrequently scored, since identifying the correct reactants and not the balancing appeared to be the problem.

04.4 Few students identified the species being reduced. Chromium, a product of the reaction, was a common incorrect answer.

04.5 This AO3 question required students to use data to give a reason for the difference in the cost of extracting aluminium and iron. Most provided a comparative, which was good, but many chose to compare reactivity or to state what the extraction methods of the metals were rather than comment on the energy implication.

04.6 Another AO3 question looking for a difference in the cost of extracting aluminium and chromium. Few students answered this correctly. Common answers referred to the rarity or difficulty of extracting chromium ores from Earth.

04.7 Just under half of students gained 1 or more marks. Students should know that pure metals are soft so are mixed with other metals to make alloys, which are harder. Those who gained one mark usually referred to the difference in the sizes of the atoms and the second most common mark was for layers not being able to slide. Layers are distorted was less frequently given. Many students gave good descriptions why metals are soft but their answers for alloys were less accurate. Many referred incorrectly to intermolecular forces.

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