AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.1.2

The reactivity series

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**8**
Available paper years	**2018–2024**

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

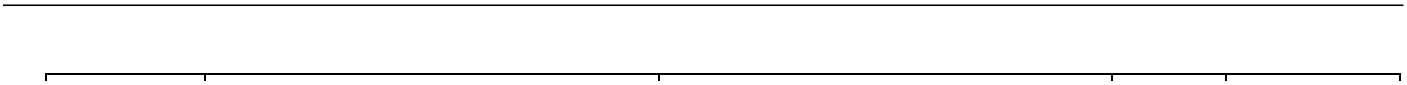
Answer 01 · Mark scheme June 2018 | 8464/C/1F | Original Q5

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

5.4.1.2 The reactivity series

Answer 01 · Mark scheme

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



5.4.1.2 The reactivity series

Answer 02 · Mark scheme June 2019 | 8464/C/1F | Original Q6

06.1	Ca Mg Zn Cu		1	AO3 5.4.1.2

06.2	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

06.3	(type of) metal / element		1	AO2 5.4.1.2

5.4.1.2 The reactivity series

Answer 02 · Mark scheme

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

06.4	(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

5.4.1.2 The reactivity series

Answer 02 · Mark scheme

06.5	$\frac{50}{1000}$ (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 02 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.4.1.2 The reactivity series

Answer 03 · Mark scheme November 2020 | 8464/C/1F | Original Q2

02.1	21.1 (°C) 14.4 (°C)	 allow correct use of an incorrect start temperature	1 1	AO2 5.4.1.2 5.5.1.1 RPA 10

02.2	any **two** from: • surface area of metal • 25 cm^3 / volume of copper sulfate solution • concentration of copper sulfate solution • mass / 1 g of metal	 ignore amount ignore temperature ignore stirring	2	AO2 5.4.1.2 5.5.1.1 RPA 10

02.3	$\frac{9.2 + 9.5 + 9.2}{3}$ **or** $\frac{27.9}{3}$ = 9.3 (°C)	 if no other mark awarded allow **1** mark for 8.8 (°C)	1 1	AO3 AO2 5.4.1.2 5.5.1.1 RPA 10

5.4.1.2 The reactivity series

Answer 03 · Mark scheme

02.4	(metal **A** / zinc) is less reactive (than magnesium) **or** (metal **A** / zinc) is lower in reactivity series **or** change in temperature is lower (with metal **A** / zinc)	allow converse	1	AO3 5.4.1.2 5.5.1.1 RPA 10
02.5	stays the same		1	AO3 5.4.1.2 5.5.1.1 RPA 10
02.6	too dangerous **or** too reactive	allow potassium would react with water	1	AO2 5.1.2.5 5.4.1.2 5.5.1.1 (RPA 10)
02.7	$\frac{25}{100} \times 1.8$ **or** $\frac{1}{4} \times 1.8$ = 0.45 (g)		1 1	AO2 5.3.2.5 RPA 10
Total			**11**	

5.4.1.2 The reactivity series

Answer 03 · Mark scheme

November 2020 | 8464/C/1F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.4.1.2 The reactivity series

Answer 04 · Mark scheme November 2020 | 8464/C/1F | Original Q4

04.1	$\frac{8}{10} \times 100$ **or** 0.8×100 = 80 (%)	 if no other mark awarded allow **1** mark for 20 (%)	1 1	AO2 5.1.2.3
04.2	any **two** from: • conducts electricity • conducts thermal energy • ductile • high melting point • malleable • shiny • strong	 allow conducts heat allow high boiling point allow can be bent / shaped allow dense allow sonorous ignore chemical properties	2	AO1 5.1.2.3
04.3	2 Na + Cl_2 → 2 NaCl	allow multiples	1	AO2 5.1.2.5 5.1.2.6 5.3.1.1
04.4	electrostatic attractions		1	AO3 5.2.1.3 5.2.2.3
04.5	(heat sodium chloride until) molten / liquid dissolve in water	 allow form aqueous solution allow add water	1 1	AO1 5.2.2.3
Total			**8**	

5.4.1.2 The reactivity series

Answer 04 · Mark scheme

November 2020 | 8464/C/1F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.4.1.2 The reactivity series

Answer 05 · Mark scheme

November 2021 | 8464/C/1F | Original Q4

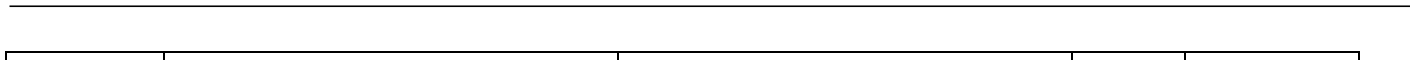
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	alkali metals		1	AO1 5.1.2.5
04.2	98 (°C)	allow a value in the range 97–99 (°C)	1	AO2 5.1.2.5
04.3	$2\,Na + 2\,H_2O \rightarrow 2\,NaOH + H_2$	allow multiples	1	AO2 5.1.2.5 5.4.1.1
04.4	(M_r =) 23 + 16 + 1 = 40		1 1	AO2 5.1.2.5 5.3.1.2

Question	Answers	Mark	AO / Spec. Ref.
04.5	**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.	3–4	AO1 AO2
	Level 1: Relevant features are identified and differences noted.	1–2	AO1
	No relevant content	0	
	Indicative Content: <u>Similarities – sodium and potassium both:</u> • float • move • bubble / effervesce / fizz • melt • form a ball • get smaller **or** disappear <u>Differences – potassium:</u> • moves faster • bubbles faster • reacts faster • disappears faster • catches fire • lilac flame		5.1.2.5
Total		**9**	

5.4.1.2 The reactivity series

Answer 05 · Mark scheme

November 2021 | 8464/C/1F | Original Q4



5.4.1.2 The reactivity series

Answer 06 · Mark scheme

June 2022 | 8464/C/1F | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	**2** Mg + O_2 → 2 MgO	allow multiples	1	AO2 5.1.2.5 5.4.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	any **one** from: • wear safety glasses / goggles • do not look directly at burning magnesium • wear heat proof glove	allow look through blue glass allow use tongs allow tie hair back	1	AO3 5.4.1.1 5.4.1.2 5.5.1.1

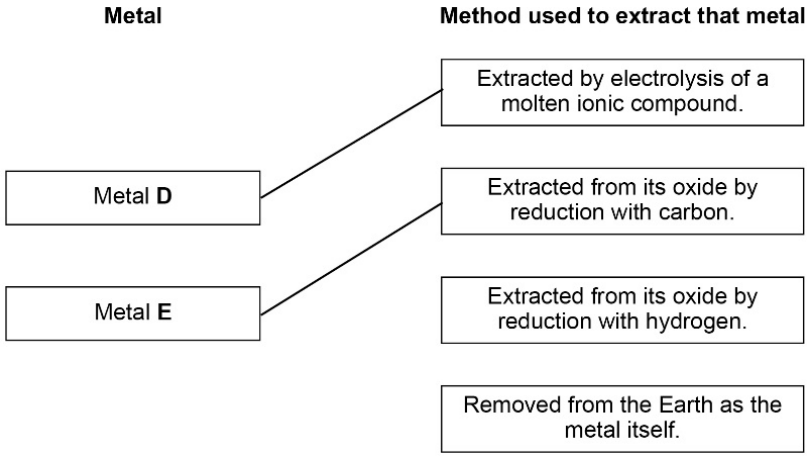
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	(M_r =) 24 + (2 × 19) = 62		1 1	AO2 5.1.2.5 5.3.1.2

5.4.1.2 The reactivity series

Answer 06 · Mark scheme

June 2022 | 8464/C/1F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	any **one** from: • argon has a full outer shell • argon has 8 electrons in the outer shell • argon has a stable arrangement of electrons.	allow energy level for shell allow does not need to lose and / or gain electrons	1	AO2
	(so) argon is unreactive	ignore argon is a noble gas	1	AO1 5.1.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	 do **not** accept more than one line from a box on the left		1 1	AO3 5.4.1.2 5.4.1.3 5.4.3.1 5.4.3.2 5.4.3.3

5.4.1.2 The reactivity series

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(because) ions (which are) free to move when molten (but are) fixed in solid	 allow reference to charged particles for MP2 and MP3	1 1 1	AO1 5.2.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	(sodium contains) delocalised electrons (which) carry (electrical) charge (through the metal / sodium)	allow free electrons ignore throughout for through ignore current / electricity	1 1	AO1 5.2.2.8

Total Question 4		13

5.4.1.2 The reactivity series

Answer 07 · Mark scheme

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

Question 7

Question	Answers	Mark	AO / Spec. Ref.
07	**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 7		**6**

5.4.1.2 The reactivity series

Answer 08 · Mark scheme

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

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	hydrogen		1	AO1 5.4.1.2 5.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	$MgCl_2(l)$		1	AO2 5.1.1.1 5.2.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(negative electrode) magnesium	allow Mg	1	AO2 5.4.3.1 5.4.3.2
	(positive electrode) chlorine	allow Cl_2	1	
		allow **1** mark if both elements are reversed		

5.4.1.2 The reactivity series

Answer 08 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(most reactive metal) magnesium (iron) copper (least reactive metal)	 allow Mg allow Fe allow Cu	 1	AO3 5.4.1.2
	any **two** from: • magnesium reacts with both copper chloride solution and iron chloride solution • iron only reacts with copper chloride solution • copper does not react with either magnesium chloride solution or iron chloride solution	 allow magnesium has two / most reactions allow iron has one reaction allow copper does not react	2	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	1.6 (g)		1	AO2 5.4.3.1 5.4.3.2

5.4.1.2 The reactivity series

Answer 08 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(conversion 30.0 cm^3 =) 0.030 dm^3		1	AO2 5.3.2.5
	(mass =) 0.030 × 180	allow correct use of incorrect / no conversion of volume	1	
	= 5.4 (g)		1	
	OR			
	1000 cm^3 contains 180 g $MgCl_2$ (1)			
	30 cm^3 contains $\frac{180}{1000}$ × 30 (g) (1)			
	(30 cm^3 contains) 5.4 (g) (1)			
	OR			
	(ratio of volume $\frac{1000}{30}$ =) 33.3 (1)			
	(so ratio of mass) = $\frac{180}{33.3}$ (1)			
	= 5.4 (g) (1)			

Total Question 5	11

5.4.1.2 The reactivity series

Answer 01 · Examiner comments

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

Question 5 (low & standard demand)

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

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

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

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

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

5.4.1.2 The reactivity series

Answer 05 · Examiner comments November 2021 | 8464/C/1F | Original Q4

Question 4 (low and standard demand)

04.1 More than two thirds of students knew that the name of the Group 1 elements is the alkali metals.

04.2 More than two thirds of students were able to determine the melting point of sodium from the bar chart recognising the *y*-axis scale of 1 small square being equal to 4 °C.

04.3 Nearly two thirds of students were able to balance the chemical equation.

04.4 More than half of students successfully calculated the relative formula mass of sodium hydroxide.

04.5 This extended response question required students to compare the observations when sodium and potassium are reacted with water. Approximately half of students either recalled or used the figure to state that with sodium fizzing occurs. Other observations seen included sodium melting, forming a ball and moving. A comparison of the similarities and differences between these metals and also the magnitude of these was required to achieve level two.

Answer 06 · Examiner comments June 2022 | 8464/C/1F | Original Q4

Question 4 (Low and standard demand)

04.1 More than 70% of students correctly balanced the equation. Some students changed the formula, usually from MgO to MgO_2

04.2 Almost three-quarters of students stated a safety precaution that should be taken when heating magnesium and oxygen. The most common correct responses were to wear eye protection and to use tongs.

04.3 Almost one-quarter of students gave the correct answer for the relative formula mass of magnesium fluoride. These students recognised that the subscript 2 means the relative atomic mass of fluorine needed to be doubled before being added to the relative atomic

5.4.1.2 The reactivity series

Answer 06 · Examiner comments

June 2022 | 8464/C/1F | Original Q4

mass of magnesium. Many showed clear steps in their calculation. The most common errors were to either add or multiply 24 and 19.

04.4 Magnesium does not react when heated with argon - argon is unreactive because argon atoms have eight electrons in the outer shell. Common responses referred to magnesium (and argon) both being unreactive, that metals (or solids) do not react with gases or that both elements had full outer shells. This question discriminated well.

04.5 Almost 60% of students gained at least one of the two marks for correctly deducing the method used to extract a metal. The students were given a reactivity series showing the position of these two metals compared to other known metals, carbon and hydrogen.

04.6 Students found difficulty in explaning why sodium chloride conducts electricity when molten but not when a solid. Many indicated that this was due to something being able to move but failed to link this to ions or charged particles. Most referred to moving particles, atoms or electrons.

04.7 Students also found difficulty in explaning why sodium conducts electricity when solid. Delocalised electrons were rarely seen as was the concept of these delocalised electrons carrying charge through the sodium.

5.4.1.2 The reactivity series

Answer 07 · Examiner comments

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

Question 7 (Standard demand)

07 This question discriminated well with around 20% of students achieving level two or above. It was based upon Required Practical Activity 10. Students were asked 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 need to 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. Common omissions were to add the metal to the acid before taking the initial temperature or failing to take the initial temperature altogether or not to control variables which would not ensure a fair test. Weaker responses could gain credit for either correctly identifying apparatus or for explaining the link between the expected results and the reactivity of the metal.

Answer 07 · 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.

Answer 08 · Examiner comments

Question 5 (low demand)

05.1 Just over two thirds of students knew that hydrogen gas is produced when a metal reacts with an acid. A quarter of students selected the distractor nitrogen.

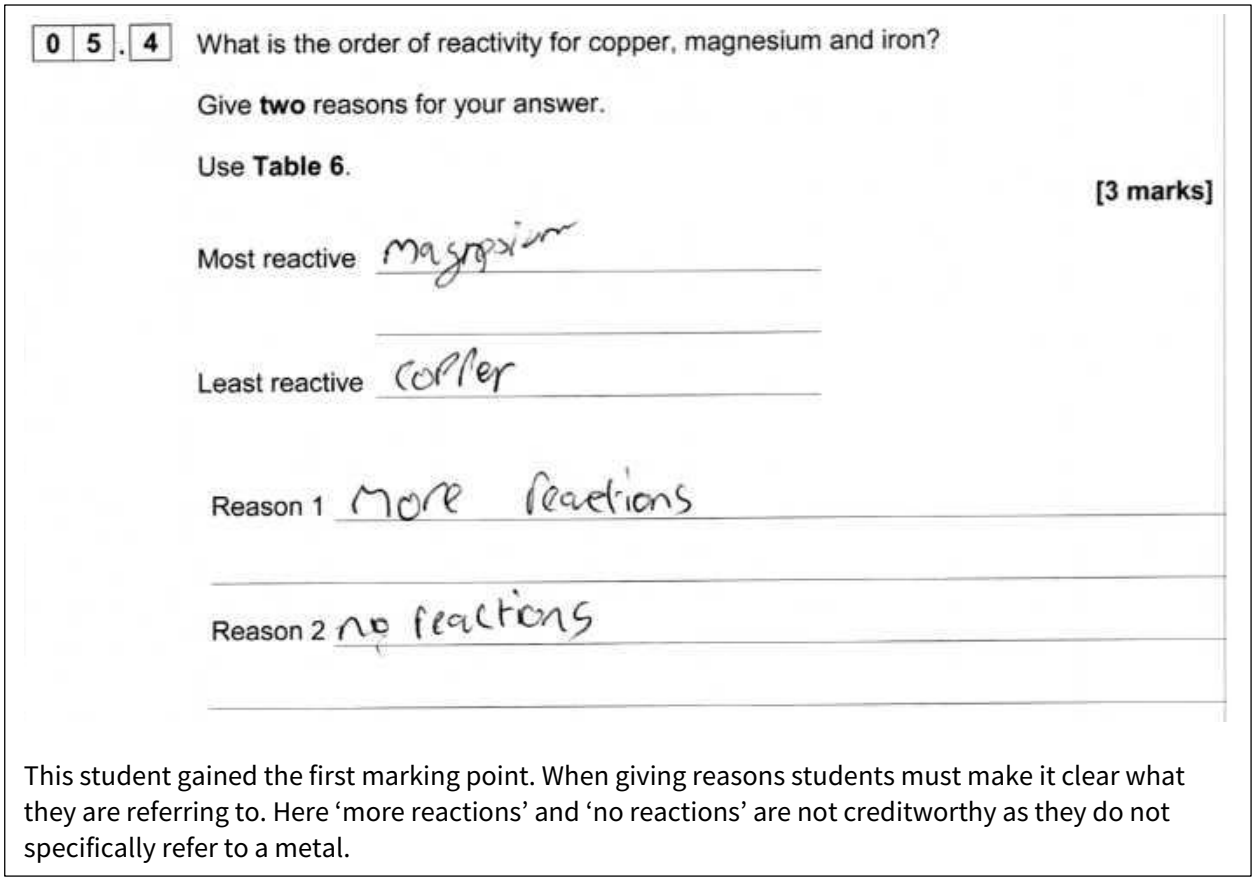
05.2 Nearly two-thirds of students knew molten magnesium chloride is a liquid, which is represented by the state symbol (l). A quarter of students incorrectly selected (g) as the state symbol.

05.3 10% of students gained both marks and students were awarded 1 mark if both elements were correct but reversed. Chlor*ide* is not creditworthy although was a common response.

Many students wrote the formula of the ions that were attracted to the electrodes rather than the element that is discharged. Nearly 20% of students did not attempt this question.

05.4 More than half of students gained 2 or 3 marks for correctly deducing the order of reactivity, with magnesium being the most reactive and copper the least reactive and giving one or two reasons. Students were able to give a reason associated with each metal eg iron only reacts with copper chloride solution or copper does not react.

Common incorrect responses included magnesium reacts with both metals (rather than both metal chloride solutions) or reasons which were not clearly linked to a metal (see example below).



0 5 . 4 What is the order of reactivity for copper, magnesium and iron?

Give **two** reasons for your answer.

Use **Table 6**.

[3 marks]

Most reactive magnesium

Least reactive copper

Reason 1 More reactions

Reason 2 no reactions

This student gained the first marking point. When giving reasons students must make it clear what they are referring to. Here 'more reactions' and 'no reactions' are not creditworthy as they do not specifically refer to a metal.

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5.4.1.2 The reactivity series

Answer 08 · Examiner comments June 2024 | 8464/C/1F | Original Q5

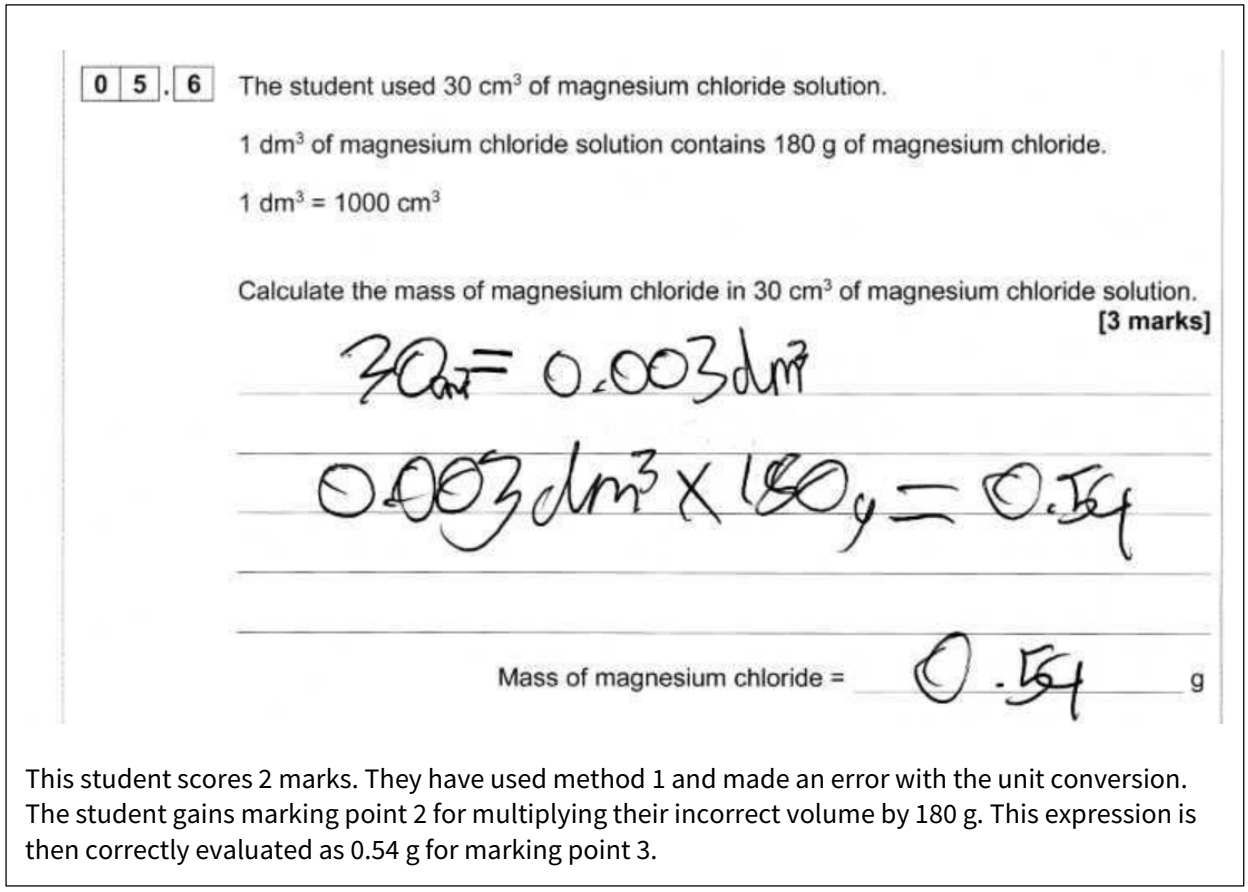
05.5 The law of conservation of mass states that the mass of reactants equals the mass of products. In this question a third of students correctly evaluated that the mass of iron oxide that reacts with 0.72 g of magnesium.

Common incorrect responses were 1.67 (multiplying 0.72 by 2.32) together with 3.2 and 0.31 (evaluated by dividing 2.32 by 0.72 or 0.72 by 2.32 respectively).

05.6 This question required a unit conversion as data is given in dm^3 and needed to be converted to cm^3. This conversion factor was given to lower the demand of the question.

Nearly 30% of students gained all 3 marks. Approximately 10% of students gained 2 marks usually for either not using the conversion factor, for multiplying rather than dividing by 1000 or for using an incorrect factor (eg dividing by 100 rather than 1000). A further 10% of students who gained 1 mark usually calculated the volume correctly in dm^3 but then did not multiply their answer by 180 g or used method 3 in the mark scheme and calculated the ratio of volume as 33.3 but then incorrectly multiplied this by 180 g.

17% of students did not attempt this question.



0 5 . 6 The student used 30 cm^3 of magnesium chloride solution.

1 dm^3 of magnesium chloride solution contains 180 g of magnesium chloride.

1 dm^3 = 1000 cm^3

Calculate the mass of magnesium chloride in 30 cm^3 of magnesium chloride solution.

[3 marks]

30cm³ = 0.003dm³

0.003dm³ x 180g = 0.54

Mass of magnesium chloride = 0.54 g

This student scores 2 marks. They have used method 1 and made an error with the unit conversion. The student gains marking point 2 for multiplying their incorrect volume by 180 g. This expression is then correctly evaluated as 0.54 g for marking point 3.

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