AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.2.5

Polymers

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**4**
Available paper years	**2022–2025**

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.

5.2.2.5 Polymers

Answer 01 · Mark scheme

June 2022 | 8464/C/1F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	giant covalent		1	AO1 5.2.2.6 5.2.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	4 / four		1	AO3 5.2.2.6 5.2.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	hexagons		1	AO1 5.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	carbon		1	AO1 5.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	electronics		1	AO1 5.2.3.3

5.2.2.5 Polymers

Answer 01 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	covalent bonds		1	AO1 5.2.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	intermolecular		1	AO1 5.2.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.8	(magnesium) 22 **and** (copper) 3 (percentage =) $\frac{3}{25}$ (× 100) =12 (%)	 allow correct use of incorrectly determined value(s) for number of magnesium atoms and / or copper atoms 	1 1 1	AO2 5.2.2.7

5.2.2.5 Polymers

Answer 01 · Mark scheme

June 2022 | 8464/C/1F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.9	(alloy is harder because) copper atoms are larger **or** (copper) atoms are a different size		1	AO2
	(so the) layers of (magnesium) atoms are distorted		1	AO2
	(and therefore the) layers cannot easily slide	allow (so) the atoms cannot slide over each other	1	AO1 5.2.1.5 5.2.2.7

Total Question 3		**13**

5.2.2.5 Polymers

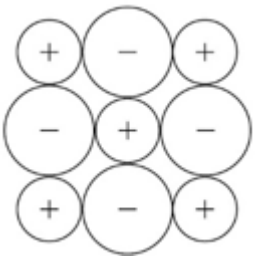
Answer 02 · Mark scheme

June 2023 | 8464/C/1F | Original Q3

Question 3

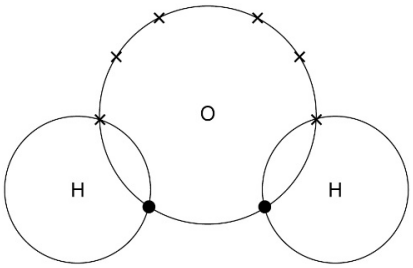
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	noble gases		1	AO1 5.2.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	potassium (atoms) lose electrons		1	AO2
	chlorine (atoms) gain electrons		1	AO2
	reference to one electron		1	AO2
	any **one** from: • to form ions • to form full outer shell(s) • to form full energy level(s)	allow to form a noble gas structure	1	AO1 5.2.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3			1	AO2 5.2.1.3

5.2.2.5 Polymers

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	one shared pair in each overlap	allow any combination of circles, dots, crosses, $e^{(-)}$ for electrons	1	AO1 5.2.1.1 5.2.1.4
	four non-bonding electrons in outer shell of oxygen	do **not** accept extra electron(s) on outer shell of hydrogen ignore any inner shell electrons the diagram below scores 2 marks 	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	1 Si : 2 O	allow 6 Si : 12 O	1	AO3 5.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	weak intermolecular forces		1	AO1 5.2.2.5

5.2.2.5 Polymers

Answer 02 · Mark scheme

June 2023 | 8464/C/1F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7		ignore references to boiling point		AO3 5.2.2.4 5.2.2.5
	the melting point increases as the length of the polymer molecule increases	allow **1** mark for melting point increases	2	
	(then the) melting point levels off (as the polymer molecule length increases)	allow (then the) melting point becomes constant (as the polymer molecule length increases)	1	

Total Question 3	**13**

Answer 03 · Mark scheme

June 2024 | 8464/C/1F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	independent		1	AO1 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	zinc sulfate	allow $ZnSO_4$	1	AO2 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3		ignore references to temperature / fizzing		AO2 5.4.1.2 5.5.1.1 RPA10
	solution becomes colourless	allow solution changes colour	1	
	(brown / orange) solid produced	allow zinc changes colour	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(highest temperature =) 36 (°C)		1	AO2 5.4.1.2 5.5.1.1 RPA10
	(temperature increase = 36 – 21 =) 15 (°C)	allow correct use of an incorrectly determined value for highest temperature ignore minus sign	1	

5.2.2.5 Polymers

Answer 03 · Mark scheme

June 2024 | 8464/C/1F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	(**B** =) $\frac{7.8 + 7.3 + 7.7}{3}$ **or** $\frac{22.8}{3}$ = 7.6 (°C) **OR** (**B** =) $\frac{7.8 + 7.7}{2}$ **or** $\frac{15.5}{2}$ (1) = 7.75 (°C) (1)	allow 7.8 (°C) if working shown for calculation of the mean using 7.8 and 7.7 (°C)	1 1	AO2 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	(range =) 13.1 (°C to) 13.8 (°C)	allow (range =) 13.8 (°C to) 13.1 (°C)	1	AO2 5.3.1.4 5.4.1.2 5.5.1.1 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7		MP2 is dependent on MP1 being awarded		AO3 5.4.1.2 5.5.1.1
	(result) 12.9 (°C)	allow (result / experiment) 2	1	RPA10
	any **one** from: • (the result is) much lower than the other two results		1	
	• (used) less than 3 g zinc	allow (used) incorrect mass of zinc		
	• (used) more than 50 cm^3 of copper sulfate (solution)	allow (used) incorrect volume of copper sulfate (solution)		
	• the mixture was not stirred			

Total Question 3	**11**

5.2.2.5 Polymers

Answer 04 · Mark scheme

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	compounds		1	AO1 5.4.1.3

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	to reduce the amount of energy used		1	AO1 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	the electrodes react with oxygen gas		1	AO1 5.4.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	the alloy is harder than the pure metal		1	AO1 5.2.2.7

5.2.2.5 Polymers

Answer 04 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(melting point of alloy) decreases		1	AO2 5.2.2.7
	until 70% (silver)	allow a value in the range 69% to 71%	1	
	or			
	until 530 °C	allow a value in the range 520 °C to 540 °C		
	then (melting point) increases		1	
		if no other mark awarded, allow **1** mark for (melting point) increases from 660 °C to 960 °C **or** (melting point) increases by 300 °C		

Total Question 4	8

5.2.2.5 Polymers

Answer 01 · Examiner comments

June 2022 | 8464/C/1F | Original Q3

Question 3 (Low and standard demand)

03.1 More than half of the students knew that silicon dioxide has a giant covalent structure.

03.2 Approximately 30% of students were able to use the diagram of the structure of silicon dioxide to correctly deduce the number of bonds formed by each silicon atom as four.

03.3 Approximately 90% of students recognised that the structure of fullerenes is based upon hexagons.

03.4 More than two thirds of students recognised that the fullerene molecules are made from atoms of carbon.

03.5 Just over 40% of students knew that fullerenes are used in electronics.

03.6 Over 40% of students recognised that covalent bonds hold atoms together in a polymer chain.

03.7 Approximately 70% of students recognised that polymer chains are held together by intermolecular forces.

03.8 Just over 40% of students achieved the first marking point for deducing the number of magnesium atoms shown in an alloy. A similar number were then able to use the number of magnesium atoms to calculate the percentage of copper atoms in the alloy. This question was a good discriminator.

03.9 This explanation of why a magnesium alloy is harder than magnesium metal was not well answered. The diagram of the magnesium alloy showed that the copper atoms were larger than the magnesium atoms and that these distort the layers that are evident in the pure metal.

5.2.2.5 Polymers

Answer 02 · Examiner comments — June 2023 | 8464/C/1F | Original Q3

Question 3 (low/standard demand)

03.1 More than half the students identified the noble gases as the group of elements that do not form ions.

03.2 This question was a good discriminator. Many gained the first three marks although MP4 was less common. Many incorrect terms such as ‘atoms sharing electrons to form ionic bonds’, ‘metal ions losing electrons’ and ‘non-metal ions gaining electrons’ were seen.

03.3 More than two thirds of students identified the structure that represents the arrangement of ions in solid potassium chloride. The first option was the best distractor.

03.4 More than a quarter of students correctly drew a dot and cross diagram for water. When only one mark was gained this was usually for the shared electrons in the overlap between oxygen and one of the hydrogen atoms. Some failed to show that there are four unshared electrons on the oxygen atom and others added more electrons into the circle around one or both of the hydrogen atoms.

03.5 More than three-quarters of students deduced the ratio of silicon atoms to oxygen atoms from the structure of silica.

Answer 02 · Examiner comments — June 2023 | 8464/C/1F | Original Q3

03.6 Only 20% of students knew that weak intermolecular forces hold polymer molecules together in a polymer. Covalent bonds and electrostatic attraction between ions were perhaps terms more familiar to the students and both proved more popular options than the correct answer.

03.7 Students found difficulty in recognising the link between the two variables from the *x*-axis and the *y*-axis. Many stated that as the melting point increases the length of the polymer molecule increases. Students should appreciate that the independent variable is on the *x*-axis and that as this is changed, the effect on the dependent variable (*y*-axis) can be observed ie as the length of the polymer molecule increases (independent, *x*-axis) then the melting point increases (dependent, *y*-axis).

Answer 03 · Examiner comments

June 2024 | 8464/C/1F | Original Q3

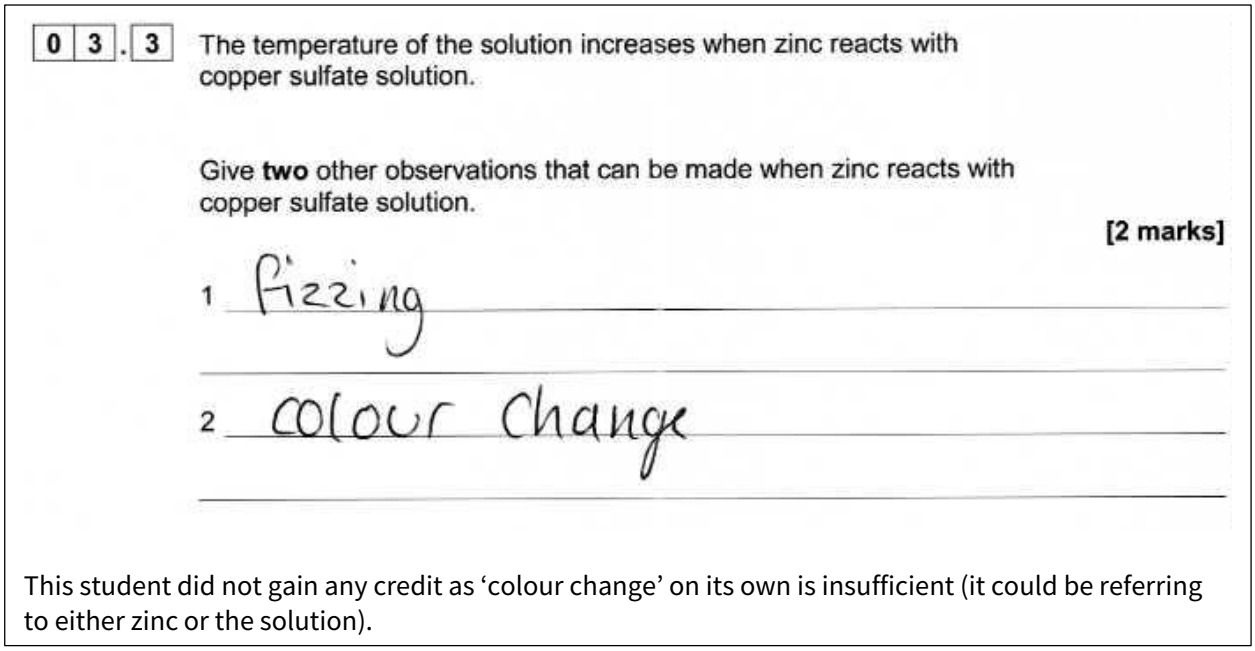
Question 3 (low & standard demand)

03.1 In an investigation the independent variable is the one that is changed, the dependent variable is the one that is measured, and all other variables must be controlled. If a student investigates the temperature change when different masses of zinc are added to copper sulfate solution the independent variable is the mass of zinc and the dependent variable is the temperature change. Just under half of the students answered this correctly. Control (variable) was a slightly more common incorrect response than dependent (variable).

03.2 A word equation was provided to help students identify that the salt zinc sulfate is produced when zinc reacts with copper sulfate solution. A quarter of students gave the correct answer.

03.3 Students found this question challenging. When a question asks for observations students should be encouraged to think 'before', 'during' and 'after'. In the reaction between zinc and copper sulfate solution, zinc is replaced by brown/orange copper solid and the blue colour of the copper sulfate solution fades as colourless zinc sulfate is produced. The colours are not required in the specification, hence the allow statements where there is just reference to the solution/zinc changing colour. 'Colour change' is too vague to gain credit as it does not refer to either the zinc solid or the copper sulfate solution.

The equation for the reaction was provided to help and, although it does not contain any gaseous products, many students gave 'bubbles' or 'fizzing' as an observation.



0 3 . 3 The temperature of the solution increases when zinc reacts with copper sulfate solution.

Give **two** other observations that can be made when zinc reacts with copper sulfate solution.

[2 marks]

1 Fizzing

2 colour change

This student did not gain any credit as 'colour change' on its own is insufficient (it could be referring to either zinc or the solution).

© 2024 AQA and its licensors. All rights reserved.

5.2.2.5 Polymers

Answer 03 · Examiner comments

03.4 The temperature shown on the diagram of the thermometer scale showed 36 °C. Most students read this correctly and then subtracted the starting temperature to give a temperature increase of 15 °C. A number of students did not use the temperature scale correctly and did not score marking point 1 but could access marking point 2 for a correct subtraction from their highest temperature.

03.5 The calculation of the mean temperature increase was correctly carried out by nearly three-quarters of students. Most students achieved either 2 or 0 marks.

Table 4

Mass of zinc in grams	Temperature increase in °C			
	Experiment 1	Experiment 2	Experiment 3	Mean
1.0	7.8	7.3	7.7	**B**
2.0	13.1	13.8	13.3	13.4
3.0	20.4	12.9	20.2	20.3

0 3 . 5 Calculate value **B** in **Table 4**.

[2 marks]

7.8 + 7.3 + 7.7 = 17.666666667

B = 17.6 °C

This student did not gain any credit. They divided only the last number (7.7) by 3, then added, rather than dividing the sum of all three numbers (ie 22.8) by 3.

03.6 The range of results is the 'minimum value to the maximum value'. In the data set the lowest value is 13.1 °C and the highest value is 13.8 °C. 60% of students gained this mark.

© 2024 AQA and its licensors. All rights reserved.

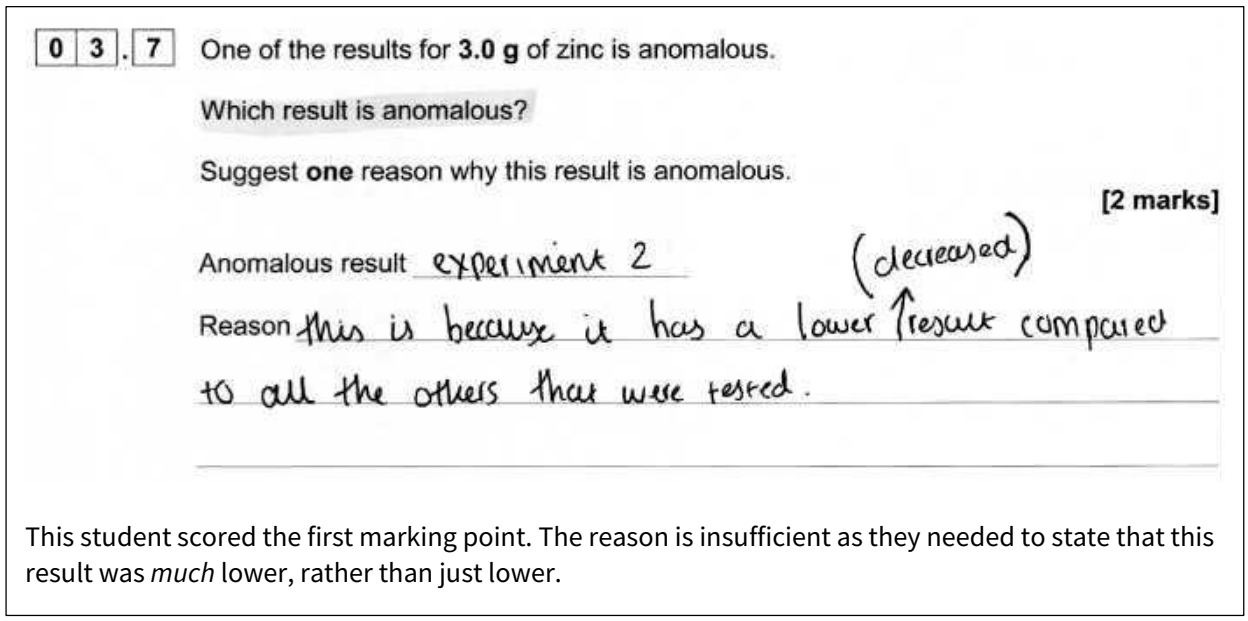
5.2.2.5 Polymers

Answer 03 · Examiner comments

June 2024 | 8464/C/1F | Original Q3

03.7 More than half of students correctly identified the anomalous result as 12.9 °C. Reasons why this result is anomalous were not well expressed, however: this result is *much* lower than the other two results (20.4 °C and 20.2 °C).

Alternative answers giving a reason why the result is anomalous such as 'used less than 3 g zinc', 'used more than 50 cm^3 of copper sulfate (solution)' or 'the mixture was not stirred' were much less common.



0 3 . 7 One of the results for **3.0 g** of zinc is anomalous.

Which result is anomalous?

Suggest **one** reason why this result is anomalous.

[2 marks]

Anomalous result experiment 2 (decreased)

Reason this is because it has a lower result compared to all the others that were tested.

This student scored the first marking point. The reason is insufficient as they needed to state that this result was *much* lower, rather than just lower.

© 2024 AQA and its licensors. All rights reserved.

Answer 04 · Examiner comments

Question 4 (Low demand)

04.1 Half the students were able to select the word from the box to complete the sentence that most metals are found in the Earth as compounds. Elements was the common incorrect distractor. Credit was awarded if the student identified the correct answer in the box.

04.2 Half the students knew that iron is extracted from iron oxide by reduction with carbon because iron is less reactive than carbon. A third of students selected the incorrect converse response that iron is more reactive than carbon.

04.3 Less than half of students knew that cryolite is added to aluminium oxide to reduce the amount of energy used in the extraction of aluminium from aluminium oxide by electrolysis. The most popular incorrect distractor was to reduce the rate of reaction.

04.4 In the extraction of aluminium from aluminium oxide by electrolysis the positive electrodes need to be replaced. Fewer than 20% of students knew that this is because the electrodes react with oxygen gas. The other three options were all more popular. The electrodes react with aluminium was the most common incorrect response.

04.5 Just under half of students recalled that an alloy is harder than a pure metal. The converse statement an alloy is less hard than a pure metal was the most popular incorrect distractor.

04.6 When describing trends in graphs examiners are looking for students to state how the change in the *x*-axis (an increase in the independent variable) affects the value plotted on the *y*-axis (the dependent variable). In figure 9 as the percentage of silver in the mixture (*x*-axis) increased the melting point (*y*-axis) decreased. However, there was a marked change in the trend at 70% silver (where the curve was a minimum) after which the melting point increased. Students may have realised how the 3 marks were allocated. Examiners were not looking for a description of the rate of changes e.g. a sharp increase after 70% silver. Some students were careless with their terminology referring to the percentage of aluminium not silver and the boiling point of the alloy. A third of students gained all 3 marks. Many were awarded 1 mark usually for the initial decrease in melting point.

© 2024 AQA and its licensors. All rights reserved.

5.2.2.5 Polymers

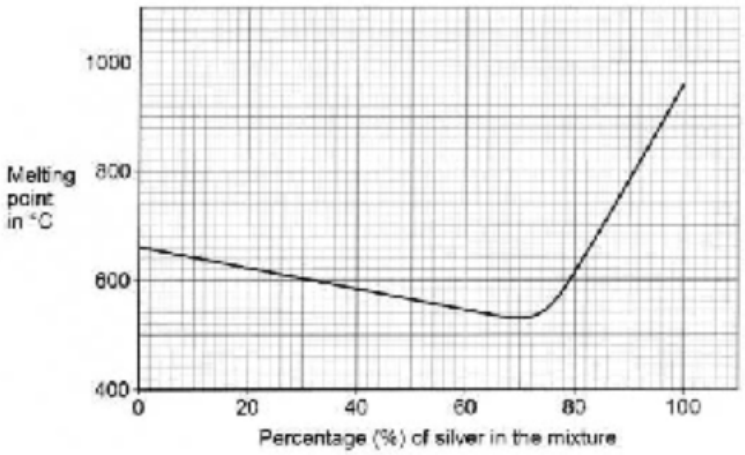
Answer 04 · Examiner comments

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

0 4 . 6 Aluminium can form an alloy with silver.

Figure 9 shows how the melting point of the alloy changes with the percentage (%) of silver in the mixture.

Figure 9



Describe how the melting point of the alloy changes as the percentage of silver in the mixture increases.

Use data from **Figure 9**.

[3 marks]

the melting point decreases as the percentage of silver increases, however once the mixture is over 70% the melting point significantly increases.

All 3 marking points were awarded. The student has described an initial decrease (in melting point), followed by an increase and has also indicated the point at which the change occurs.

© 2024 AQA and its licensors. All rights reserved.