AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.2.7

Properties of metals and alloys

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**5**
Available paper years	**2021–2025**

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.

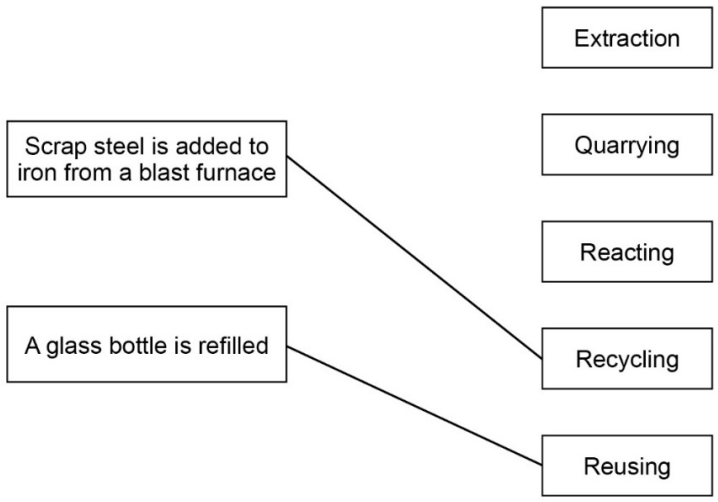
5.2.2.7 Properties of metals and alloys

Answer 01 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	as population increased, copper production increased		1	AO3 5.10.1.1
05.2	(copper ore) (70 × 100 =) 7000 (recycled copper) (27×100 =) 2700 (7000 – 2700 =) 4300 (MJ)	 allow correct use of incorrectly determined values for MP1 (copper ore) and/or MP2 (recycled copper)	1 1 1	AO2 5.10.2.2
05.3	any **one** from: • reduces acid rain • reduces respiratory problems (in humans)	 allow sulfur dioxide causes acid rain allow sulfur dioxide causes respiratory problems (in humans)	1	AO1 5.9.3.2
05.4	$\frac{75}{100}$ × 8 = 6 (g)		1 1	AO2 5.10.1.1

5.2.2.7 Properties of metals and alloys

Answer 01 · Mark scheme

05.5	 do **not** accept more than one line from a box on the left	1 1	AO2 5.10.2.2
05.6	**B**, **C**, **D**, **A**	1	AO1 5.10.2.2
Total		**10**	

5.2.2.7 Properties of metals and alloys

Answer 01 · Mark scheme

November 2021 | 8464/C/2F | Original Q5

5.2.2.7 Properties of metals and alloys

Answer 02 · 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

5.2.2.7 Properties of metals and alloys

Answer 02 · 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

5.2.2.7 Properties of metals and alloys

Answer 02 · 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**

5.2.2.7 Properties of metals and alloys

Answer 03 · Mark scheme

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

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	any **two** from: • mass of copper produced increased (from 1900 to 2010) • before 1930 the mass of copper produced increased slightly • after 1930 the mass of copper produced increased rapidly • the highest mass of copper was produced in 2010 • the lowest mass of copper was produced in 1900 • the increase in the mass of copper produced was not linear	 allow a value in the range 1925 to 1930 allow a value in the range 1925 to 1930 allow the highest mass of copper produced was 15.8 ($\times 10^9$ kilograms) allow the lowest mass of copper produced was 0.2 ($\times 10^9$ kilograms)	2	AO3 5.2.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(alloy of copper and zinc is harder because) the atoms are different sizes (so the) layers are distorted (so the) layers cannot easily slide	 allow (so the) atoms cannot slide over each other	1 1 1	AO2 5.2.2.7

5.2.2.7 Properties of metals and alloys

Answer 03 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	(% copper = 100 – 13.5 =) 86.5 (%)		1	AO2 5.2.2.7
	(mass of copper =) $\frac{86.5}{100}$ × 5.25	allow correct use of an incorrectly determined percentage of copper	1	
	= 4.54125 (g)		1	
	= 4.54 (g)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question	1	
	OR			
	(mass of zinc =) $\frac{13.5}{100}$ × 5.25 (1)			
	= 0.70875 (g) (1)			
	(mass of copper = 5.25 – 0.70875) = 4.54125 (g) (1)	allow correct use of an incorrectly determined mass of zinc		
	= 4.54 (g) (1)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question		

Total Question 6	9

5.2.2.7 Properties of metals and alloys

Answer 04 · Mark scheme

June 2024 | 8464/C/2F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(mass of aluminium recycled =) $\frac{212 \times 68.0}{100}$		1	AO2 5.10.2.1 5.10.2.2
	= 144 (million kg)	allow 144.16 (million kg) allow for **1** mark only an answer of 144 000 000 (million kg) **or** 144 160 000 (million kg)	1	

5.2.2.7 Properties of metals and alloys

Answer 04 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(unit conversion 4 kg =) 4000 g		1	AO2 5.10.2.2
	(number of cans =) $\frac{4000}{15.8}$	allow correct use of an incorrect / no conversion	1	
	= 253.16		1	
	= 253	allow correct whole number from an incorrectly determined number of cans using the values from the question	1	
	alternative approach 1			
	(unit conversion 15.8 g =) 0.0158 kg (1)			
	(number of cans =) $\frac{4}{0.0158}$ (1)	allow correct use of an incorrect / no conversion		
	= 253.16 (1)			
	= 253 (1)	allow correct whole number from an incorrectly determined number of cans using the values from the question		
	alternative approach 2			
	(number of cans from 1000 g =) $\frac{1000}{15.8}$ (1)			
	= 63.29 (1)			
	(number of cans from 4000 g) = 63.29 × 4 (1)	allow correct use of an incorrectly determined number of cans from 1000 g		
	(= 253.16) = 253 (1)	allow correct whole number from an incorrectly determined number of cans using the values from the question		

5.2.2.7 Properties of metals and alloys

Answer 04 · Mark scheme

June 2024 | 8464/C/2F | Original Q5

Question	Answers	Mark	AO / Spec. Ref.
05.3	**Level 2:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3–4	AO3 5.10.2.1 5.10.2.2
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content • less steel (than wood) goes to waste • (so) less space taken up in landfill • more steel (than wood) is recycled • (so) less non-renewable resources are needed • no steel is burnt • (so) no carbon dioxide produced • (so) no contribution to climate change • most wood is disposed of as waste • (so) more space taken up in landfill • least wood is disposed of by burning • (but) still produces carbon dioxide • (which) contributes to climate change • most steel is disposed of by recycling • (so) less non-renewable resources are needed • judgement		

Total Question 5	**10**

5.2.2.7 Properties of metals and alloys

Answer 05 · Mark scheme

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

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

5.2.2.7 Properties of metals and alloys

Answer 05 · 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

5.2.2.7 Properties of metals and alloys

Answer 01 · Examiner comments November 2021 | 8464/C/2F | Original Q5

Question 5 (low and standard demand)

The interpretation of data and the associated calculations were generally well done, and many students scored highly on this question. The exception was question 05.3, where no credit was given for sulfur dioxide being toxic or harmful, as these are not the most significant reasons for reducing the global emissions of the gas.

Answer 02 · 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.

Question 6 (standard demand)

06.1 Few students gained 2 marks on the although more than half gained 1 mark. The graph showed that the mass of copper produced each year slowly increased from 1900 to 1930 and then rapidly increased until 2010. Students were asked to give two conclusions, so statements that merely quoted numerical values and years from the graph or made predictions of the future were insufficient.

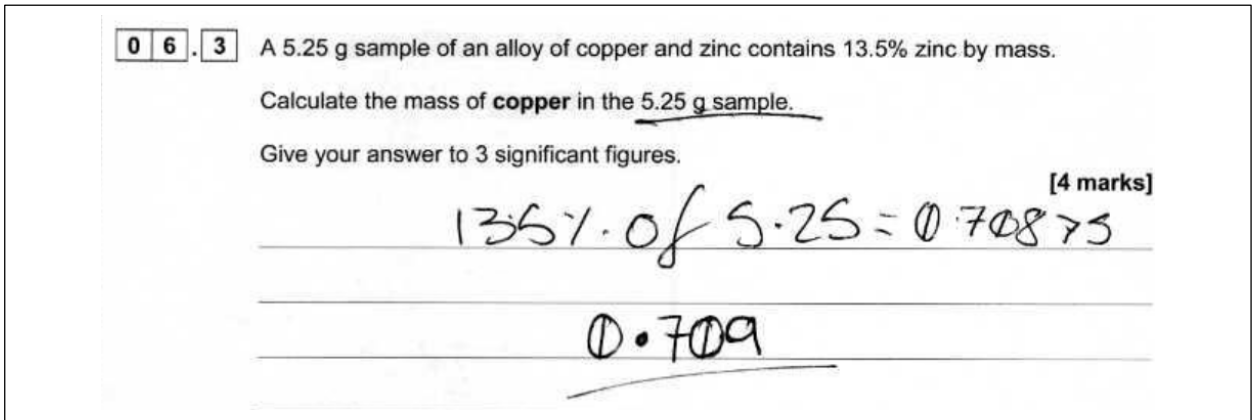
Non-creditworthy responses referred to use or demand of copper or involved incorrect readings, for example 'rapid increase from 1950' (rather than from 1925 to 1930) was common.

06.2 Students should know that metals are soft so are mixed with other metals to make alloys, which are harder. A diagram representing the structures of pure copper and of an alloy of copper and zinc was given that showed larger zinc atoms disrupting the layers of atoms in the alloy, thus the layers of atoms cannot easily slide. Some students did not read the question carefully and talked about copper rather than the alloy.

15% of students gained 1 mark or more and few students achieved all 3 marks. Those who gained a mark usually referred to the difference in the sizes of the atoms. Many answers attributed hardness of the alloy to some form of bonding between copper and zinc.

06.3 In this calculation students were told that the alloy contains 13.5% zinc by mass and were asked to calculate the mass of copper in the alloy. As always there are a number of approaches students took and those who showed their working often gained credit even after making errors. In the calculation working with an accompanying percentage sign, such as 13.5% or 86.5% are considered to be equivalent to 13.5 ÷ 100 and 86.5 ÷ 100 respectively eg 13.5% of 5.25 gains marking point 1 in the second method.

More than half of students scored at least 1 mark and nearly a fifth gained all 4. 16% of students did not attempt this question. Those who gained 1 mark achieved this by either determining the percentage of copper as 86.5% (mark scheme method one) or for a calculation that used the values in the question (5.25 and 13.5) if the expression was evaluated correctly and the answer was rounded to 3 significant figures eg 13.5 ÷ 5.25 = 2.57 (marking point 4 in either method one or method two).



This response (from a Foundation tier paper) used mark scheme method 2. The student correctly determined the mass of zinc to 3 significant figures but did not subtract this from the mass of the sample. They achieved marking points 1, 2 and 4 so scored 3 of the 4 marks.

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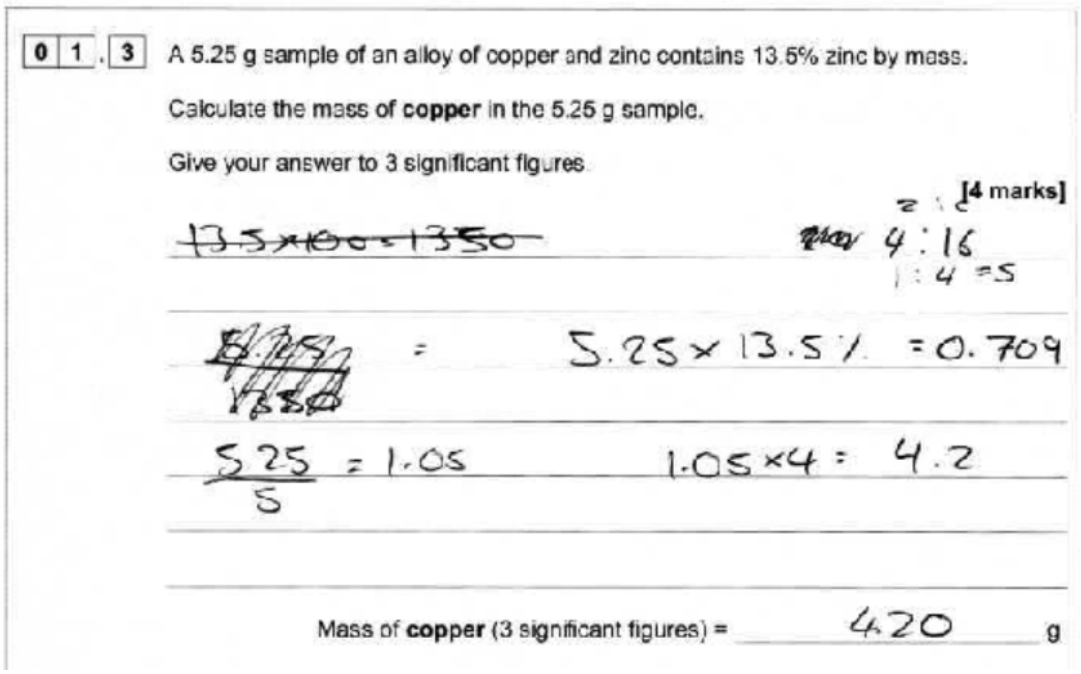
5.2.2.7 Properties of metals and alloys

Answer 03 · Examiner comments June 2024 | 8464/C/1F | Original Q6



0 1 . 3 A 5.25 g sample of an alloy of copper and zinc contains 13.5% zinc by mass.

Calculate the mass of **copper** in the 5.25 g sample.

Give your answer to 3 significant figures

[4 marks]

~~13.5×100=1350~~ 4 : 16

1 : 4 = 5

5.25 = 5.25 × 13.5% = 0.709

$\frac{5.25}{5} = 1.05$ 1.05 × 4 = 4.2

Mass of **copper** (3 significant figures) = 420 g

This response (from a Higher tier paper) has several different methods in the answer box. Initially the student might gain marking points 1, 2 and 4 from method 2 (as the previous example did). However, the student then gives a totally different method which gives the answer on the answer line and this is the one that takes precedence so the method attached to this is the one that is marked. Although 4.20 is correctly rounded to 3 significant figures it does not come from a calculation using all values in the question (ie 13.5% has not been used) so gains no credit.

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Answer 04 · Examiner comments

Question 5 (low & standard demand)

05.1 This calculation proved accessible to many students, with over half gaining at least 1 mark.

A common error included unnecessary unit conversions, particularly multiplying by 1 000 000, but such students could still get the compensation mark. Failure to divide by 100 for the percentage often appeared, meaning no credit could be given. Many students divided 212 by 68% rather than multiplying them together.

A few students coincidentally arrived at the correct numerical value by incorrectly subtracting, 212 – 68 = 144, but this gained no credit.

05.2 Although unfamiliar, this AO2 calculation was well attempted by many students, with just over 50% gaining full marks.

For marking point 1 incorrect conversions, such as 15.8 × 1000, or 4 ÷ 1000, were commonplace although marks could still be awarded consequentially. Some students inappropriately rounded 15.8 to 16 and used this in their calculations, which meant marking points 2 and 3 could not be awarded. Marking point 4 was often missed by students rounding up instead of down, or not reading the question properly and leaving a decimal point in their final answer.

All the alternative mathematical methods on the mark scheme were used in arriving at the right answer. Some students arrived at the correct answer by simply scaling up 15.8 many times until they got to (eg) 253 cans = 3997.4 g and 254 cans = 4013.2 g, then correctly choosing the lower value. Simple incorrect use of the values (eg 15.8 × 4) was seen, giving an answer of 63.2 which could not gain credit, but the consequential whole number of 63 cans could be awarded marking point 4 because the values in the question had been used.

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5.2.2.7 Properties of metals and alloys

Answer 04 · Examiner comments June 2024 | 8464/C/2F | Original Q5

05.3 Fewer than 10% of students were able to achieve marks in Level 2 on this AO3 extended response evaluation question. To access marks in Level 2 students needed to provide a judgement supported by appropriate comparisons and links.

Simply repeating data from the table without interpretation or using it was common and was not credited.

Most comparisons were made between steel and wood, but also comparisons made horizontally across the table (eg most wood is wasted) were quite common. Some solid answers with more than one link were lacking in a judgement, which did not address the command word and so were restricted to Level 1.

Judgements were often muddled by describing both wood and steel as sustainable 'because they're both recycled', failing to see the advantage of steel. Wasting wood was often considered to be a good thing as it could be used for animal habitats, or because it rots back into the ground and burning wood was seen as a good thing since it is a good fuel. Imprecise language such as 'steel can be re-used' (rather than 're-cycled') was often used.

Of the links, carbon dioxide and climate change was most used; landfill descriptions were a rarity and no mention was seen of conserving non-renewable resources.

0 5 . 3 **Table 5** shows three methods used to dispose of wood and steel after use.

Table 5

	Percentage (%) of material disposed of by each method		
	As waste	Recycled	Burnt
Wood	58	36	6
Steel	15	85	0

Evaluate the sustainability of the disposal of wood and steel.

[4 marks]

Steel is more sustainable than wood as the table shows it is recycled more and less put into waste

Despite making a judgement in their opening sentence and then going on to make two valid comparisons ('it [steel] is recycled more' and 'less put into waste'), this student has not made any links so is limited to the top of Level 1 and gains 2 marks.

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5.2.2.7 Properties of metals and alloys

Answer 04 · Examiner comments June 2024 | 8464/C/2F | Original Q5

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	As waste	Recycled	Burnt
Wood	58	36	6
Steel	15	85	0

Evaluate the sustainability of the disposal of wood and steel.

[4 marks]

~~out of 100 only 58%~~
~~of w~~ 58% of wood wasted.
36% Recycled and put to use
6% burned which Releases
CO_2 which is a greenhouse
gas, contributes to global
warming

only 15% steel waste as its
hard to Dispose off

In this response, the student is quoting numbers from the table without adding anything, which is not creditworthy; however, they have made a link to burning wood releases carbon dioxide which is a greenhouse gas. There is no judgement given and no comparisons, which are required to access Level 2, so this response is at the top of Level 1 and gains 2 marks.

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5.2.2.7 Properties of metals and alloys

Answer 04 · Examiner comments June 2024 | 8464/C/2F | Original Q5

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	As waste	Recycled	Burnt
Wood	58	36	6
Steel	15	85	0

Evaluate the sustainability of the disposal of wood and steel.

[4 marks]

The sustainability of wood and steel is wood as 58% of waste, 36% recycled and 6% burnt. Steel has 15% waste, 85% recycled, 0% burnt so steel would be more sustainably as there less of it.

This student has only quoted numbers from the table, again not doing anything with them, which is not creditworthy. The final sentence is a judgement; however, it is not logically supported so is also not creditworthy. This response gained no marks.

Answer 05 · Examiner comments

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

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.

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5.2.2.7 Properties of metals and alloys

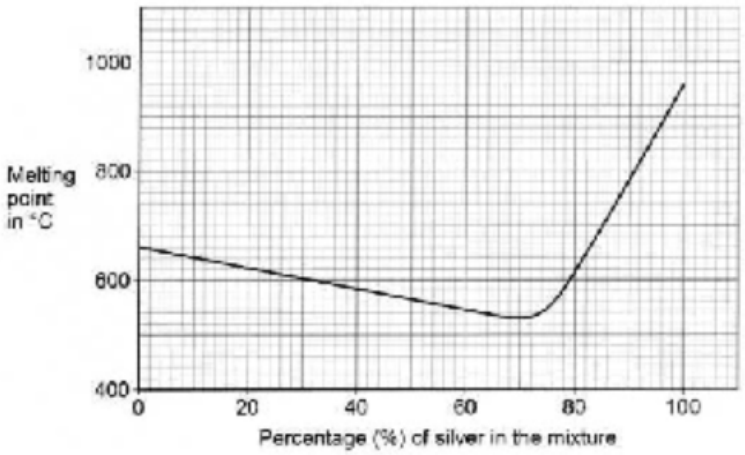
Answer 05 · Examiner comments

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.

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