AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.2.7

Properties of metals and alloys

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**4**
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

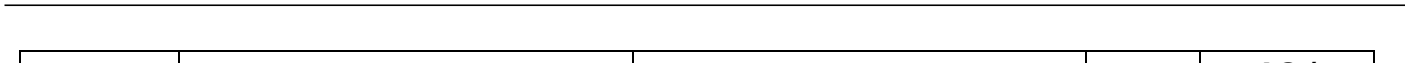
November 2021 | 8464/C/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	C_{60}		1	AO1 5.2.3.3
04.2	(graphite has) delocalised electrons (so the delocalised electrons) carry electrical charge through the structure	 allow (so the delocalised electrons) move through the structure	1 1	AO1 5.2.3.2
04.3	carbon atoms have different sizes to iron atoms / ions (so carbon atoms) distort the layers of iron atoms / ions (therefore) the layers cannot slide		1 1 1	AO1 5.2.2.7
04.4	(percentage and mass of other elements) 28.08 (%) = 16.29 (g) (mass of fork) = $\frac{16.29}{28.08} \times 100$ (g) = 58.01 (g) (mass of iron = $\frac{71.92}{100} \times 58.01$) = 41.72 (g)	 allow (mass of fork – mass of other elements) = 41.72 (g) allow 41.7 (g) allow correct use of incorrect calculation of mass and / or percentages	 1 1 1 1	AO2 5.2.2.7
Total			**10**	

5.2.2.7 Properties of metals and alloys

Answer 01 · Mark scheme

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5.2.2.7 Properties of metals and alloys

Answer 02 · Mark scheme

June 2022 | 8464/C/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	fullerene	allow (carbon) nanotube do **not** accept Buckministerfullerene	1	AO1 5.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	any **one** from: • conducts heat • conducts electricity • very high length to diameter ratio	 allow large surface area to volume ratio allow high tensile strength allow can trap other molecules / atoms / ions	1	AO2 5.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	other metal atoms have different sizes to aluminium atoms (so) the layers of aluminium atoms are distorted (so) the layers cannot slide (which) makes the alloy harder	 allow (so) the atoms cannot slide over each other allow (which) makes the alloy stronger	1 1 1 1	AO1 5.2.2.7

5.2.2.7 Properties of metals and alloys

Answer 02 · Mark scheme

June 2022 | 8464/C/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	covalent bonds (between atoms) in the chain intermolecular forces between the chains covalent bonds are strong **and** intermolecular forces are weak		1 1 1	AO1 5.2.2.5

Total Question 5		**9**

5.2.2.7 Properties of metals and alloys

Answer 03 · Mark scheme

June 2024 | 8464/C/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	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.
01.2	(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.
01.3	(% 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 1	9

5.2.2.7 Properties of metals and alloys

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

5.2.2.7 Properties of metals and alloys

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

5.2.2.7 Properties of metals and alloys

Answer 01 · Examiner comments — November 2021 | 8464/C/1H | Original Q4

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

04.1 The formula of Buckminsterfullerene was known by just over half of students.

04.2 Approximately one quarter of students gained one mark for delocalised electrons. Few gained the second mark for stating that these delocalised electrons carry electrical charge through the structure.

Answer 01 · Examiner comments — November 2021 | 8464/C/1H | Original Q4

04.3 A small number of students knew that layers cannot slide in an alloy and understood that the carbon atoms distort the layers of iron atoms. Very few students recognised that carbon and iron atoms have different sizes.

04.4 Just under one fifth of students successfully completed this calculation. In calculations students must show all their working.

Answer 02 · Examiner comments — June 2022 | 8464/C/1H | Original Q5

Question 5 (Standard/high and high demand)

05.1 This question discriminated well with a third of students recognising the structure of a fullerene.

05.2 Students struggled to suggest a property of the fullerene molecule, with just over 30% gaining a mark.

05.3 More than half the students scored one mark or more in their explanation of why metals are added to aluminium to produce an alloy. However students found developing an explanation challenging. The most commonly awarded mark was for the alloy being harder or stronger. In some responses there was confusion about layers sliding over each other when many talked about ‘metals’ or ‘molecules’ rather than ‘atoms’. The marking point stating that atoms of other metals have different sizes was the least often awarded.

5.2.2.7 Properties of metals and alloys

Answer 02 · Examiner comments June 2022 | 8464/C/1H | Original Q5

05.4 This question required students to use correct scientific terminology. This question discriminated well with 30% of students gaining at least one mark though many students seemed to know that the bonds in the chains were strong and between chains were weak, but they did not name them correctly and therefore failed to score.

Answer 03 · Examiner comments

June 2024 | 8464/C/1H | Original Q1

Question 1 (standard demand)

01.1 Nearly three-quarters of students scored at least 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.

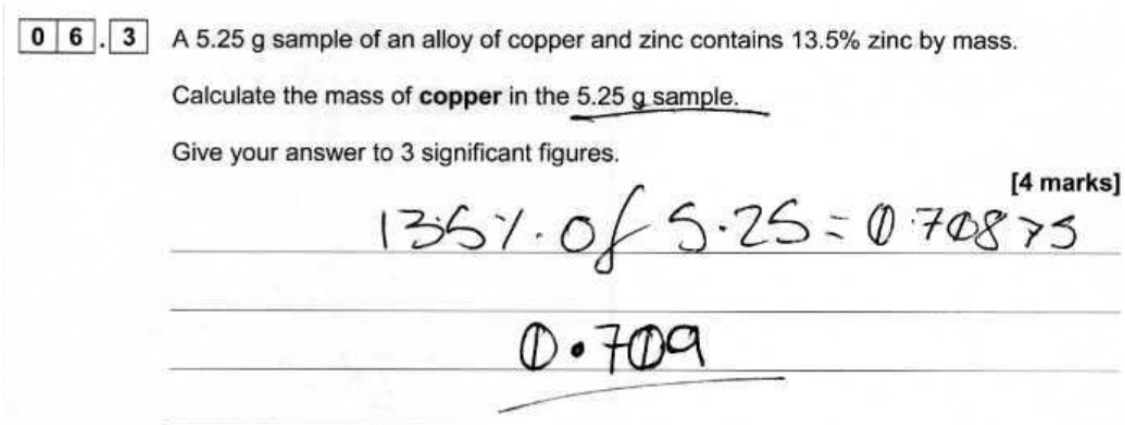
Non-creditworthy responses referred to use or demand of copper or involved incorrect readings, for example 'rapid increase from 1950' (rather than from 1925 to 1930) was common.

01.2 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.

Just under half of students gained 1 mark or more and approximately a quarter of students scored 2 marks or more. Those who gained a 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. The diagram showed that the layers are distorted in the alloy compared to the pure metal but this marking point was less frequently given.

01.3 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.

Nearly two-thirds of students scored 4 marks. Those who only gained 3 marks either failed to round their answer to 3 significant figures or determined the mass of zinc rather than the mass of copper.



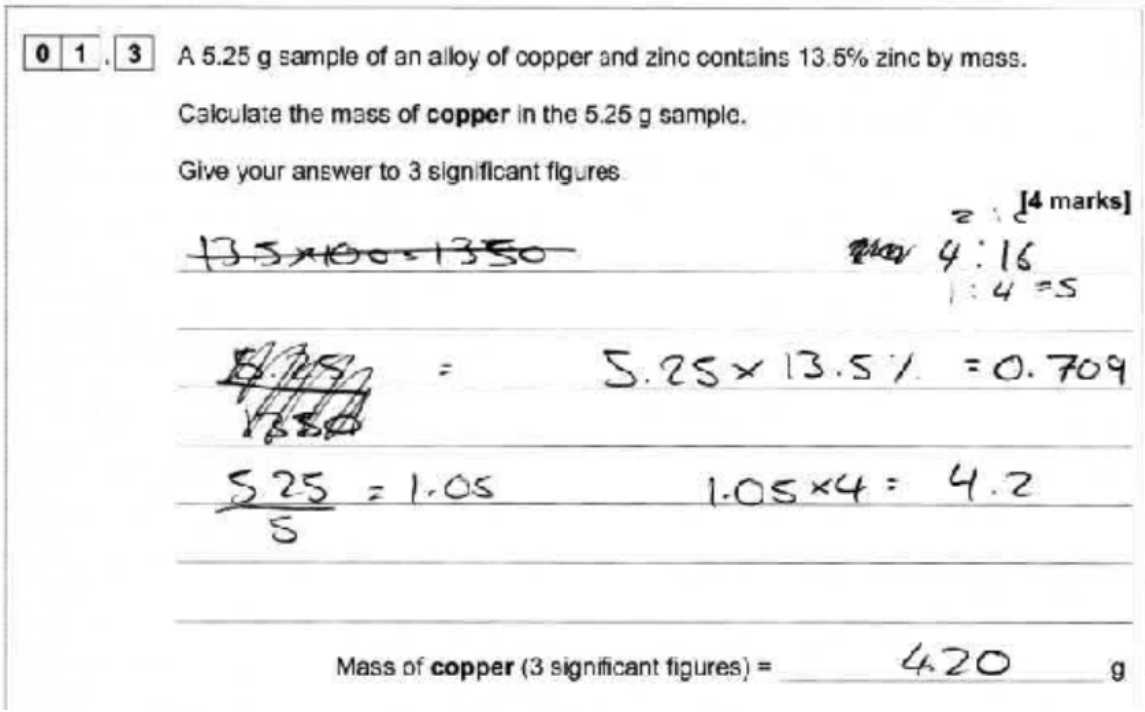
This response (from a Foundation tier paper) used mark scheme method 2. The student correctly determined the mass of zinc to 3 significant figures but did not subtract this from the mass of the sample. They achieved marking points 1, 2 and 4 so scored 3 of the 4 marks.

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5.2.2.7 Properties of metals and alloys

Answer 03 · Examiner comments

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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) = 4.20 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

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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