AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.2.8

# Metals as conductors

## Mark schemes and examiner comments

| | |
|---|---|
| Tier | **Higher** |
| Question groups | **2** |
| 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.

5.2.2.8 Metals as conductors

Answer 01 · Mark scheme

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

## Question 7

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.1 | electrolysis<br><br>of molten compound (of metal **Y**)<br><br>**OR**<br><br>displacement (1)<br><br>by heating with a more reactive metal<br>**or**<br>by heating with potassium / magnesium (1) | <br><br>allow liquid for molten | 1<br><br>1 | AO3<br>5.4.1.3<br>5.4.3.2<br>5.4.3.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.2 | 4 Na + $TiCl_4$ → 4 NaCl + Ti | allow multiples<br><br>allow **1** mark for NaCl **and** Ti with incorrect / no balancing | 2 | AO2<br>5.1.1.1<br>5.3.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.3 | $Na \rightarrow Na^+ + e^-$ | ignore state symbols<br><br>allow multiples<br><br>allow **1** mark for $Na \rightarrow Na^+ + e^-$ with incorrect balancing | 2 | AO2<br>5.4.1.2<br>5.4.1.4 |

### 5.2.2.8 Metals as conductors

**Answer 01 · Mark scheme**

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

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.4 | **method 1:**<br>(moles of Al = $\frac{108}{27}$ =) 4 | | 1 | AO2<br>5.3.2.2<br>5.3.2.4 |
| | (moles $CuCl_2$ = $\frac{1210}{134.5}$ = )<br>8.996 | allow 9 | 1 | |
| | (identifying limiting reactant)<br>4 moles Al gives 6 moles Cu<br>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)<br>= 6 × 63.5 | | 1 | |
| | = 381 (g) | | 1 | |

5.2.2.8 Metals as conductors

Answer 01 · Mark scheme

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

| | | | | |
|---|---|---|---|---|
| **07.4 cont.** | **method 2:**<br><br>$2\,Al + 3\,CuCl_2 \rightarrow 3\,Cu + 2\,AlCl_3$<br><br>(2×27) (3×134.5) (3×63.5)<br><br>54 (g) 403.5 (g) 190.5 (g)<br>(1) (1) (1)<br><br>(so)<br>108 g Al (reacts with 807 g $CuCl_2$) to produce 381 g Cu (1)<br><br>(so) there is excess $CuCl_2$<br>**or**<br>807 g $CuCl_2$ is less than 1210 g $CuCl_2$ (1)<br><br>therefore aluminium is limiting reactant (1)<br><br>**method 3:**<br>134.5 g $CuCl_2$ produces 63.5 g Cu (1)<br><br>(mass conversion 1.21 kg $CuCl_2$ =) 1210 (g) (1)<br><br>1210 g $CuCl_2$ produces ($\frac{63.5}{134.5}$ × 1210 =) 571 g Cu (1)<br><br>54 g Al produces 190.5 g Cu (1)<br><br>108 g Al produces ( $\frac{190.5}{54}$ × 108 =) 381 (g) (1)<br><br>(therefore) aluminium is the limiting reactant (1) | allow correct use of an incorrect calculation of mass for Al / $CuCl_2$ / Cu<br><br>must follow on from MP4 / MP5<br><br>allow correct use of an incorrect / no conversion of mass of $CuCl_2$<br><br>must follow on from MP3 and MP5 | | |

5.2.2.8 Metals as conductors

Answer 01 · Mark scheme

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| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.5 | delocalised electrons<br><br>carry (electrical) charge through the metal / sodium | allow free electrons<br><br>ignore throughout for through<br><br>ignore current / electricity<br><br>MP2 is dependent upon MP1 | 1<br><br>1 | AO1 5.2.2.8 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.6 | (conducts electricity) when liquid / molten<br>**or**<br>(conducts electricity) in (aqueous) solution<br><br>(because) ions<br><br>(ions) are free to move<br>**or**<br>(ions) allow charge to flow | allow (conducts electricity) when dissolved in water | 1<br><br>1<br><br>1 | AO1 5.2.2.3 |

| Total Question 7 | | 17 |
|---|---|---|

5.2.2.8 Metals as conductors

Answer 02 · Mark scheme

June 2025 | 8464/C/1H | Original Q7

## Question 7

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.1 | (model **A**) does not show the 3D arrangement (of the ions / particles) | allow (model **A**) only shows the 2D arrangement (of the ions / particles)<br><br>allow (model **A**) does not show lattice arrangement (of the ions / particles)<br><br>allow (model **A**) only shows two ions / particles | 1 | AO3<br>5.2.1.3 |
| | (model **A**) does not show the relative sizes of the ions / particles | | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.2 | $Al_2(SO_4)_3$ | | 1 | AO2<br>5.1.1.1<br>5.2.1.2<br>5.4.2.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 07.3 | aluminium has more delocalised electrons per atom than sodium | allow aluminium has more outer shell electrons per atom than sodium | 1 | AO2<br>5.1.1.7<br>5.2.1.5<br>5.2.2.8 |

5.2.2.8 Metals as conductors

Answer 02 · Mark scheme

June 2025 | 8464/C/1H | Original Q7

| Question | Answers | Mark | AO / Spec. Ref. |
|---|---|---|---|
| 07.4 | **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. | 3–4 | AO1<br>5.2.1.4<br>5.2.2.5<br>5.2.2.6 |
| | **Level 1:** Relevant features are identified and differences noted. | 1–2 | |
| | **No relevant content** | 0 | |
| | **Indicative content**<br><br>**Similarities**<br>• both have covalent bonding<br>  ○ both form bonds by sharing electrons<br><br>• both have atoms that form 4 bonds<br>  ○ in silicon dioxide each silicon atom forms 4 bonds, in poly(ethene) each carbon atom forms 4 bonds<br><br>• both substances have strong (covalent) bonds<br><br>**Differences**<br>• silicon dioxide has atoms that form 2 bonds<br>  ○ in silicon dioxide each oxygen atom forms 2 bonds<br>• poly(ethene) has atoms that form 1 bond<br>  ○ in poly(ethene) each hydrogen atom forms 1 bond<br><br>• silicon dioxide only has covalent bonds<br>• poly(ethene) has intermolecular forces between polymer molecules<br><br>• silicon dioxide is a giant structure<br>• poly(ethene) has very large molecules<br><br>For **Level 2** a comparison and reference to magnitude, structure and bonding is required | | |

| Total Question 7 | 8 |
|---|---|

### 5.2.2.8 Metals as conductors

**Answer 01 · 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.

### 5.2.2.8 Metals as conductors

**Answer 01 · 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.

5.2.2.8 Metals as conductors

Answer 01 · Examiner comments

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### 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 02 · Examiner comments



# Question 7 (Standard, Standard/High and High demand)

**07.1** Very few students gained full credit in this question. The most common creditworthy statement was 'A shows the 2D arrangement' or 'B shows the 3D arrangement'. Many referred to atom, molecule or subatomic particle instead of ion; some students thought that the + and – charges meant the spheres were protons and electrons. There were many descriptions of what the models showed rather than a comparison of how they represented ionic bonding. Relative size of the ions seems to be a difficult concept; some wrote about not seeing the actual size of the particles in A whereas you could in B.

**07.2** Very few knew how to construct a formula from the constituent ions. Those who were successful in writing the formula of aluminium sulfate either used the lowest common multiple or 'swap and drop' methods. Many answers placed the two ions together and reported the remaining charge, rather than forming a neutral formula. $AlSO_4$ was the most common incorrect answer.

**07.3** Many students recognised that 'more delocalised electrons' was why aluminium metal conducts electricity better than sodium metal. However, this answer needed 'per atom' to be creditworthy. Some students answered in terms of properties, bond strength and reactivity.

**07.4** This was an 'extended response' style of question. Such questions are marked holistically. There are overall generic descriptions for the two levels of response at the top of the mark scheme, giving a hierarchy of response. Within each level there are 2 marks.

Students were asked to compare the structure and bonding of silicon dioxide and poly(ethene). In the indicative content the first 4 black bullet points in the 'differences' relate to bonding, the last 2 to structure.

At Level 1, students needed to identify some relevant features. To enter Level 2 a comparison, reference to magnitude and reference to the structure and bonding of silicon dioxide or poly(ethene) were required.

Students found this question challenging and a significant proportion did not attempt it. Neither the structure nor bonding of these two compounds were well known. Silicon dioxide has a giant structure was common, but some did not state whether this was ionic or covalent. Poly(ethene) contains covalent bonds was common but long chain molecules very rare. Few knew the intermolecular forces were between chains of poly(ethene). There were many contradictions such as giant ionic and giant covalent and many wrote that silicon dioxide contained carbon or carbon dioxide bonded to silicon or formed a simple molecule containing 3 atoms. There were many two-paragraph answers and very few comparisons which would have lifted many responses from Level 1 to Level 2 and lots of references to properties.

Students often contradicted themselves, sometimes seemingly when later adding to their answer. The most common contradiction was correctly stating that silicon dioxide had a giant covalent structure and later stating that it had intermolecular forces. A common expression was 'is a covalent bond'.

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### 5.2.2.8 Metals as conductors

**Answer 02 · Examiner comments** June 2025 | 8464/C/1H | Original Q7

**0 7 . 4** Silicon dioxide and the polymer poly(ethene) are solid substances.

Compare silicon dioxide with the polymer, poly(ethene).

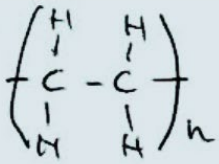
Answer in terms of structure and bonding.

**[4 marks]**

Silicon dioxide is a allotrope of carbon it is a giant covalent structure. it is held together by strong covalent bonds meaning it has a high melting and boiling point as lot's of energy is needed to break the bonds. Silicon dioxide can transfer electricity as it has delocalised electron.

Poly(ethene) is a Hydrocarbon made up of 2 carbon atoms each bonded to 2 Hydrogen atoms. Carbon

Extra space it's a lighter Hydrocarbon which means it has a lower boiling/melting point. It's held together via covalent bonding.



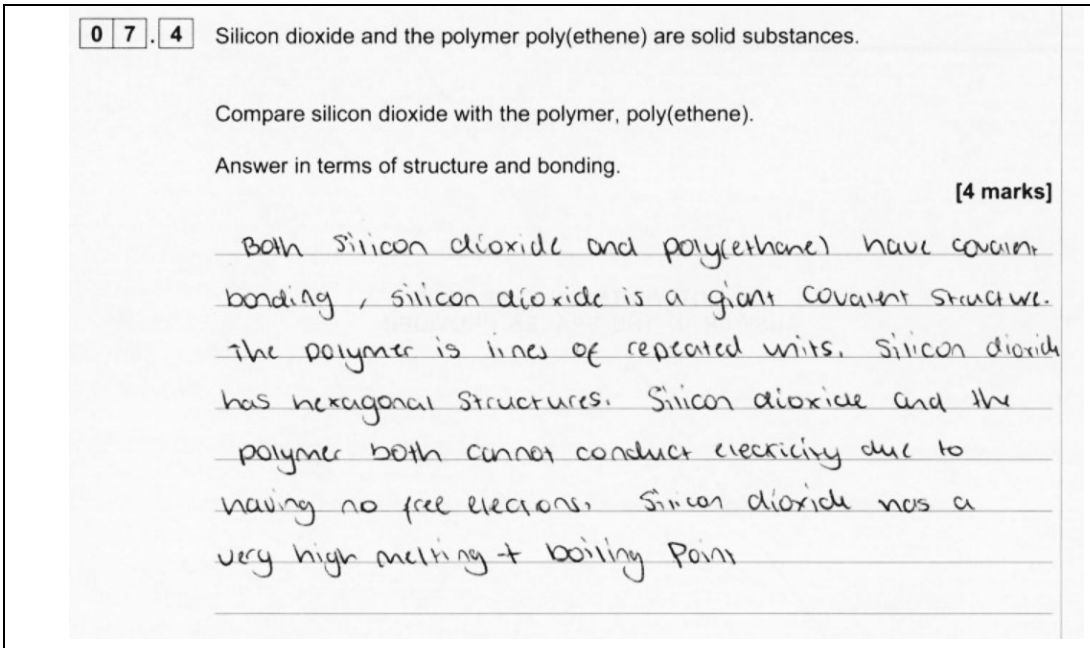
**END OF QUESTIONS**

This response includes references to magnitude (*giant* structure and *strong* covalent bonds) and sufficient indicative content to access Level 2; strong bonds, both have covalent bonding and giant structure. There are also some incorrect statements. However, there is no comparison (simply a paragraph referring to silicon dioxide and then one for poly(ethene)), so the response does not meet the Level 2 descriptor. They have identified a number of relevant features, so the response was awarded 2 marks, in Level 1.

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### 5.2.2.8 Metals as conductors

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0 7 . 4 Silicon dioxide and the polymer poly(ethene) are solid substances.

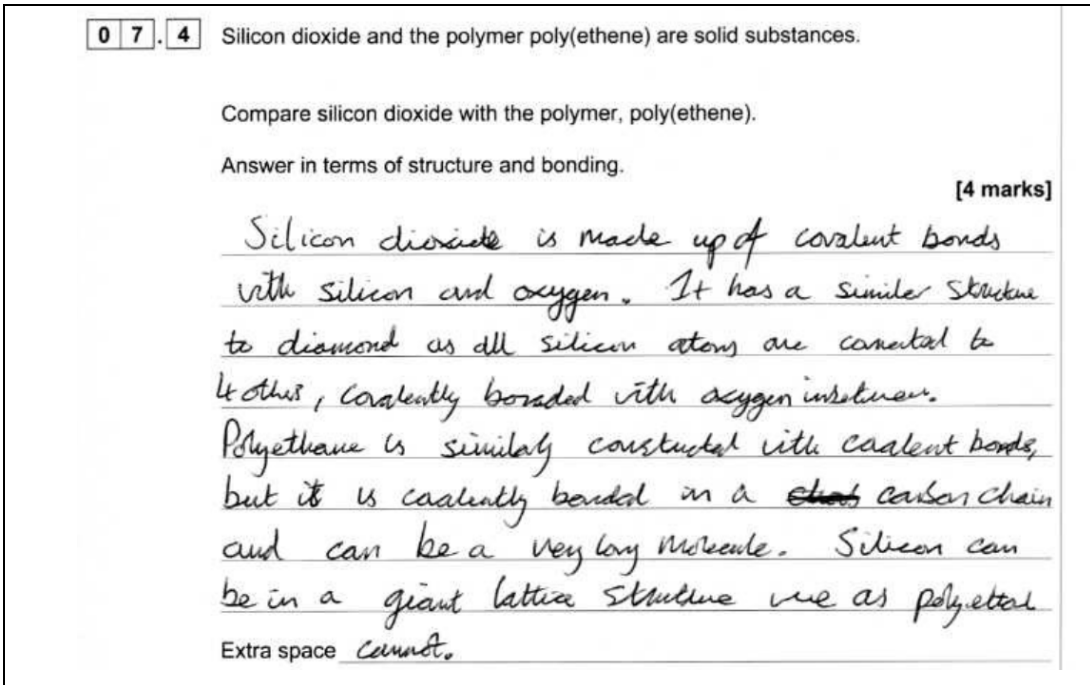
Compare silicon dioxide with the polymer, poly(ethene).

Answer in terms of structure and bonding.

**[4 marks]**

Both silicon dioxide and poly(ethene) have covalent bonding, silicon dioxide is a giant covalent structure. The polymer is lines of repeated units. Silicon dioxide has hexagonal structures. Silicon dioxide and the polymer both cannot conduct electricity due to having no free electrons. Silicon dioxide has a very high melting + boiling Point

In the first two lines of this response there is a reference to magnitude (*giant* structure) and sufficient indicative content; both have covalent bonding and giant structure and a comparison so the response meets the Level 2 descriptor. With a comparison, reference to magnitude and to the structure and bonding of silicon dioxide, this response was awarded 3 marks, in Level 2.



0 7 . 4 Silicon dioxide and the polymer poly(ethene) are solid substances.

Compare silicon dioxide with the polymer, poly(ethene).

Answer in terms of structure and bonding.

**[4 marks]**

Silicon dioxide is made up of covalent bonds with silicon and oxygen. It has a similar structure to diamond as all silicon atoms are covalent to 4 others, covalently bonded with oxygen inbetween. Polyethene is similarly constructed with covalent bonds, but it is covalently bonded in a ~~chain~~ carbon chain and can be a very long molecule. Silicon can be in a giant lattice structure we as polyetal

Extra space cannot.

This response includes references to magnitude (*giant* structure and *very long* molecule) and sufficient indicative content; both have covalent bonding, very long molecule and giant structure and there is a comparison, so the response meets the Level 2 descriptor. With 2 comparisons, a reference to magnitude and to the structure and bonding of silicon dioxide and of poly(ethene), this response was awarded the maximum 4 marks.

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5.2.2.8 Metals as conductors

Answer 02 · Examiner comments

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# Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

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