AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.2.6

# Giant covalent structures

## Mark schemes and examiner comments

| | |
|---|---|
| Tier | **Foundation** |
| Question groups | **10** |
| 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.

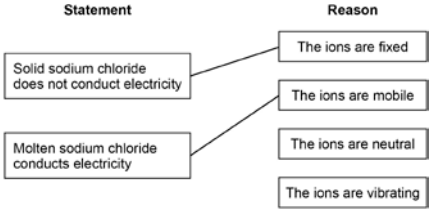
**Name:** _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

### 5.2.2.6 Giant covalent structures

**Answer 01 · Mark scheme**

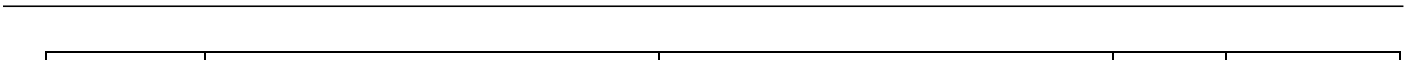
June 2018 | 8464/C/1F | Original Q1

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **01.1** | ionic | | 1 | AO1 5.2.1.3 |
| **01.2** | a molecule | | 1 | AO1 5.2.1.4 |
| **01.3** | a fullerene | | 1 | AO1 5.2.3.3 |
| **01.4** | covalent | | 1 | AO1 5.2.3.2 |
| **01.5** | 1 | | 1 | AO1 5.2.3.2 |
| **01.6** | solid | | 1 | AO1 5.2.2.8 |
| **01.7** | electrons | | 1 | AO1 5.2.2.8 |
| **01.8** | dissolved | | 1 | AO1 5.2.2.3 |
| **01.9** |  | do **not** accept if more than 1 line from 1 box | 1<br>1 | AO1 5.2.2.3 |
| **Total** | | | **10** | |

### 5.2.2.6 Giant covalent structures

**Answer 01 · Mark scheme**

June 2018 | 8464/C/1F | Original Q1



### 5.2.2.6 Giant covalent structures

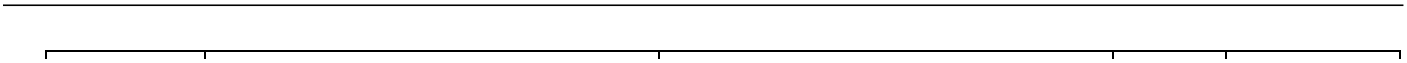
**Answer 02 · Mark scheme** June 2018 | 8464/C/1F | Original Q3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.1** | $H^+$ | | 1 | AO1<br>5.4.2.4 |
| **03.2** | nitric (acid) **or** $HNO_3$<br><br>zinc (oxide) **or** ZnO | this order only | 1<br><br>1 | AO2<br>5.4.2.3 |
| **03.3** | dissolved in water | | 1 | AO1<br>5.1.1.1 |
| **03.4** | any value from 0 to less than 8 | | 1 | AO2<br>5.4.2.4 |
| **03.5** | **Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and 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 | AO2 |
| | **No relevant content** | | 0 | |
| | **Indicative content**<br><br>• add universal indicator **or** wide range indicator<br><br>indicator turns blue / purple / violet (because pH = 14)<br>**or** has highest pH **or** is an alkali<br>so A is sodium hydroxide<br><br>indicator turns red (because pH = 2)<br>**or** has lowest pH **or** is an acid<br>so B is phosphorus oxide<br><br>indicator turns green (because pH = 7)<br>**or** neutral<br>so C is silicon dioxide<br><br>• add solid to water<br><br>A and B dissolve; C does not<br>so C is silicon dioxide | | | 5.1.2.3<br>5.4.2.4 |
| **Total** | | | **9** | |

### 5.2.2.6 Giant covalent structures

**Answer 02 · Mark scheme**

June 2018 | 8464/C/1F | Original Q3

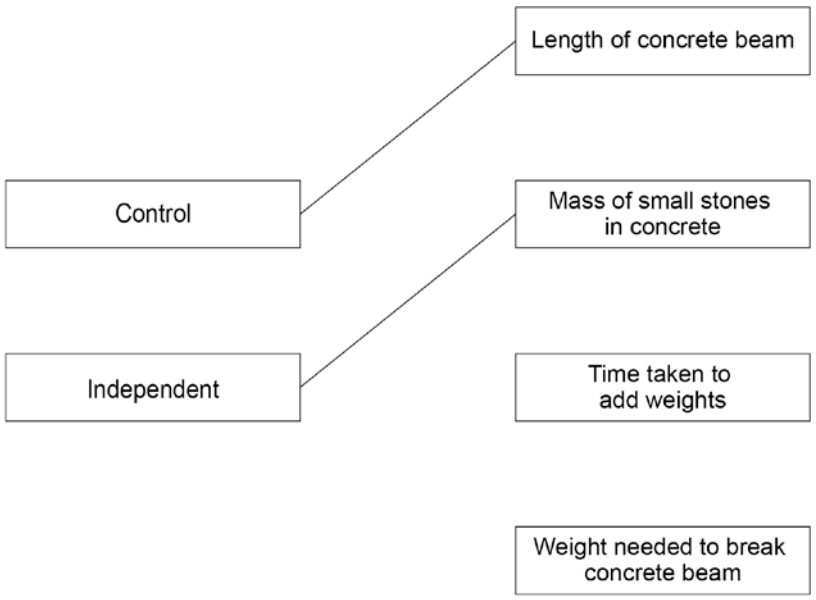


### 5.2.2.6 Giant covalent structures

**Answer 03 · Mark scheme** June 2019 | 8464/C/2F | Original Q2

| | | | | |
|---|---|---|---|---|
| **02.1** | formulation | | 1 | AO1<br>5.8.1.2 |

| | | | | |
|---|---|---|---|---|
| **02.2** | it has a giant structure<br><br>it has strong covalent bonds | | 1<br><br>1 | AO1<br>5.2.2.6<br>5.2.1.4 |

| | | | | |
|---|---|---|---|---|
| **02.3** |  | | 1<br><br>1 | AO3<br><br>AO2<br><br>5.8.1.2 |

| | | | | |
|---|---|---|---|---|
| **02.4** | all points correctly plotted<br><br>line of best fit | allow a tolerance of ± ½ a small square<br>allow 1 mark for 3 points correctly plotted<br><br>allow reasonable attempt at line of best fit using incorrectly plotted points | 2<br><br>1 | AO2.2<br>5.8.1.2 |

### 5.2.2.6 Giant covalent structures

**Answer 03 · Mark scheme**



| | | | | |
|---|---|---|---|---|
| **02.5** | 1500 (g)<br><br>highest point on graph | allow range from 1400 (g) to 1600 (g)<br>allow ecf from graph drawn in **Figure 2**<br><br>MP2 dependent on MP1<br>allow highest / largest / greatest / most weight needed to break concrete.<br>ignore numbers quoted from graph<br>ignore strongest | 1<br><br>1 | AO3<br>5.8.1.2 |

| | | | | |
|---|---|---|---|---|
| **02.6** | take more measurements | allow indication of a greater range of values<br>or<br>allow indication of measurements at smaller intervals<br><br>ignore repeat the investigation | 1 | AO3<br>5.8.1.2 |

| | | | |
|---|---|---|---|
| **Total** | | | **11** |

### 5.2.2.6 Giant covalent structures

**Answer 03 · Mark scheme**

June 2019 | 8464/C/2F | Original Q2

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|

### 5.2.2.6 Giant covalent structures

**Answer 04 · Mark scheme** November 2020 | 8464/C/1F | Original Q6

| | | | | |
|---|---|---|---|---|
| **06.1** | 13<br><br>14 | this order only | 1<br><br>1 | AO2<br>5.1.1.4<br>5.1.1.5 |

| | | | | |
|---|---|---|---|---|
| **06.2** | loss of oxygen | allow ($Al^{3+}$) gain of electrons<br><br>allow aluminium oxide loses oxygen | 1 | AO1<br>5.4.1.1<br>5.4.1.3 |

| | | | | |
|---|---|---|---|---|
| **06.3** | <br><br>(at high temperature) oxygen reacts with carbon / electrode<br><br>(so the positive) electrode burns / wears away<br><br>to produce carbon dioxide | allow anode for (positive) electrode<br><br><br><br><br><br>$C + O_2 \rightarrow CO_2$ scores MP1 and MP3 | <br><br>1<br><br><br><br>1<br><br><br>1 | <br><br>AO1<br>5.4.3.1<br>5.4.3.2<br>5.4.3.3 |

| | | | | |
|---|---|---|---|---|
| **06.4** | (delocalised) electron(s)<br><br>ion(s)<br><br>(delocalised) electron(s) | | 1<br><br>1<br><br>1 | AO1<br><br>AO2<br><br>AO1<br><br>5.2.2.3<br>5.2.2.8<br>5.2.3.2 |

| | | | |
|---|---|---|---|
| **Total** | | | **9** |

### 5.2.2.6 Giant covalent structures

**Answer 04 · Mark scheme**

November 2020 | 8464/C/1F | Original Q6

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|

### 5.2.2.6 Giant covalent structures

**Answer 05 · Mark scheme** November 2020 | 8464/C/1F | Original Q7

| | | | | |
|---|---|---|---|---|
| **07.1** | any **one** from:<br>• not to scale<br>• not 3 dimensional / D<br>• incorrect arrangement in space<br>• electrons / shells not shown | allow size of atoms incorrect<br>allow atoms are separated<br>ignore properties of water | 1 | AO2<br>5.2.1.4 |
| **07.2** | weak | allow weaker | 1 | AO1<br>5.2.2.4 |
| **07.3** | $CH_4O$ | allow $CH_3OH$ | 1 | AO2<br>5.2.1.4 |
| **07.4** | 4 | | 1 | AO1<br>5.2.3.1 |
| **07.5** | any **two** from:<br>• (very) hard<br>• (very) high melting point<br>• does not conduct electricity | allow strong<br>allow high thermal conductivity<br>ignore shiny | 2 | AO1<br>5.2.3.1 |

5.2.2.6 Giant covalent structures



| | | | | |
|---|---|---|---|---|
| **07.6** | graphite<br><br>silicon dioxide | allow graphene<br><br>allow silica<br><br>allow silicon<br><br>allow polymer(s)<br>**or** allow (named) polymer(s)<br><br>allow fullerene<br>**or** allow carbon nanotubes<br><br>ignore buckminsterfullerene | 1<br><br>1 | AO1<br>5.2.2.6 |
| **Total** | | | **8** | |

### 5.2.2.6 Giant covalent structures

**Answer 05 · Mark scheme**

November 2020 | 8464/C/1F | Original Q7

| Question | Answers | Mark | AO/ Spec. Ref |
|---|---|---|---|

### 5.2.2.6 Giant covalent structures

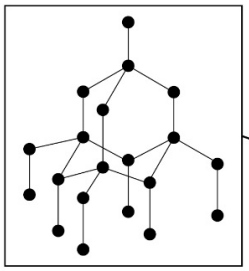
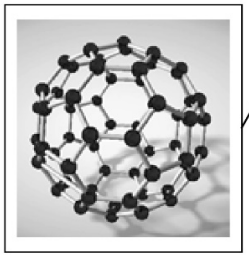
**Answer 06 · Mark scheme** November 2021 | 8464/C/1F | Original Q3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.1** | 0.1 nm | | 1 | AO1<br>5.1.1.5 |
| **03.2** | 6 protons | | 1 | AO2 |
| | 8 neutrons | | 1 | AO2 |
| | 6 electrons | allow electron (structure) 2,4 | 1 | AO2 |
| | protons in nucleus | | 1 | AO1 |
| | neutrons in nucleus | | 1 | AO1 |
| | electrons (around nucleus) in energy levels / shells | | 1 | AO1<br>5.1.1.4<br>5.1.1.5<br>5.1.1.7 |
| **03.3** | 3 | | 1 | AO1<br>5.2.2.6<br>5.2.3.2 |
| **03.4** | covalent | | 1 | AO1<br>5.2.2.6<br>5.2.3.2 |
| **03.5** | layers slide (over each other) | allow atoms slide over each other | 1 | AO3<br>5.2.3.2 |

### 5.2.2.6 Giant covalent structures

**Answer 06 · Mark scheme**

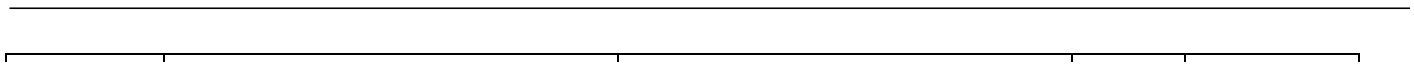


| | | | |
|---|---|---|---|
| **03.6** | **Structure**   **Form of carbon** Buckminsterfullerene — Diamond — Graphene — Nanotube<br>do **not** accept more than **one** line from a box on the left | 1<br>1 | AO1<br>5.2.3.1<br>5.2.3.3 |
| **Total** | | **12** | |

### 5.2.2.6 Giant covalent structures

**Answer 06 · Mark scheme**

November 2021 | 8464/C/1F | Original Q3



5.2.2.6 Giant covalent structures

Answer 07 · 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<br>5.2.2.6<br>5.2.3.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.2 | 4 / four | | 1 | AO3<br>5.2.2.6<br>5.2.3.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.3 | hexagons | | 1 | AO1<br>5.2.3.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.4 | carbon | | 1 | AO1<br>5.2.3.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.5 | electronics | | 1 | AO1<br>5.2.3.3 |

5.2.2.6 Giant covalent structures

Answer 07 · 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<br><br>(percentage =)<br><br>$\frac{3}{25}$ (× 100)<br><br>=12 (%) | <br><br><br>allow correct use of incorrectly determined value(s) for number of magnesium atoms and / or copper atoms<br><br> | 1<br><br><br>1<br><br><br>1 | AO2 5.2.2.7 |

5.2.2.6 Giant covalent structures

Answer 07 · 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<br>5.2.1.5<br>5.2.2.7 |

| | | |
|---|---|---|
| **Total Question 3** | | **13** |

5.2.2.6 Giant covalent structures

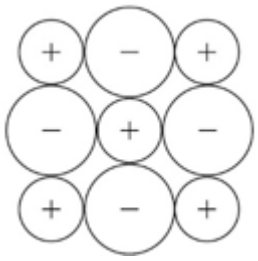
Answer 08 · Mark scheme

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

## Question 3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.1** | noble gases | | 1 | AO1<br>5.2.1.2 |

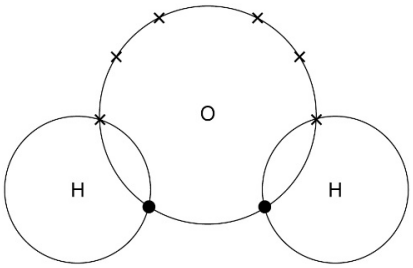
| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.2** | potassium (atoms) lose electrons | | 1 | AO2 |
| | chlorine (atoms) gain electrons | | 1 | AO2 |
| | reference to one electron | | 1 | AO2 |
| | any **one** from:<br>• to form ions<br>• to form full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

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.3** |  | | 1 | AO2<br>5.2.1.3 |

5.2.2.6 Giant covalent structures

Answer 08 · 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<br>ignore any inner shell electrons<br>the diagram below scores 2 marks<br> | 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 |

5.2.2.6 Giant covalent structures

Answer 08 · Mark scheme

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

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.7 | the melting point increases as the length of the polymer molecule increases | ignore references to boiling point<br>allow **1** mark for melting point increases | 2 | AO3<br>5.2.2.4<br>5.2.2.5 |
| | (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 | |

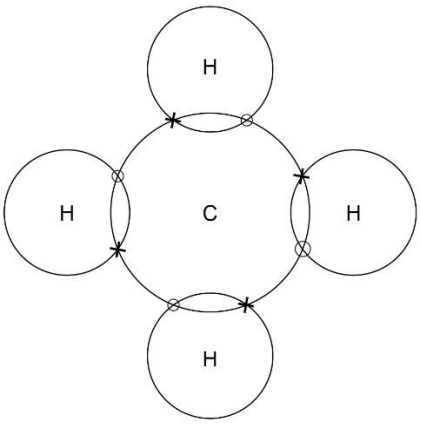
| Total Question 3 | 13 |
|---|---|

5.2.2.6 Giant covalent structures

Answer 09 · Mark scheme

June 2024 | 8464/C/1F | Original Q2

## Question 2

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 02.1 | one pair of electrons drawn in each of the three overlaps | allow any combination of circles, dots, crosses, $e^{(-)}$ for electrons<br><br>ignore inner shell electrons on the carbon atom<br><br>do **not** accept extra electron(s) on outer shell of carbon / hydrogen<br><br>allow **1** mark for one shared pair in one overlap without non-bonding electron(s) on that hydrogen<br><br>an answer of   scores **2** marks | 2 | AO1<br>5.2.1.1<br>5.2.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 02.2 |  | | 1 | AO1<br>5.2.1.4<br>5.2.2.6<br>5.2.3.1 |

5.2.2.6 Giant covalent structures

Answer 09 · Mark scheme

June 2024 | 8464/C/1F | Original Q2

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.3** | 3 | | 1 | AO1<br>5.2.3.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.4** | (delocalised) electrons | allow (free) electrons | 1 | AO2<br>5.2.3.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.5** | in electronic components | | 1 | AO1<br>5.2.3.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.6** | any **two** from:<br>• hollow (shape)<br>• hexagonal rings<br>• (of) carbon atoms<br>• each (carbon) atom forms 3 (covalent) bonds | <br>allow cylindrical (shape)<br>allow (nano)tube<br>allow (made of) hexagons | 2 | AO1<br>5.2.3.3 |

| Total Question 2 | 8 |
|---|---|

5.2.2.6 Giant covalent structures

Answer 10 · Mark scheme

June 2024 | 8464/C/1F | Original Q8

## Question 8

| Question | Answers | Mark | AO / Spec. Ref. |
|---|---|---|---|
| 08 | **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. | 4–6 | AO1<br>5.2.1.1<br>5.2.1.2<br>5.2.1.3<br>5.2.1.4<br>5.2.2.3<br>5.2.2.4 |
| | **Level 1:** Relevant features are identified and differences noted. | 1–3 | |
| | **No relevant content** | 0 | |
| | **Indicative content:**<br><br>Similarities<br>• both have strong bonds<br>• particles have full outer shells<br><br>Differences<br>• sodium chloride is a compound<br>• sodium chloride is made from two elements<br>• oxygen is an element<br><br>• sodium chloride is a giant structure of ions<br>• oxygen is a small molecule<br><br>• sodium chloride has ionic bonds<br>• sodium chloride consists of oppositely charged ions<br>• electrons are transferred from sodium atoms to chlorine atoms<br>• oxygen is covalent<br>• oxygen (molecules) are made up of oxygen atoms<br>• joined by double covalent bond<br>• electrons are shared between oxygen atoms<br>• with weak forces between oxygen molecules<br><br>For **Level 2**, there must be a comparison of either the structure **or** bonding of both sodium chloride **and** oxygen, and a description of magnitude. | | |

| | |
|---|---|
| **Total Question 8** | **6** |

5.2.2.6 Giant covalent structures

Answer 01 · Examiner comments

June 2018 | 8464/C/1F | Original Q1

## Question 1 (low demand)

**01.1** 47% of students correctly identified that the diagram for calcium oxide showed ionic bonding.

**01.2** 41% of students recognised that the bonding diagram for methane showed a molecule of methane.

**01.3** The diagram of a fullerene was not recognised by 71% of students.

**01.4** 44% of students correctly identified, from the diagram, that the type of bond in graphite is covalent.

**01.5** This question proved to be difficult because it required students to understand that in one covalent bond there is a shared pair of electrons, so one electron comes from each atom. 11% of students gave a correct answer.

**01.6** This question was accessible to most students (76%) because the answer should have been obvious from the diagram that showed a solid between the electrodes.

**01.7** 66% of students knew that copper conducts electricity by the movement of delocalised electrons.

**01.8** 49% of students could use the labelled diagram to understand that the sodium chloride was dissolved to form the sodium chloride solution.

Answer 01 · Examiner comments

June 2018 | 8464/C/1F | Original Q1

**01.9** 19% of students knew that solid sodium chloride does not conduct electricity because the ions are fixed, whereas molten sodium chloride conducts electricity because the ions are mobile. Some students did not follow the instructions and drew more than one line from each statement box. 56% of students were awarded at least one mark.

5.2.2.6 Giant covalent structures

Answer 02 · Examiner comments — June 2018 | 8464/C/1F | Original Q3

## Question 3 (low & standard demand)

No reportable questions.

Answer 06 · Examiner comments — November 2021 | 8464/C/1F | Original Q3

### Question 3 (low demand)

**03.1** Nearly two thirds of students were able to give the approximate radius of a carbon atom.

**03.2** Students were good at describing the atomic structure of the carbon atom. More than half of students scored at least three marks. A few did not use the given diagram of the carbon atom to determine the number of neutrons located in this atom's nucleus.

**03.3** Nearly half of students were able to use the diagram of graphite's structure to determine the number of covalent bonds each carbon atom has in graphite. Four proved to be a popular incorrect response, which is the number of covalent bonds each carbon atom forms in substances such as diamond or methane.

**03.4** Nearly two thirds of students knew that covalent bonds hold carbon atoms together in graphite.

**03.5** Few students stated that layers (of carbon atoms) can slide over each other in graphite or were able to use the diagram of graphite's structure to explain why graphite can be used as a lubricant.

**03.6** Nearly two thirds of students gained one mark and approximately one sixth of students gained two marks for linking the structures with the correct form of carbon.

### 5.2.2.6 Giant covalent structures

**Answer 07 · 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.

### 5.2.2.6 Giant covalent structures

**Answer 08 · 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.

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**Answer 08 · Examiner comments** June 2023 | 8464/C/1F | Original Q3

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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).

5.2.2.6 Giant covalent structures

Answer 09 · Examiner comments

June 2024 | 8464/C/1F | Original Q2

# Question 2 (low & standard demand)

**02.1** To help students complete the dot and cross diagram for a methane molecule one shared pair of electrons was drawn in one of the overlap areas. More than half the students correctly added three more shared pairs of electrons. Some gained only 1 mark by either adding just one shared pair or including extra electrons in the outer shells of either the carbon atom or hydrogen atoms.

**02.2** Three-quarters of students recognised the structure of diamond. Buckminsterfullerene was the most common incorrect response.

**02.3** A diagram to represent part of the structure of graphite was given to show that each carbon atom forms three covalent bonds. Nearly 60% of students answered the question correctly. Approximately equal numbers of students thought that carbon atoms formed either two or four bonds with only a small number choosing one bond.

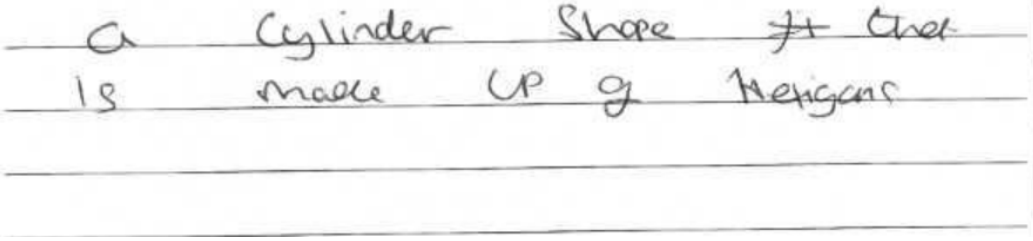
**02.4** Just over 40% of the students knew that (delocalised) electrons carry electrical charge through graphite. Many students incorrectly answered that ions or atoms were the particles responsible or wrote carbon for their answer.

**02.5** Half of the students knew that fullerenes are used in electronic components. The other two distractors were equally popular.

**02.6** Nearly half of the students scored at least 1 mark. A diagram was included to help students describe the structure of a fullerene. The better responses stated that fullerenes are hollow and have hexagonal rings of carbon atoms, although few stated that each carbon atom forms three covalent bonds.

0 2 . 6 Describe the structure of the fullerene shown in **Figure 4**.

**[2 marks]**




This answer gave two points from the 'extra information' column of the mark scheme so gave *just* enough information to gain 2 marks.

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5.2.2.6 Giant covalent structures

Answer 10 · Examiner comments

June 2024 | 8464/C/1F | Original Q8

# Question 8 (standard demand)

**08** 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 3 marks.

Students were asked to compare the structure and bonding of sodium chloride and oxygen; diagrams that represent the structures were given. The indicative content was not an exhaustive list and examiners used professional judgement with other content.

At Level 1, students needed to identify some relevant features of each substance and note some differences. To enter Level 2 students needed to clearly show the ways in which the structure and bonding of the two substances are similar/different and note the magnitude of the similarity/difference. Examples of magnitude include strong (bond), weak (forces), giant (structure of ions), small (molecule) and two or one (elements). To access Level 2 a minimum of four comments on the relevant features were required, at least one of which must include a comparison, and a reference to magnitude had to have been made. To gain 5 or 6 marks there needed to be a minimum of two comparative statements, a reference to magnitude and statements referring to the structures.

Most students wrote a great deal but said little that was creditworthy. A quarter of students gained 1 mark or more and there were very few Level 2 answers. Attempts were made at comparisons but what they were comparing was incorrect chemistry. Indications of magnitude were rarely seen. Many students wrote about the properties of sodium chloride and oxygen, in particular referring to their melting and boiling points and electrical conductivity, or they referred to the number of protons, neutrons and electrons in atoms of each of the elements involved; none of which answered the question.

Most students gained their marks from stating that sodium chloride is a compound of two elements and oxygen is an element made up of atoms. There were very few correct descriptions of the type of bonding. Many responses described the ions in sodium chloride as protons and electrons, charged atoms or simply positive and negative charges. 'Sodium chloride is an ionic bond' was a common error. Similarly, in the case of oxygen many students stated that 'it is a covalent bond' and is 'made up of two molecules'. Students tended to describe the bonding in sodium chloride in more detail than that for oxygen. Many explained in detail how sodium transfers its outer electron to chlorine but lost the credit by saying that it was gained by chlori*de*.

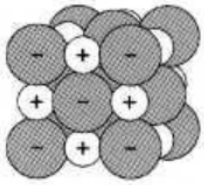
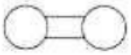
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### 5.2.2.6 Giant covalent structures

**Answer 10 · Examiner comments** June 2024 | 8464/C/1F | Original Q8

**0 8** **Table 8** shows diagrams which represent the structures of two substances.

**Table 8**

| Substance | Structure |
|---|---|
| Sodium chloride<br>NaCl<br>metal + non |  |
| Oxygen<br>$O_2$<br>non |  |

Compare the structure and bonding of sodium chloride and oxygen.

**[6 marks]**

Sodium chloride is ionic bonding which is between a metal and a non metal. They use electrostatic forces to transfer electrons. They create giant structures and have a high melting point. ①
Oxygen is a non metal which is used for covalent bonding as its for two non metals. They have strong covalent bonds but have weak intermolecular forces. They can conduct electricity. ① They can also conduct electricity but only when molten

The response (from a Foundation tier paper) includes references to magnitude (*weak* intermolecular forces and *strong* bonds) and sufficient indicative content to access Level 2 (bullet points 4, 10, 11, 15). However, there is no comparison (simply a list of statements referring to sodium chloride and then a list for oxygen), so the response does not meet the Level 2 descriptor. They have identified a number of relevant features, so the response was awarded 3 marks, top of Level 1.

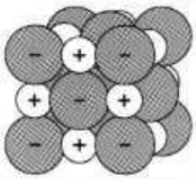
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### 5.2.2.6 Giant covalent structures

**Answer 10 · Examiner comments** June 2024 | 8464/C/1F | Original Q8

**0 8** **Table 8** shows diagrams which represent the structures of two substances.

**Table 8**

| Substance | Structure |
|---|---|
| Sodium chloride NaCl |  |
| Oxygen $O_2$ |  |

Compare the structure and bonding of sodium chloride and oxygen.

**[6 marks]**

Oxygen is an element and Sodium Chloride is a compound which is arranged in a lattice structure with positive and negative ions. Oxygen has Sodium Chloride has ionic bonds.

The response (also from a Foundation tier paper) is set out as a comparison with sufficient indicative content to access Level 2 (bullet points 5, 3, 9 and 8) but there is no reference to magnitude (strong/weak, giant/small or one/two element(s)). Therefore, similarly to the previous example, the response does not meet the Level 2 descriptor. It was awarded 3 marks.

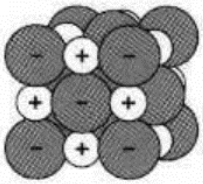
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### 5.2.2.6 Giant covalent structures

**Answer 10 · Examiner comments** June 2024 | 8464/C/1F | Original Q8

**0 3** **Table 2** shows diagrams which represent the structures of two substances.

**Table 2**

| Substance | Structure | |
|---|---|---|
| Sodium chloride NaCl |  | Ionic |
| Oxygen $O_2$ |  | covalent |

Compare the structure and bonding of sodium chloride and oxygen.

**[6 marks]**

In NaCl, ionic bonding occurs. Sodium will transfer its outer electron to chlorine to form a positive ion and when chlorine receives this transfered electron, it will form a $1^-$ ion. Due to the ions being oppositely charged, strong electrostatic forces holds them together. In $O_2$ however, covalent bonding occurs as it is non metal and $O_2$ will form a double covalent bond as it shares 2 electrons from their outer shell with each other in order to get a full outer shell and maine it stable.

This response (from a Higher tier paper) is set out as a comparison (use of 'however' in line 8) with sufficient indicative content to access Level 2 (bullet points 8, 9, 10, 11, 13 and 14). Bullet points 1 and 2 are mentioned for oxygen but not sodium chloride. In addition to the comparison a reference to magnitude (*strong* electrostatic forces) is included so 4 marks are awarded. Statement(s) referring to the *structure* of sodium chloride and/or oxygen were required for 5+ marks

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**5.2.2.6 Giant covalent structures**

**Answer 10 · Examiner comments** June 2024 | 8464/C/1F | Original Q8

# Contact us

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

Tel: 01483 477756
Email: gcsescience@aqa.org.uk

aqa.org.uk

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