AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.3.3

Graphene and fullerenes

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**4**
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.

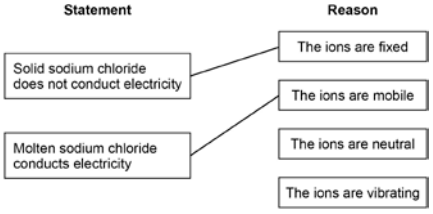
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Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

5.2.3.3 Graphene and fullerenes

Answer 01 · Mark scheme

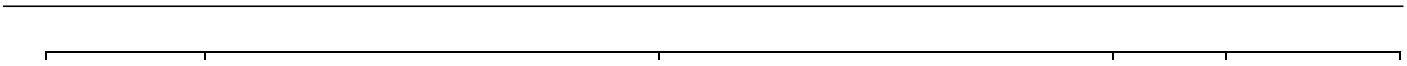
June 2018 | 8464/C/1F | Original Q1

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 1	AO1 5.2.2.3
Total			**10**	

5.2.3.3 Graphene and fullerenes

Answer 01 · Mark scheme

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



5.2.3.3 Graphene and fullerenes

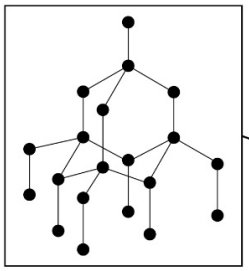
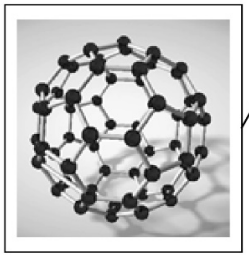
Answer 02 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	0.1 nm		1	AO1 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 5.1.1.4 5.1.1.5 5.1.1.7
03.3	3		1	AO1 5.2.2.6 5.2.3.2
03.4	covalent		1	AO1 5.2.2.6 5.2.3.2
03.5	layers slide (over each other)	allow atoms slide over each other	1	AO3 5.2.3.2

5.2.3.3 Graphene and fullerenes

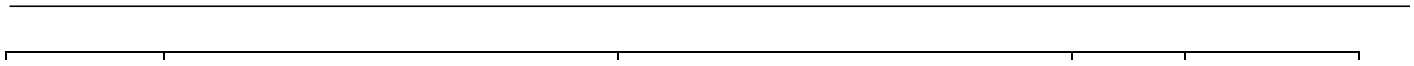
Answer 02 · Mark scheme

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

5.2.3.3 Graphene and fullerenes

Answer 02 · Mark scheme

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



5.2.3.3 Graphene and fullerenes

Answer 03 · 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

5.2.3.3 Graphene and fullerenes

Answer 03 · 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

5.2.3.3 Graphene and fullerenes

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

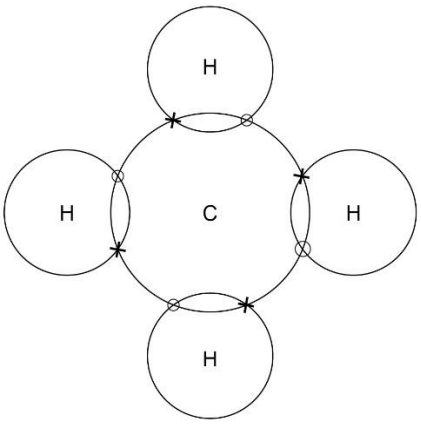
Total Question 3		**13**

5.2.3.3 Graphene and fullerenes

Answer 04 · 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 ignore inner shell electrons on the carbon atom do **not** accept extra electron(s) on outer shell of carbon / hydrogen allow **1** mark for one shared pair in one overlap without non-bonding electron(s) on that hydrogen an answer of  scores **2** marks	2	AO1 5.2.1.1 5.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2			1	AO1 5.2.1.4 5.2.2.6 5.2.3.1

5.2.3.3 Graphene and fullerenes

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	3		1	AO1 5.2.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	(delocalised) electrons	allow (free) electrons	1	AO2 5.2.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	in electronic components		1	AO1 5.2.3.3

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

Total Question 2	**8**

5.2.3.3 Graphene and fullerenes

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.

5.2.3.3 Graphene and fullerenes

Answer 02 · 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.

5.2.3.3 Graphene and fullerenes

Answer 03 · 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.

5.2.3.3 Graphene and fullerenes

Answer 04 · 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.

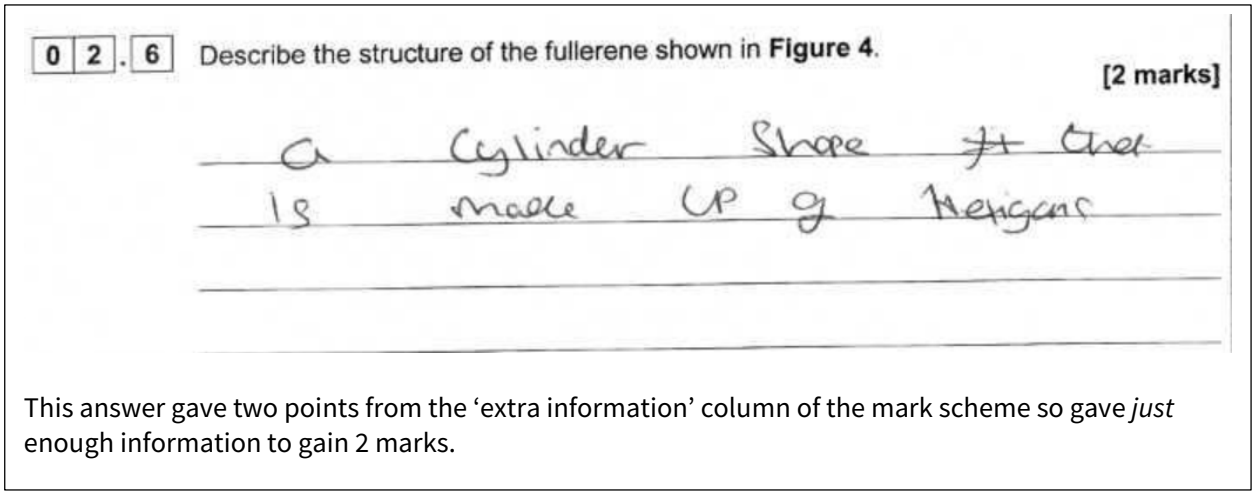
02.2 Three-quarters of students recognised the structure of diamond. Buckminsterfullerene was the most common incorrect response.

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.



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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