AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.2.3.3

Graphene and fullerenes

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**4**
Available paper years	**2010–2021**

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.

4.2.3.3 Graphene and fullerenes

Answer 01 · Mark scheme January 2010 | CHY2H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)	any **four** from: • giant structure / lattice • positive ions • sea of electrons **or** delocalised / free electrons • awareness of outer shell / highest energy level electrons are involved • (electrostatic) attractions / bonds between electrons and positive ions • bonds / attractions (between atoms/ ions) are strong • a lot of energy / heat is needed to break these bonds / attractions	max **3** marks if any reference made to covalent / ionic bonding / molecules **or** intermolecular forces **or** graphite / diamond **or** forces of attraction between electrons and then ignore throughout ignore layers ignore electrons can move allow hard to break for strong ignore forces unqualified ignore high temperature	4

Question 4 continues on next page

4.2.3.3 Graphene and fullerenes

CHY2H

Question 4 continued

question	answers	extra information	mark
4(b)(i)	that they are very small **or** 1–100 nanometres **or** a few (hundred) atoms	accept tiny / really small / a lot smaller / any indication of very small eg microscopic, smaller than the eye can see ignore incorrect numerical values if very small is given	1
4(b)(ii)	any **2** from: • one (non-bonded) electron from each atom • delocalised / free electrons • electron carry / form / pass current / charge	 allow sea of electrons ignore electrons can move ignore carry electricity	2
Total			**7**

4.2.3.3 Graphene and fullerenes

Answer 01 · Mark scheme

January 2010 | CHY2H | Original Q4 | Legacy

CHY2H

4.2.3.3 Graphene and fullerenes

Answer 02 · Mark scheme June 2014 | CH2HP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
5(a)	nanotubes can slide (over each other) because no (covalent) bonds between the nanotubes	allow nanotubes can roll (over each other) *accept weak forces between the nanotubes **or** weak intermolecular forces* *allow layers for nanotubes throughout*	1 1	1 / 2.2.3d	E
5(b)	delocalised electrons *so (delocalised) electrons* can move through the graphite	*accept free electrons* *accept so (delocalised) electrons can carry charge through the graphite*	1 1	1 + 2 / 2.2.3c/e	E
Total			**4**		

4.2.3.3 Graphene and fullerenes

Answer 02 · Mark scheme

June 2014 | CH2HP | Original Q5 | Legacy



4.2.3.3 Graphene and fullerenes

Answer 03 · Mark scheme

June 2019 | 8462/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	contain delocalised electrons (so) electrons can move through the structure / nanotube	allow contain free electrons allow (so) electrons can carry charge through the structure / nanotube ignore throughout for through ignore current / electricity for charge	1 1	AO1 4.2.3.3

Question	Answers	Mark	AO / Spec. Ref.
03.2	**Level 2:** Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3 4.2.2.7 4.2.3.3
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content • wood is the least dense so lightest to use • aluminium is the most dense so will make the racket too heavy • carbon nanotube is the strongest so least likely to break • wood / aluminium are too weak so the racket will break more easily • carbon nanotube is the stiffest so least likely to bend out of shape • wood / aluminium are not very stiff so could bend out of shape • justified conclusion		

Question 3 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3		an answer of 4.0 x 10^4 (nm^2) scores **3** marks an answer of 40344 (nm^2) scores **2** marks		AO2 4.2.4.1
	(82^2 =) 6724 (nm^2)		1	
	(6 x 6724 =) 40344 (nm^2)	allow 40344 (nm^2) correctly rounded to any number of significant figures allow correct calculation using incorrectly calculated value of area of one face from step 1	1	
	= 4.0 x 10^4 (nm^2)	allow 4.0344 x 10^4 (nm^2) correctly rounded to 1 or more significant figures allow a correctly calculated and rounded conversion to standard form of an incorrect calculation of surface area	1	
03.4	any **one** from: • less can be used (for the same effect) • greater surface area (to volume ratio)	allow converse statements about fine particles ignore nanoparticles are smaller	1	AO3 4.2.4.2
Total			**10**	

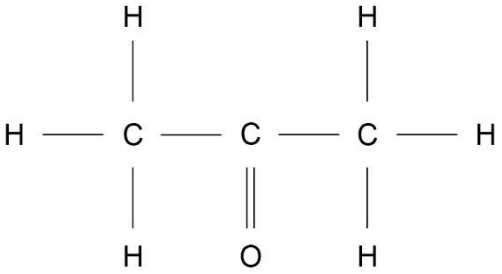
4.2.3.3 Graphene and fullerenes

Answer 04 · Mark scheme November 2021 | 8462/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	spherical	allow ball-shaped ignore round / circular	1	AO1 4.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	any **one** from: • drug delivery (round the body) • hydrogen storage • anti-oxidants • reduction of bacterial growth • catalysts • (cylindrical fullerenes for) strengthening materials • (spherical fullerenes for) lubricants		1	AO1 4.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3			1	AO2 4.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	C_3H_6O	allow CH_3COCH_3 allow elements in any order	1	AO2 4.2.1.4

Question 1 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	the intermolecular forces are weak		1	AO1 4.2.2.1 4.2.2.4

Question	Answers	Mark	AO/ Spec. Ref
01.6	**Level 3**: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.2.2.6 4.2.3.2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • bonds are covalent • giant / macromolecular structure • three (covalent) bonds per carbon atom **or** only three electrons per carbon atom used in (covalent) bonds • so one electron per carbon atom (is delocalised) • these delocalised electrons • can move through the structure • carrying (electrical) charge • so graphite conducts electricity • layered structure • of (interlocking) hexagonal rings • with weak (intermolecular) forces between layers **or** no (covalent) bonds between layers • so the layers can slide over each other • so graphite is soft and slippery		

Total			11

4.2.3.3 Graphene and fullerenes

Answer 03 · Examiner comments

June 2019 | 8462/1H | Original Q3

Question 3 (standard demand)

03.1 Most students scored a mark for referring to the presence of delocalised electrons in carbon nanotubes.

Only a small proportion scored the mark for explaining the role of these electrons in the conduction of electricity.
Some students only referred to the delocalised electrons being able to carry charge without further qualification.
Others were not sufficiently precise in describing the movement of electrons through the structure. This implies movement in a particular direction as opposed to random movement, for example, around the structure.

03.2 Almost all students made an attempt at comparing the properties of the three materials.

Most achieved a Level 2 mark by giving a consequence of one of the stated differences in properties. Many gave a justified conclusion in referencing the most suitable material for the racket frame.

4.2.3.3 Graphene and fullerenes

Answer 03 · Examiner comments

June 2019 | 8462/1H | Original Q3

03.3 Almost 70% of students scored full marks. Of those that didn't, most scored 2 marks for calculating the surface area as 40344 nm^2 but incorrectly converting or not converting this answer to standard form.

Even if the answer to their calculation was incorrect, a mark could still be scored for correctly converting this answer to standard form, provided that an attempt to calculate the surface area had been made.

03.4 Almost half of students scored this mark.

The most common correct response referred to nanoparticles having a greater surface area to volume ratio (compared to fine particles).

Some students linked the greater surface area to less zinc oxide being needed for the same effect. This covered both alternative bullet points in the mark scheme.

Common responses seen that were not credited included:

- nanoparticles are smaller
- nanoparticles are easier to manufacture
- less energy is required.

4.2.3.3 Graphene and fullerenes

Answer 04 · Examiner comments

November 2021 | 8462/1H | Original Q1

Question 1 (standard demand)

01.1 There were many good answers but some focused on the hexagonal arrangement of bonds rather than the molecule as a whole. Others did not appear to realise the shape is three dimensional and described the molecule as a circle.

01.2 Many students knew the uses as catalysts, for drug delivery round the body, as lubricants' and for strengthening other materials. There were, however, some vague answers such as 'in medicine'.

01.3 This was well done. A few students drew double bonds between all the atoms. Some students did not appear to realise that all they had to do was copy the positions of the atoms and replace each shared pair of electrons with a line.

01.4 This was answered well, although a number of students had two oxygen atoms in their formula. A few appeared to misunderstand the question and gave the relative formula mass.

01.6 Some students gave full, detailed accounts of both properties. The reasons for the slipperiness of graphite were better understood than its electrical conductivity, though many did not refer to the weakness of the forces between the layers. There was some poor use of language in the description of the structure, with atoms, molecules and ions being used interchangeably. A fairly common misconception is that there are gaps between the layers, allowing 'electricity' to somehow slip through. Many students did not seem to appreciate that the electric current is delocalised electrons themselves flowing through the structure.