AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.2.2.6

Giant covalent structures

Past-paper questions

Tier	**Foundation**
Question groups	**10**
Available paper years	**2018–2024**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

5.2.2.6 Giant covalent structures

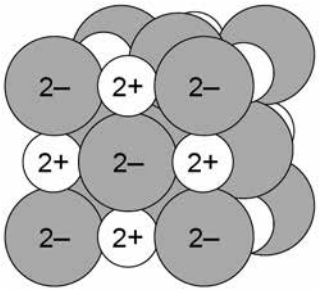
Question 01

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

0 1 This question is about structure and bonding.

0 1 . 1 **Figure 1** shows part of the structure of calcium oxide (CaO).

Figure 1



What type of bonding is present in calcium oxide?

[1 mark]

Tick **one** box.

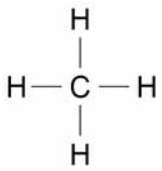
- Covalent ☐
- Ionic ☐
- Macromolecular ☐
- Metallic ☐

5.2.2.6 Giant covalent structures

Question 01 · continued

0 1 . 2 **Figure 2** shows a particle of methane (CH_4).

Figure 2



What type of particle is present in **Figure 2**?

[1 mark]

Tick **one** box.

An ion ☐

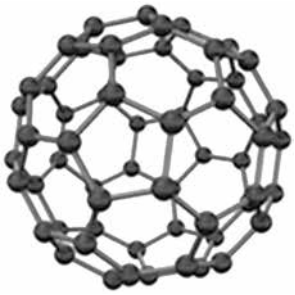
A lattice ☐

A molecule ☐

A polymer ☐

0 1 . 3 **Figure 3** shows the structure of C_{60}

Figure 3



Complete the sentence.

Choose the answer from the box.

[1 mark]

diatomic	**giant ionic**	**a fullerene**	**giant metallic**

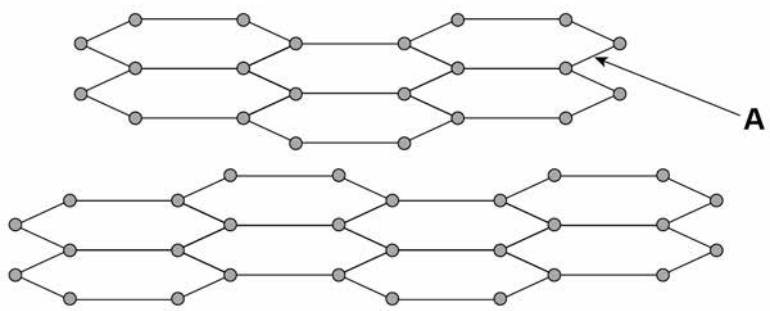
The structure of C_{60} is _____ .

5.2.2.6 Giant covalent structures

Question 01 · continued

Figure 4 shows the structure of graphite.

Figure 4



0 1 . 4 What type of bond is labelled **A** in **Figure 4**?

[1 mark]

Tick **one** box.

- covalent ☐
- double ☐
- ionic ☐
- metallic ☐

0 1 . 5 In graphite, each carbon atom forms bonds with other carbon atoms as shown in **Figure 4**

How many electrons does **one** carbon atom use to form **one** bond?

[1 mark]

Tick **one** box.

1 ☐ **2** ☐ **3** ☐ **4** ☐

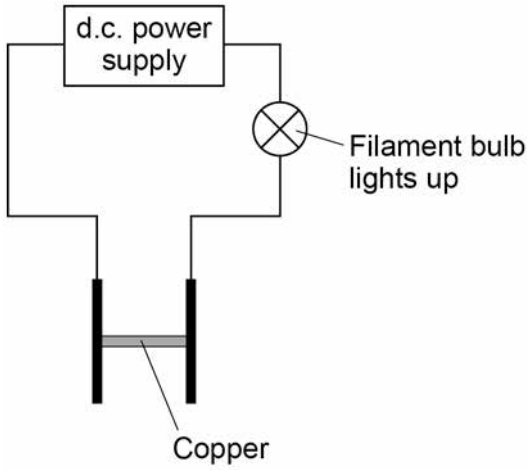
5.2.2.6 Giant covalent structures

Question 01 · continued

An electric current is passed through copper.

Figure 5 shows the apparatus used.

Figure 5



0 1 . 6 Complete the sentence.

Choose the answer from the box.

[1 mark]

gas	**liquid**	**solid**	**solution**

Figure 5 shows that copper conducts electricity as a _____ .

0 1 . 7 Complete the sentence.

Choose the answer from the box.

[1 mark]

atoms	**electrons**	**ions**	**molecules**

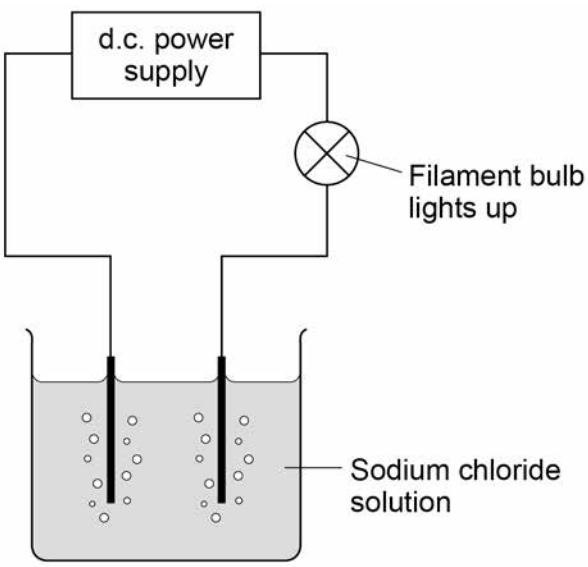
Copper conducts electricity because of the movement of delocalised _____ .

5.2.2.6 Giant covalent structures

Question 01 · continued

0 1 . 8 **Figure 6** shows the apparatus used to investigate the effect of electricity on sodium chloride solution.

Figure 6



Complete the sentence.

Choose the answer from the box.

[1 mark]

dissolved	**gaseous**	**molten**

Figure 6 shows that sodium chloride conducts electricity when _____ .

5.2.2.6 Giant covalent structures

Question 01 · continued

0 1 . 9 Sodium chloride is made up of ions.

Figure 7 shows the apparatus used to investigate the effect of electricity on solid sodium chloride and molten sodium chloride.

Figure 7

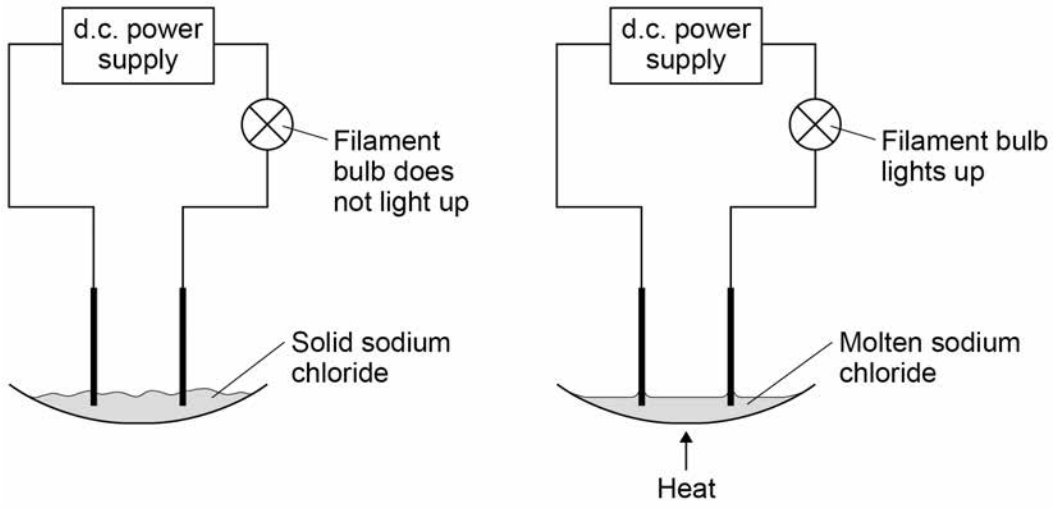


Table 1 shows the results.

Table 1

	Solid sodium chloride	Molten sodium chloride
Observation	The filament bulb does not light up	The filament bulb lights up
Deduction	Does not conduct electricity	Does conduct electricity

Draw **one** line from each statement to the correct reason.

[2 marks]

Statement	Reason
Solid sodium chloride does not conduct electricity.	The ions are fixed.
	The ions are mobile.
Molten sodium chloride conducts electricity.	The ions are neutral.
	The ions are vibrating.

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5.2.2.6 Giant covalent structures

Question 02

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

0 3 This question is about acids and bases.

0 3 . 1 Which ion is found in all acids?

[1 mark]

Tick **one** box.

Cl^- ☐ H^+ ☐ Na^+ ☐ OH^- ☐

0 3 . 2 Zinc nitrate can be produced by reacting an acid and a metal oxide.

Name the acid and the metal oxide used to produce zinc nitrate.

[2 marks]

Acid _____

Metal oxide _____

0 3 . 3 In an equation, zinc nitrate is written as $Zn(NO_3)_2(aq)$.

What does (aq) mean?

[1 mark]

Tick **one** box.

Dissolved in water ☐

Insoluble ☐

Not all reacted ☐

Reactant ☐

0 3 . 4 The pH of a solution is 8

Some hydrochloric acid is added to the solution.

Suggest the pH of the solution after mixing.

[1 mark]

pH = _____

5.2.2.6 Giant covalent structures

Question 02 · continued

0 3 . 5 **Table 2** shows the solubility of three solids in water at room temperature.

Table 2

Solid	The mass of the solid that dissolves in 100 cm^3 of water
Phosphorus oxide	50 g
Silicon dioxide	0 g
Sodium hydroxide	100 g

A teacher labelled these three solids **A**, **B** and **C**.

She gave a student the information shown in **Table 3**

Table 3

Solid	Observation when added to water	pH of the solid in water
A	colourless solution	14
B	colourless solution	2
C	solid does not dissolve	7

Describe a method that could be used to identify each of the three solids **A**, **B** and **C**.

You must use an indicator in the method.

Use information in **Table 2** and **Table 3**

[4 marks]

9

5.2.2.6 Giant covalent structures

Question 03

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

0 2 Concrete contains cement, water, sand and small stones.

0 2 . 1 Concrete is a mixture designed as a useful product.

What do we call a mixture which has been designed as a useful product?

[1 mark]

Tick (✓) **one** box.

- Finite ☐
- Formula ☐
- Formulation ☐
- Fraction ☐

0 2 . 2 Concrete contains cement.

Cement is made by heating a mixture containing silicon dioxide (SiO_2).

Why does silicon dioxide have a very high melting point?

[2 marks]

Tick (✓) **two** boxes.

- It has a giant structure ☐
- It has a simple molecular structure ☐
- It has strong covalent bonds ☐
- It has strong ionic bonds ☐
- It has weak intermolecular forces ☐

5.2.2.6 Giant covalent structures

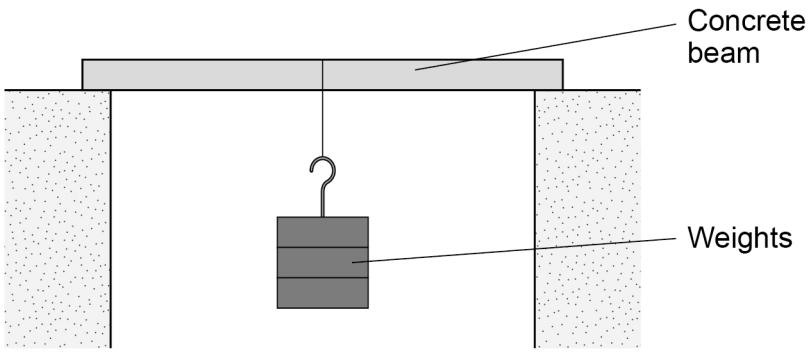
Question 03 · continued

Student **A** investigated how the mass of the small stones in concrete affects the strength of a concrete beam. All other variables were kept the same.

The student added weights until the concrete beam broke.

Figure 1 shows the apparatus Student **A** used.

Figure 1



0 2 . 3 Draw **one** line from each type of variable to the correct example of the variable.

[2 marks]

Type of variable	Example of variable
	Length of concrete beam
Control	Mass of small stones in concrete
Independent	Time taken to add weights
	Weight needed to break concrete beam

5.2.2.6 Giant covalent structures

Question 03 · continued

Table 1 shows Student **A**'s results.

Table 1

Mass of small stones in grams (g)	Weight needed to break concrete beam in newtons (N)
500	70
1000	100
1500	110
2000	100
2250	85
2500	65
2750	35

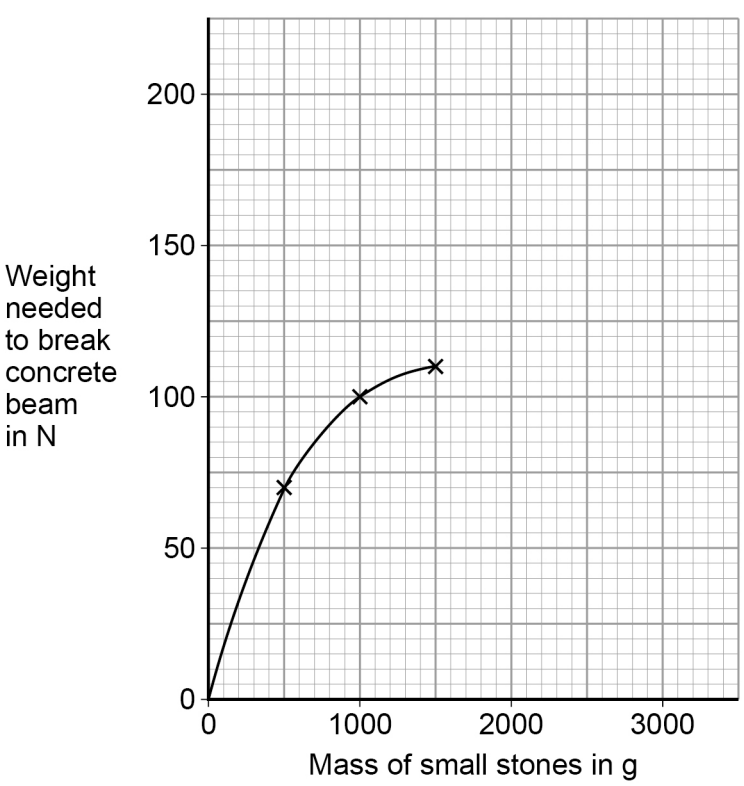
0 2 . 4 Plot the data from **Table 1** on **Figure 2**.

The first three points are plotted for you.

Draw the line of best fit.

[3 marks]

Figure 2



5.2.2.6 Giant covalent structures

Question 03 · continued

0 2 . 5 What mass of small stones would be needed to make the strongest concrete?

Give a reason for your answer.

Use **Figure 2**.

[2 marks]

Mass = _____ g

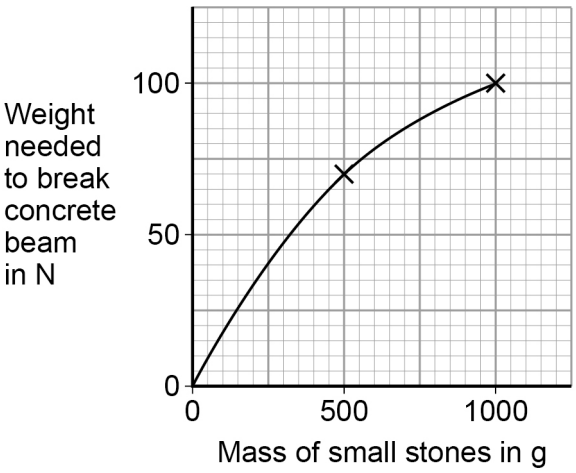
Reason _____

_____

0 2 . 6 Student **B** did a similar investigation.

Figure 3 shows Student **B**'s results.

Figure 3



How could Student **B** improve their investigation?

Use **Figure 2** and **Figure 3**.

[1 mark]

_____

_____

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5.2.2.6 Giant covalent structures

Question 04

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

0 6 This question is about the extraction of aluminium.

0 6 . 1 An aluminium atom is represented as:

$$^{27}_{13}Al$$

Give the number of electrons and neutrons in the aluminium atom.

[2 marks]

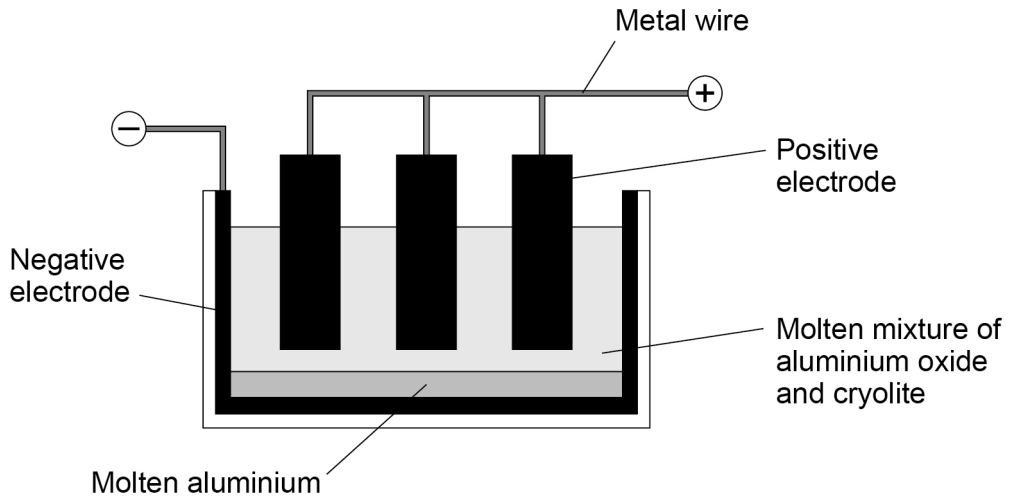
Number of electrons _____

Number of neutrons _____

Aluminium is extracted by the electrolysis of a molten mixture of aluminium oxide and cryolite.

Figure 11 shows the cell used for the electrolysis.

Figure 11



0 6 . 2 Aluminium is produced by the reduction of aluminium oxide (Al_2O_3).

What is meant by the term reduction?

[1 mark]

_____

_____

5.2.2.6 Giant covalent structures

Question 04 · continued

0 6 . 3 Oxygen is formed at the positive carbon electrodes.

Explain why the positive carbon electrodes must be continually replaced.

[3 marks]

0 6 . 4 A substance conducts electricity because of free moving, charged particles.

What are the free moving, charged particles in a:

- carbon electrode (made from graphite)
- molten mixture of aluminium oxide and cryolite
- metal wire?

[3 marks]

Carbon electrode (made from graphite) _____

Molten mixture of aluminium oxide and cryolite _____

Metal wire _____

9

5.2.2.6 Giant covalent structures

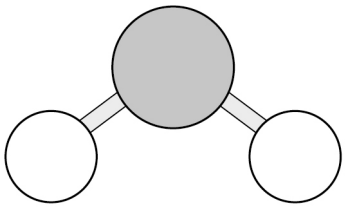
Question 05

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

0 7 This question is about substances with covalent bonding.

0 7 . 1 **Figure 12** shows a ball and stick model of a water molecule (H_2O).

Figure 12



Suggest **one** limitation of using a ball and stick model for a water molecule.

[1 mark]

_____

_____

_____

0 7 . 2 Ice has a low melting point.

Water molecules in ice are held together by intermolecular forces.

Complete the sentence.

[1 mark]

Ice has a low melting point because the

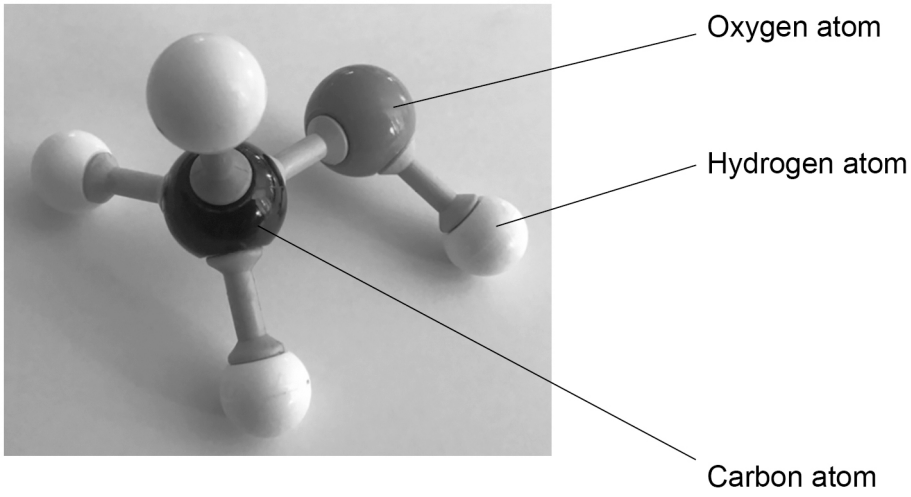
intermolecular forces are _____.

5.2.2.6 Giant covalent structures

Question 05 · continued

0 7 . 3 **Figure 13** shows the structure of a molecule.

Figure 13



What is the molecular formula of the molecule in **Figure 13**?

[1 mark]

Question 7 continues on the next page

5.2.2.6 Giant covalent structures

Question 05 · continued

Diamond has a giant covalent structure.

0 7 . 4 What is the number of bonds formed by each carbon atom in diamond?

[1 mark]

Tick (✓) **one** box.

2 ☐ 3 ☐ 4 ☐ 8 ☐

0 7 . 5 Give **two** physical properties of diamond.

[2 marks]

1 _____

2 _____

0 7 . 6 Name **two** other substances with giant covalent structures.

[2 marks]

1 _____

2 _____

8

5.2.2.6 Giant covalent structures

Question 06

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

0 3 Carbon can exist in a number of different structures.

0 3 . 1 What is the approximate radius of a carbon atom?

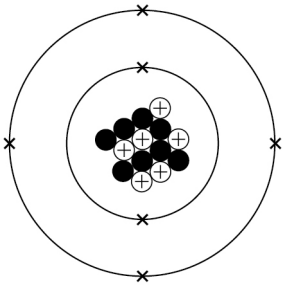
[1 mark]

Tick (✓) **one** box.

0.1 m ☐ 0.1 mm ☐ 0.1 nm ☐

0 3 . 2 **Figure 3** shows an atom of carbon.

Figure 3



Describe the atomic structure of this carbon atom.

You should include the number of electrons, neutrons and protons.

[6 marks]

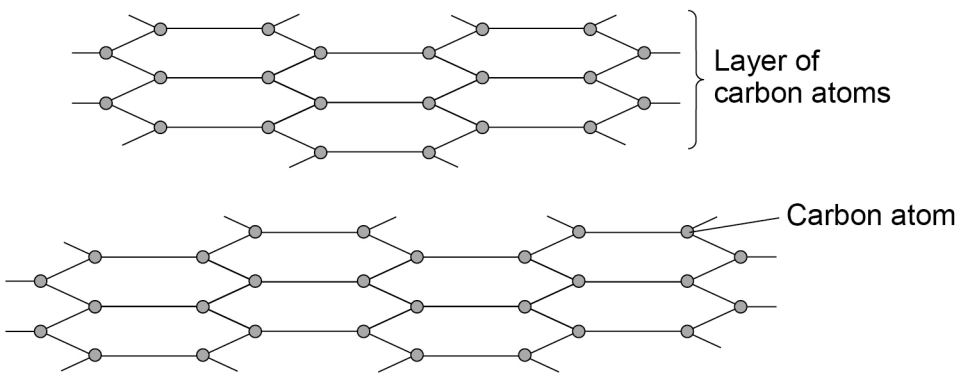
5.2.2.6 Giant covalent structures

Question 06 · continued

In graphite the carbon atoms are held together by bonds.

Figure 4 represents part of the structure of graphite.

Figure 4



0 3 . 3 How many bonds does each carbon atom have in graphite?

Use **Figure 4**.

[1 mark]

Tick (✓) **one** box.

1 ☐ 2 ☐ 3 ☐ 4 ☐

0 3 . 4 What type of bonds hold the carbon atoms together in graphite?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

5.2.2.6 Giant covalent structures

Question 06 · continued

0 3 . 5 Lubricants allow objects to slide over each other easily.

Suggest why graphite can be used as a lubricant.

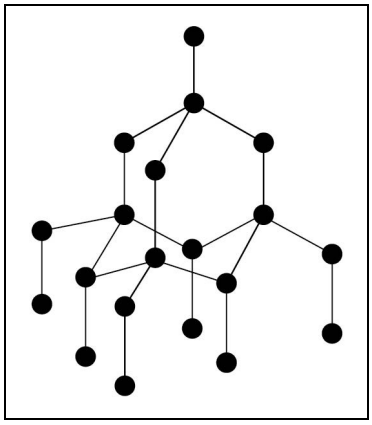
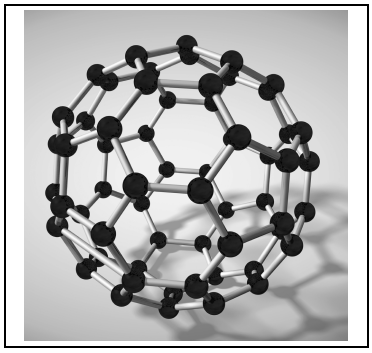
Use **Figure 4**.

[1 mark]

0 3 . 6 The two structures represent different forms of carbon.

Draw **one** line from each structure to the form of carbon.

[2 marks]

Structure	Form of carbon
	Buckminsterfullerene
	Diamond
	Graphene
	Nanotube

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5.2.2.6 Giant covalent structures

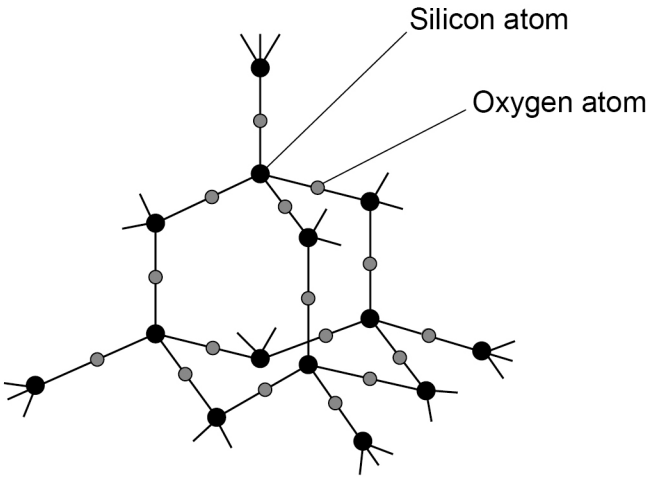
Question 07

June 2022 | 8464/C/1F | Original Q3

0 3 This question is about structure and bonding.

Figure 6 represents part of the structure of silicon dioxide.

Figure 6



0 3 . 1 What type of structure is silicon dioxide?

[1 mark]

Tick (✓) **one** box.

Giant covalent ☐

Ionic lattice ☐

Simple molecular ☐

0 3 . 2 Each oxygen atom forms two bonds.

What is the number of bonds formed by each silicon atom?

Use **Figure 6**.

[1 mark]

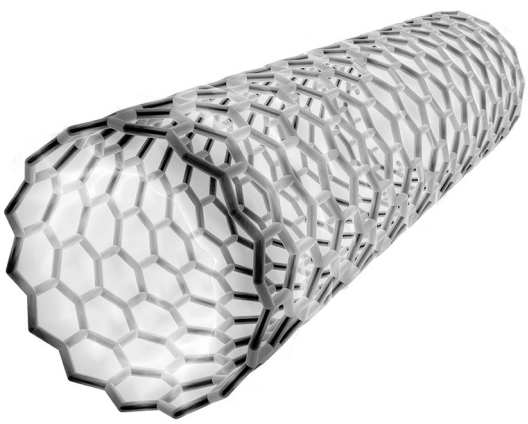
_____

5.2.2.6 Giant covalent structures

Question 07 · continued

Figure 7 represents part of a fullerene.

Figure 7



0 3 . 3 Complete the sentence.

Choose the answer from the box.

[1 mark]

hexagons	**octagons**	**squares**	**triangles**

The structure of fullerenes is based on _____ .

0 3 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

carbon	**hydrogen**	**oxygen**

The fullerene molecule shown in **Figure 7** is made from

atoms of _____ .

5.2.2.6 Giant covalent structures

Question 07 · continued

0 3 . 5 What is the fullerene molecule shown in **Figure 7** used for?

[1 mark]

Tick (✓) **one** box.

Electronics ☐

Hand warmers ☐

Sports injury packs ☐

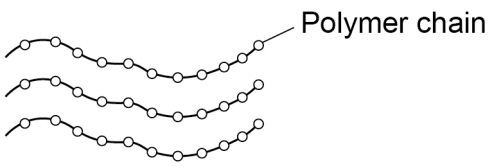
Question 3 continues on the next page

5.2.2.6 Giant covalent structures

Question 07 · continued

Figure 8 represents part of the structure of a polymer.

Figure 8



0 3 . 6 What holds the atoms together in a polymer chain?

[1 mark]

Tick (✓) **one** box.

Covalent bonds ☐

Ionic bonds ☐

Metallic bonds ☐

0 3 . 7 Complete the sentence.

Choose the answer from the box.

[1 mark]

atomic	**intermolecular**	**macromolecular**

In **Figure 8** the polymer chains are held together by

_____ forces.

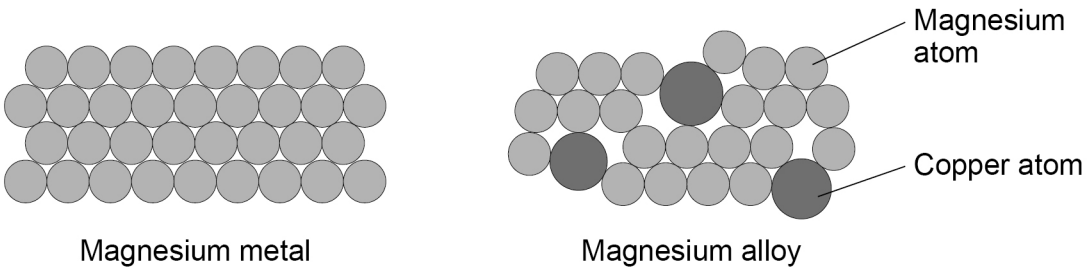
5.2.2.6 Giant covalent structures

Question 07 · continued

Figure 9 represents part of the structures of:

- magnesium metal
- a magnesium alloy.

Figure 9



Magnesium metal

Magnesium alloy

0 3 . 8 Calculate the percentage of copper atoms in the alloy.

[3 marks]

Number of magnesium atoms in the alloy = _____

Number of copper atoms in the alloy = _____

Total number of atoms in the alloy = _____

_____

Percentage of copper atoms in the alloy = _____ %

0 3 . 9 Explain why the magnesium alloy is harder than magnesium metal.

Use **Figure 9**.

[3 marks]

_____

_____

_____

_____

_____

_____

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5.2.2.6 Giant covalent structures

Question 08

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

0 3 Structure and bonding is used to explain properties of compounds.

Metal atoms react with non-metal atoms to form ions.

0 3 . 1 Which group of elements does **not** form ions?

[1 mark]

Tick (✓) **one** box.

- Alkali metals ☐
- Halogens ☐
- Noble gases ☐

Question 3 continues on the next page

5.2.2.6 Giant covalent structures

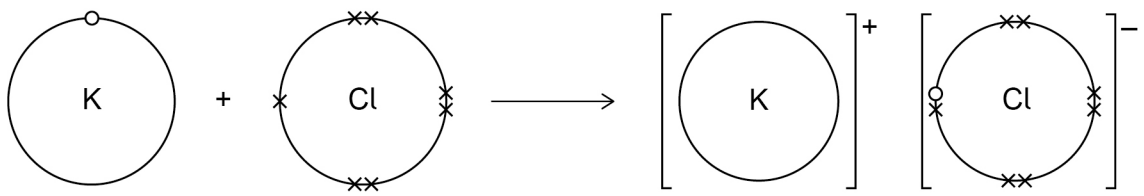
Question 08 · continued

0 3 . 2 Potassium reacts with chlorine to produce potassium chloride (KCl).

Figure 6 shows what happens to the electrons in the outer shells when a potassium atom reacts with a chlorine atom.

The dots (o) and crosses (×) represent electrons.

Figure 6



Describe what happens when a potassium atom reacts with a chlorine atom to produce potassium chloride.

Answer in terms of electrons.

[4 marks]

5.2.2.6 Giant covalent structures

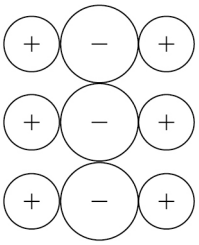
Question 08 · continued

0 3 . 3 In solid ionic compounds, oppositely charged ions attract to form a giant structure.

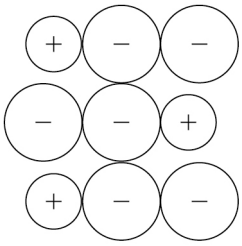
Which structure represents the arrangement of ions in solid potassium chloride?

[1 mark]

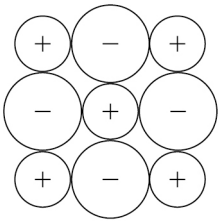
Tick (✓) **one** box.



☐



☐



☐

Question 3 continues on the next page

5.2.2.6 Giant covalent structures

Question 08 · continued

Non-metal atoms share electrons to form covalent bonds.

0 3 . 4 Water (H_2O) is a covalent molecule.

Table 2 shows the number of electrons in the outer shells of hydrogen atoms and of oxygen atoms.

Table 2

Element	Number of electrons in the outer shell of an atom
Hydrogen	1
Oxygen	6

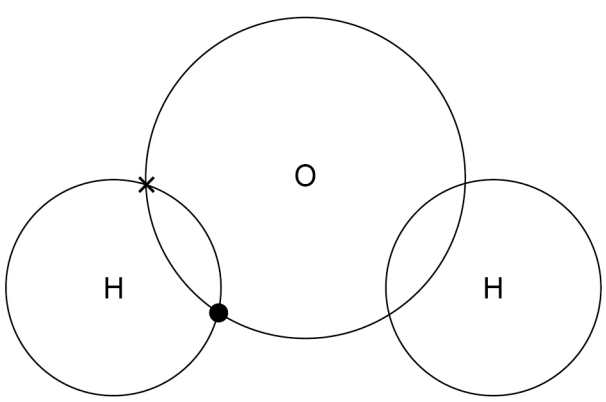
Figure 7 shows part of a dot and cross diagram for a molecule of water.

Complete the dot and cross diagram.

You should only show electrons in the outer shells.

[2 marks]

Figure 7



5.2.2.6 Giant covalent structures

Question 08 · continued

0 3 . 5 Silica has a giant covalent structure.

Figure 8 represents the structure of silica.

Figure 8



Determine the ratio of silicon (Si) atoms to oxygen (O) atoms in silica.

Use **Figure 8**.

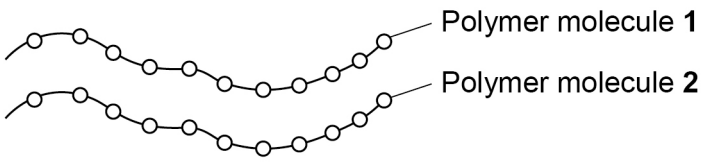
[1 mark]

_____ Si : _____ O

0 3 . 6 Polymers have very large molecules.

Figure 9 represents part of the structure of a polymer.

Figure 9



What holds polymer molecule **1** and polymer molecule **2** together in a polymer?

[1 mark]

Tick (✓) **one** box.

Covalent bonds ☐

Electrostatic attraction between ions ☐

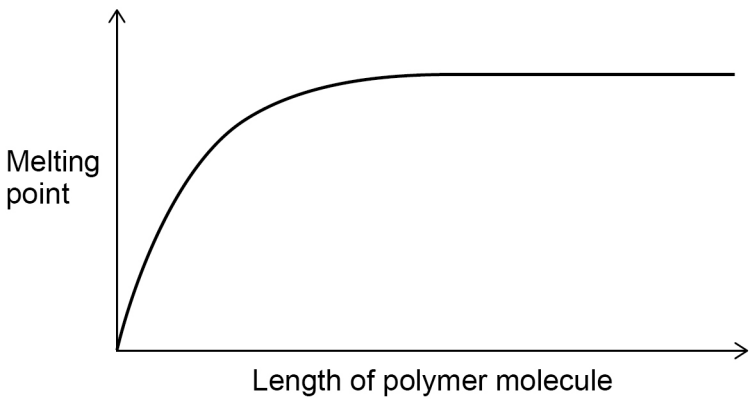
Weak intermolecular forces ☐

5.2.2.6 Giant covalent structures

Question 08 · continued

0 3 . 7 **Figure 10** shows the melting point of a polymer as the length of the polymer molecule increases.

Figure 10



Describe the trend shown in **Figure 10**.

[3 marks]

13

5.2.2.6 Giant covalent structures

Question 09

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0 2 Carbon is in Group 4 of the periodic table.

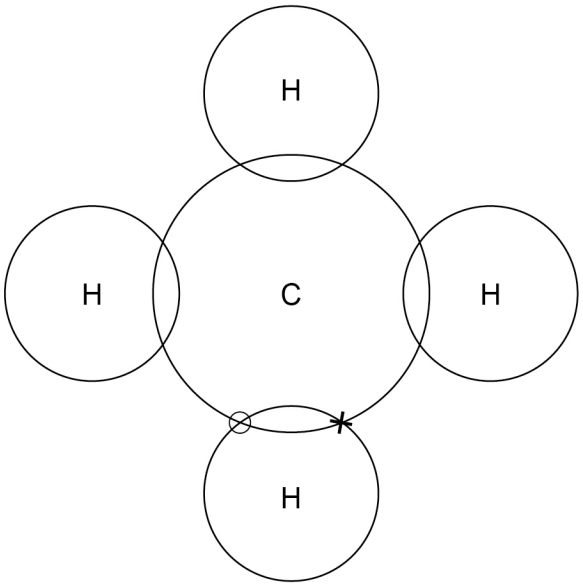
0 2 . 1 Methane contains carbon and hydrogen atoms.

A carbon atom has 4 electrons in the outer shell.

A hydrogen atom has 1 electron in the outer shell.

Complete the dot and cross diagram for a methane molecule.

[2 marks]



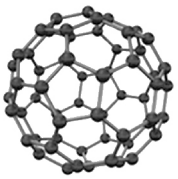
5.2.2.6 Giant covalent structures

Question 09 · continued

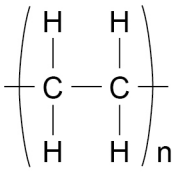
0 2 . 2 Which diagram represents the structure of diamond?

[1 mark]

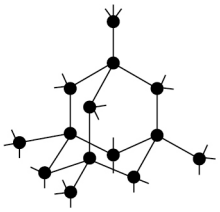
Tick (✓) **one** box.



☐



☐



☐

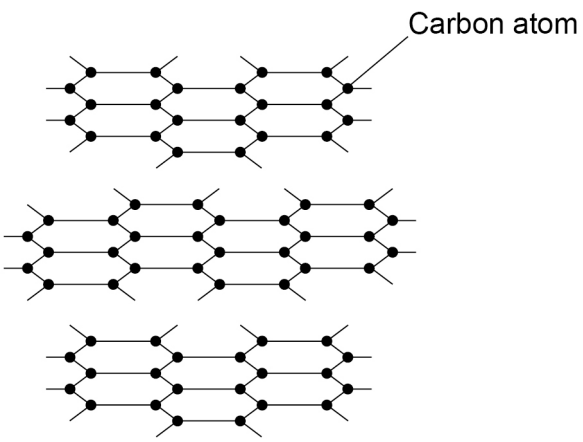
Question 2 continues on the next page

5.2.2.6 Giant covalent structures

Question 09 · continued

Figure 3 represents part of the structure of graphite.

Figure 3



0 2 . 3 In graphite each carbon atom forms covalent bonds.

How many covalent bonds does each carbon atom form in graphite?

[1 mark]

Tick (✓) **one** box.

1 ☐ 2 ☐ 3 ☐ 4 ☐

0 2 . 4 Graphite conducts electricity.

Which particles carry electrical charge through graphite?

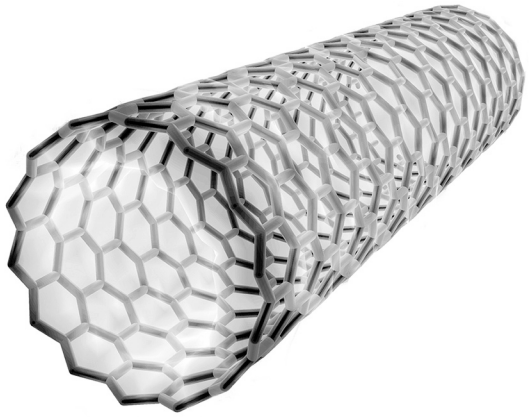
[1 mark]

5.2.2.6 Giant covalent structures

Question 09 · continued

Figure 4 represents the structure of a fullerene.

Figure 4



0 2 . 5 Where are fullerenes used?

[1 mark]

Tick (✓) **one** box.

- In electronic components ☐
- In self-heating cans ☐
- In sports injury packs ☐

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

[2 marks]

8

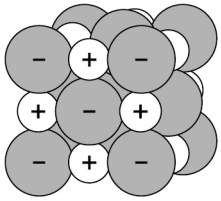
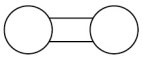
5.2.2.6 Giant covalent structures

Question 10

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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]

6