

Foundation

Question number	Description	Marks	Page number
4.2.1 Chemical bonds, ionic covalent and metallic			
1	Identifying bonding type from diagrams multiple choice, (4.4.3 electrolysis gap fills, and statement/reason box matching)	10	3
5	State symbol for oxygen at room temperature, percentage by mass from a pie chart, calculating a mean from a results table to 3 significant figures , completing dot and cross diagram for H ₂ O, bonding gap fill, (4.2.2 comparing boiling points of molecule gap fill using relative sizes from a diagram)	10	9
4.2.2 How bonding and structure are related to the properties of substances			
2	Ratio of metal atoms in an alloy diagram, multiple choice based on calculated ratio, electron structure of silicon multiple choice, identifying bonding in silicon dioxide from diagram, identifying number of atoms bonding in diagram, state symbol for silicon dioxide at room temperature.	8	13
4	Reading values from a graph, completing bar graph for metals in an alloy, ratio calculation of metals in alloy based on values read from graph, defining alloy, reason why alloys are used rather than pure metals, metallic metals multiple choice.		17

Common content

Question number	Description	Marks	Page number
4.2.1 Chemical bonds, ionic covalent and metallic			
2	(4.2.1 comparing electronic structure of sodium and chlorine, positions in periodic table are given), describing electron transfer when sodium and chlorine react (4.5.1 completing reaction profile for exothermic reaction)	8	19

4.2.3 Structure and bonding of carbon			
9	Converting metres in standard form to nanometres, use of graphene multiple choice, suggest reason graphene more suitable than graphite for electronics, explain why graphite conducts electricity and is slippery (6 marks)	9	21
4.2.4 Bulk and surface properties of matter including nanoparticles			
3	Explain why carbon nanotubes conduct electricity, evaluate information in a table on the use of aluminium, carbon nanotube and wood for making badminton racket frames, calculating the surface area of a nanoparticle, suggesting reason it costs less to use nanoparticles than fine particles in sun cream.	10	24

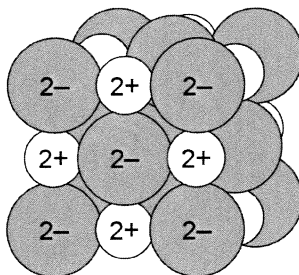
Higher

Question number	Description	Marks	Page number
4.2.1 Chemical bonds, ionic covalent and metallic			
7	Recall value of Avogadro constant, ratio calculation the mass of copper in g in 1kg of a sample when told 70ng of copper in 1g of sample answer in standard form, empirical formula of silicon dioxide from diagram, describe the structure and bonding in silicon dioxide	11	27
4.2.2 How bonding and structure are related to the properties of substances			
5	Explain conditions needed for sodium chloride needed to conduct electricity, describe how sodium conducts thermal energy (question continued in 4.2.3)	6	29
4.2.3 Structure and bonding of carbon			
5	(Question continued from 4.2.3) explain why diamond has a high melting point	3	31

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

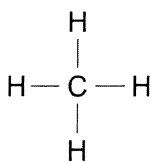
☐

Metallic

☐

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

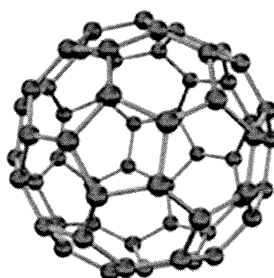
☐

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

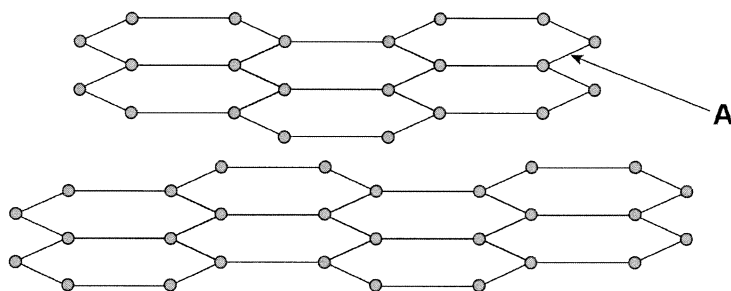
The structure of C_{60} is _____.

Turn over ►



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

☐

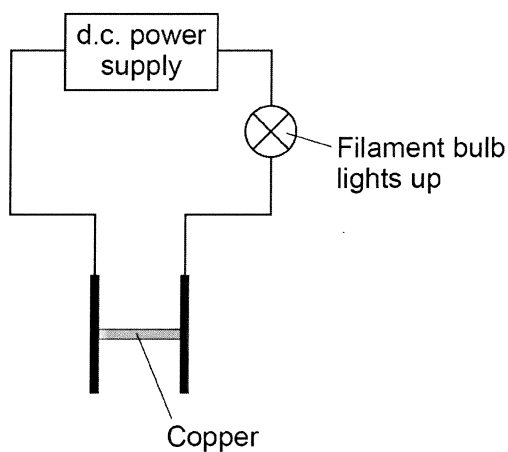
4

☐


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
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Copper conducts electricity because of the movement of delocalised _____.

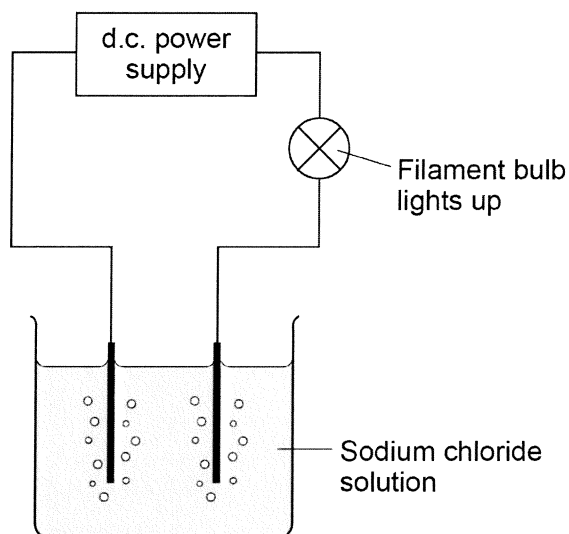
Turn over ►



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 _____.



0 1 . 9

Sodium chloride is made up of ions.

Do not write
outside the
box

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

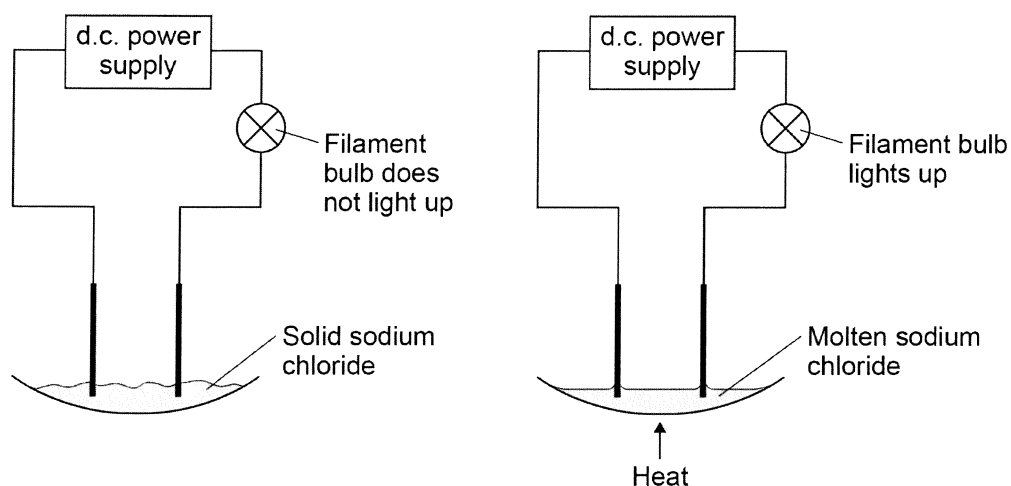
Figure 7

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.

Turn over ►

0 5

This question is about oxygen and compounds of oxygen.

0 5

1

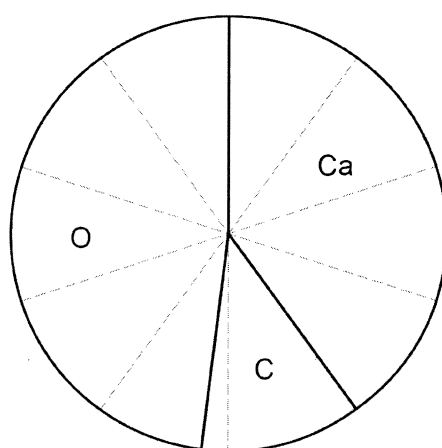
What is the state symbol of oxygen at room temperature?

[1 mark]

0 5

2

Figure 4 shows the percentage by mass of the elements calcium, carbon and oxygen in calcium carbonate.

Figure 4

What is the percentage by mass of calcium in calcium carbonate?

[1 mark]

Percentage = _____ %



0 5 . 3 At high temperature, sodium nitrate decomposes into sodium nitrite and oxygen.

A student heats three samples of sodium nitrate.

The mass of each sample was 4.50 g

The mass of solid after heating was recorded.

Table 2 shows the mass of solid after heating in each experiment.

Table 2

Experiment	Mass of solid after heating in g
1	3.76
2	3.98
3	4.09

Calculate the mean mass of solid after heating.

Give your answer to 3 significant figures.

[3 marks]

Mean mass of solid after heating = _____ g

Question 5 continues on the next page

Turn over ►



0 5 . 4

Table 3 shows the electronic structure of hydrogen and oxygen.

Table 3

Element	Electronic structure
Hydrogen	1
Oxygen	2,6

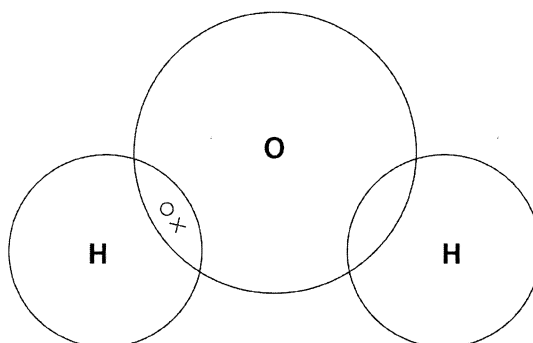
Figure 5 shows part of a dot and cross diagram of a molecule of water (H_2O).

Complete the dot and cross diagram.

You should show only the electrons in the outer energy levels.

[2 marks]

Figure 5



Oxygen and sulfur are examples of simple molecules.

0 5 . 5

Complete the sentence.

Choose the answer from the box.

[1 mark]

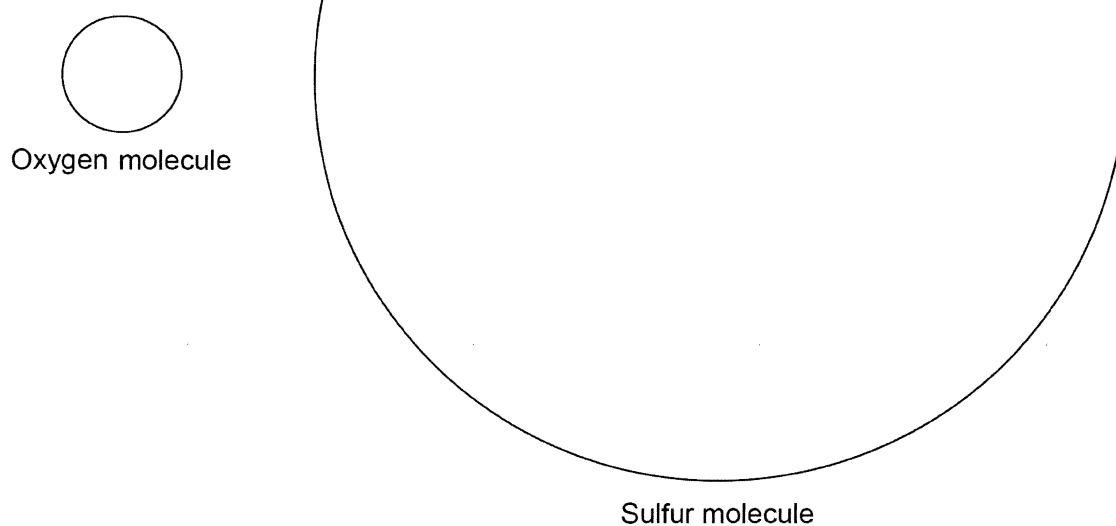
covalent	ionic	metallic
----------	-------	----------

There are _____ bonds between the atoms of oxygen in an oxygen molecule.



0 5 . 6 Figure 6 shows the relative sizes of an oxygen molecule and a sulfur molecule.

Figure 6



How does the boiling point of sulfur compare with the boiling point of oxygen?

Complete the sentences.

[2 marks]

The boiling point of sulfur is _____ the boiling point of oxygen.

This is because in sulfur the intermolecular forces are _____
than the intermolecular forces in oxygen.

10

Turn over ►

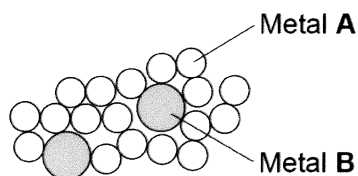


0 2

A 1 kilogram mass is made from a mixture of metal **A** and metal **B**.

Figure 3 represents part of the structure of the 1 kilogram mass.

Figure 3



0 2 . 1

What is the ratio of metal **A** atoms to metal **B** atoms in **Figure 3**?

[1 mark]

Ratio of **A:B** atoms = _____ : _____

0 2 . 2

What is a mixture of metals called?

[1 mark]

Tick (✓) **one** box.

A polymer

☐

A salt

☐

An alkene

☐

An alloy

☐


0 2 . 3

A silicon sphere has a mass of 1 kilogram.

The largest impurity in the silicon sphere is copper.

There are 7×10^{-5} g of copper in the silicon sphere.

What is the mass of copper in kilograms in the silicon sphere?

[1 mark]

Tick (✓) **one** box.

 7×10^{-2} kg☐ 7×10^{-4} kg☐ 7×10^{-6} kg☐ 7×10^{-8} kg☐

0 2 . 4

An atom of silicon has 14 electrons.

What is the electronic structure of silicon?

[1 mark]

Tick (✓) **one** box.

2,4,8

☐

2,8,4

☐

4,2,8

☐

8,4,2

☐

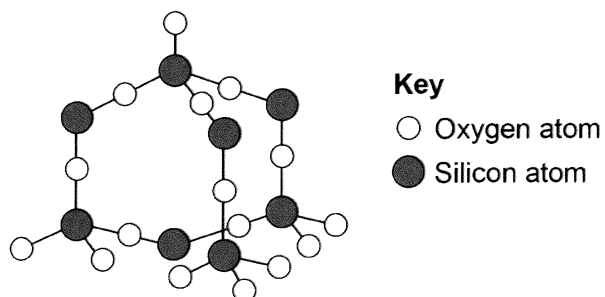
Question 2 continues on the next page

Turn over ►

Silicon dioxide is a compound of silicon and oxygen.

Figure 4 represents part of the giant structure of silicon dioxide.

Figure 4



0 2 . 5 Which **two** words describe the bonding in silicon dioxide?

[2 marks]

Tick (✓) **two** boxes.

Covalent

☐

Intermolecular

☐

Ionic

☐

Metallic

☐

Strong

☐

0 2 . 6 How many silicon atoms are bonded to each oxygen atom in silicon dioxide?

Use **Figure 4**.

[1 mark]

Tick (✓) **one** box.

1	2	3	4
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

0 2 . 7 Which symbol represents the state of silicon dioxide at room temperature?

[1 mark]

Tick (✓) **one** box.

(aq)	<input type="checkbox"/>
(g)	<input type="checkbox"/>
(l)	<input type="checkbox"/>
(s)	<input type="checkbox"/>

8

Turn over for the next question

Turn over ►

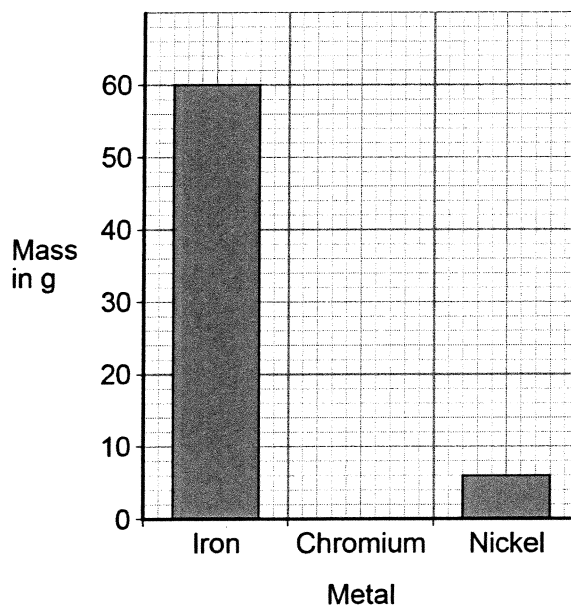


0 4

One alloy contains iron, chromium and nickel.

Figure 2 shows the mass of iron and the mass of nickel in 80 g of this alloy.

Figure 2



0 4 . 1

Determine the mass of iron and nickel in 80 g of the alloy.

Use Figure 2.

[1 mark]

Mass of iron = _____ g

Mass of nickel = _____ g

0 4 . 2

Calculate the mass of chromium in 80 g of the alloy.

Draw a bar on Figure 2 to show the mass of chromium in 80 g of the alloy.

[2 marks]

Mass of chromium = _____ g



0 4 . 3 What mass of iron is present in **0.80 kg** of the alloy?

Give your answer in grams.

[1 mark]

Mass of iron = _____ g

0 4 . 4 What is an alloy?

[1 mark]

0 4 . 5 Give **one** reason why alloys are used instead of pure metals.

[1 mark]

0 4 . 6 Iron and nickel are both magnetic metals.

Which is also a magnetic metal?

[1 mark]

Tick **one** box.

Cobalt

☐

Copper

☐

Sodium

☐

Zinc

☐

7

Turn over ►



Figure 2 shows the positions of sodium and chlorine in the periodic table.

[illegible]

[2 marks]

Similarity

[4 marks]

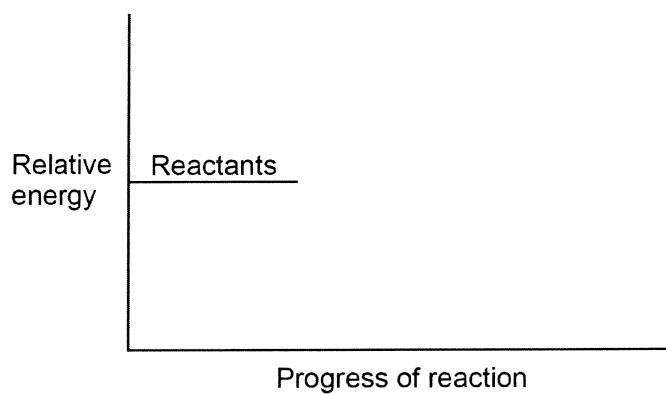
0 2 . 3

The reaction between sodium and chlorine is an exothermic reaction.

Complete the reaction profile for the reaction between sodium and chlorine.

[2 marks]

Figure 3



8



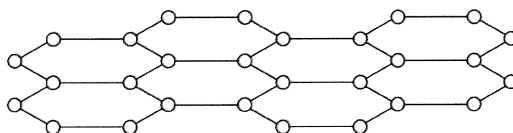
0 9

This question is about graphene and graphite.

Graphene is a single layer of graphite.

Figure 11 represents part of the structure of graphene.

Figure 11



0 9 . 1

Graphene is one atom thick. The diameter of the atom is 3.4×10^{-10} m

What is the thickness of a graphene layer in nanometres?

$$1 \text{ nm} = 10^{-9} \text{ m}$$

[1 mark]

Tick (✓) **one** box.

0.034 nm

☐

0.34 nm

☐

3.4 nm

☐

34 nm

☐


0 9 . 2

Which is **one** use of graphene?**[1 mark]**Tick (✓) **one** box.

As a detergent

☐

As a solvent

☐

In composites

☐

To produce polymers

☐

0 9 . 3

Graphene and graphite are used in electronics.

Suggest **one** reason why graphene is a more suitable material for use in electronics than graphite.**[1 mark]**

Question 9 continues on the next page

Turn over ►



Figure 12 represents part of the structure of graphite.

The diagram illustrates the structure of graphite, showing three parallel layers of carbon atoms. Each layer is a hexagonal lattice of carbon atoms, with the layers stacked on top of each other. The delocalized pi system is represented by the overlapping of p-orbitals perpendicular to the plane of the layers.

- conducts electricity
- is slippery.

You should refer to the structure and bonding of graphite in your answer.

[6 marks]

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END OF QUESTIONS

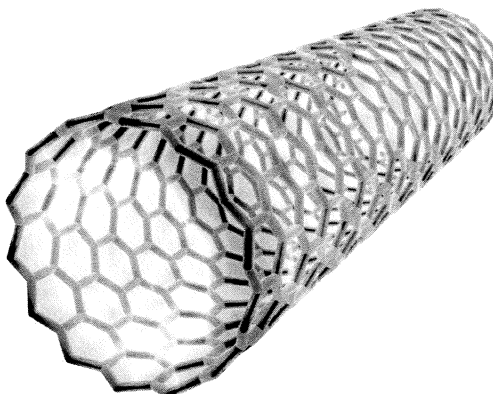
0 3

This question is about materials and their properties.

0 3 . 1

Figure 3 shows a carbon nanotube.

Figure 3



The structure and bonding in a carbon nanotube are similar to graphene.

Carbon nanotubes are used in electronics because they conduct electricity.

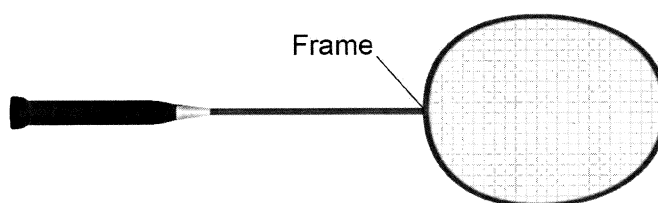
Explain why carbon nanotubes conduct electricity.

[2 marks]

0 3 . 2

Figure 4 shows a badminton racket.

Figure 4



The materials could be used to make badminton racket frames.

Material	Density in g/cm ³	Relative strength	Relative stiffness
Aluminium	2.7	0.3	69
Carbon nanotube	1.5	60	1000
Wood	0.71	0.1	10

Use Table 1.

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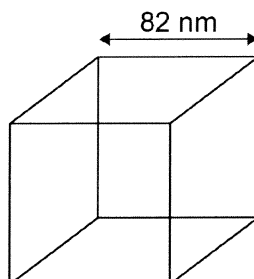
Zinc oxide can be produced as nanoparticles and as fine particles.

0 3 . 3

A nanoparticle of zinc oxide is a cube of side 82 nm

Figure 5 represents a nanoparticle of zinc oxide.

Figure 5



Calculate the surface area of a nanoparticle of zinc oxide.

Give your answer in standard form.

[3 marks]

Surface area = _____ nm²

0 3 . 4

Some suncreams contain zinc oxide as nanoparticles or as fine particles.

Suggest **one** reason why it costs less to use nanoparticles rather than fine particles in suncreams.

[1 mark]



The Avogadro constant is the number of atoms in 1 mole of a substance.

0 7 . 3 What is the value of the Avogadro constant?

[1 mark]

Tick (✓) **one** box.

6.02×10^{23} per mole

☐

6.02×10^{24} per mole

☐

6.02×10^{25} per mole

☐

6.02×10^{26} per mole

☐

0 7 . 4 Scientists could use a sample of silicon to define the Avogadro constant.

Copper is an impurity in the silicon sample.

There are 70 nanograms of copper in 1 g of the sample.

Calculate the mass of copper in grams in 1 kg of the sample.

Give your answer in standard form.

1 nanogram = 10^{-9} g

[2 marks]

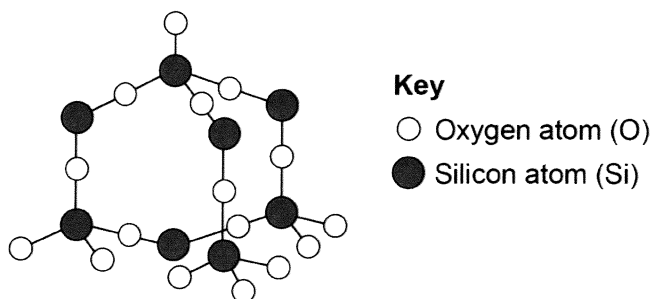
Mass of copper = _____ g



Silicon mainly occurs in the Earth's crust as silicon dioxide.

Figure 8 represents part of the structure of silicon dioxide.

Figure 8



0 7 . 5 Determine the empirical formula of silicon dioxide.

Use **Figure 8**.

[1 mark]

Empirical formula = _____

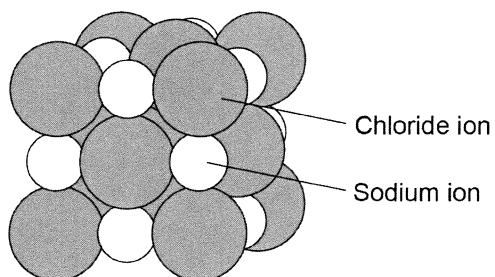
0 7 . 6 Describe the structure and bonding in silicon dioxide.

[3 marks]



0 5 . 2 **Figure 6** shows part of the structure and bonding in sodium chloride (NaCl).

Figure 6



Explain the conditions needed for sodium chloride to conduct electricity.

[3 marks]

Question 5 continues on the next page

Turn over ►

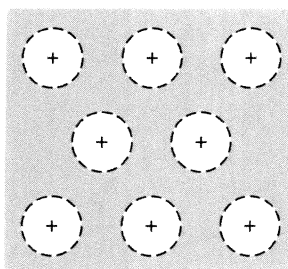


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0	5	.	3
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Figure 7 shows the structure of sodium.

Figure 7



Describe how sodium conducts thermal energy.

[3 marks]

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7



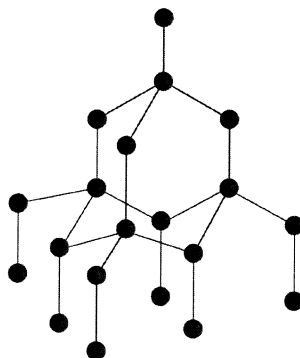
0	5
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This question is about structure and bonding.

0	5	.	1
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Figure 5 shows part of the structure and bonding in diamond.

Figure 5



Explain why diamond has a high melting point.

[3 marks]

3

