

Questions are for both separate science and combined science students unless indicated in the question

Q1.

This question is about carbon and its compounds.

Fullerenes are molecules of carbon atoms.

The first fullerene to be discovered was Buckminsterfullerene (C_{60}).

(a) What shape is a Buckminsterfullerene molecule?

_____ (1)

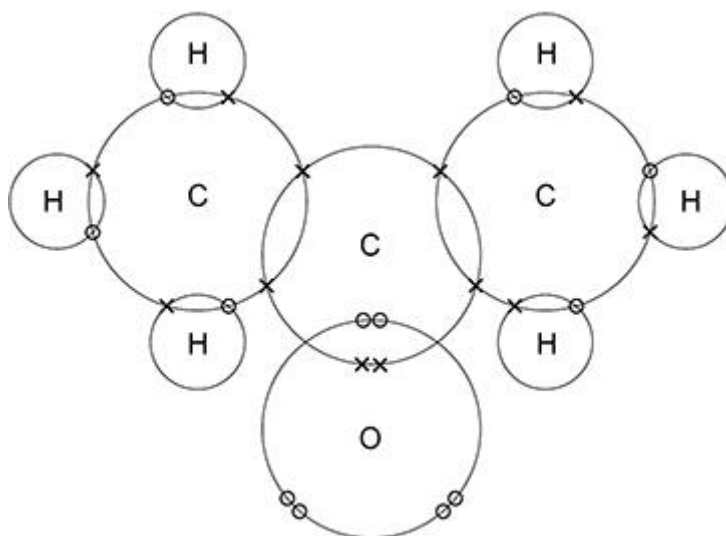
(b) Give **one** use of a fullerene.

 _____ (1)

Propanone is a compound of carbon, hydrogen and oxygen.

Figure 1 shows the dot and cross for a propanone molecule.

Figure 1

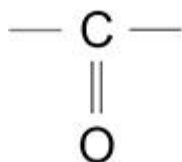


(c) Complete **Figure 2** to show a propanone molecule.

Use a line to represent each single bond.

Use **Figure 1**.

Figure 2



(1)

- (d) Determine the molecular formula of propanone.

Use **Figure 1**.

Molecular formula = _____

(1)

- (e) Propanone is a liquid with a low boiling point.

Why does propanone have a low boiling point?

Tick (✓) **one** box.

The covalent bonds are strong.

The covalent bonds are weak.

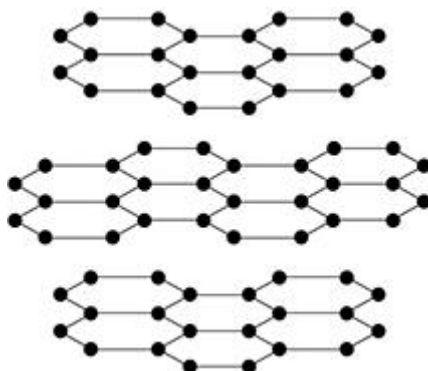
The intermolecular forces are strong.

The intermolecular forces are weak.

(1)

- (f) **Figure 3** represents the structure of graphite.

Figure 3



Explain why graphite is:

- a good electrical conductor
- soft and slippery.

You should answer in terms of structure and bonding.

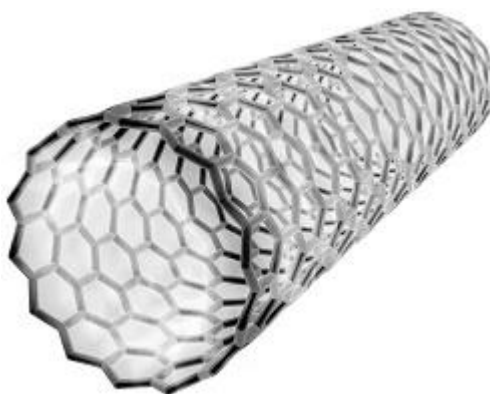
(6)
(Total 11 marks)

Q2.

This question is about materials and their properties.

- (a) **Figure 1** shows a carbon nanotube.

Figure 1

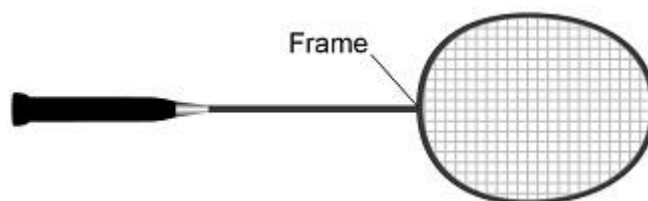


The structure and bonding in a carbon nanotube are similar to graphene.
Carbon nanotubes are used in electronics because they conduct electricity.
Explain why carbon nanotubes conduct electricity.

(2)

(b) **Figure 2** shows a badminton racket.

Figure 2



The following table shows some properties of materials.

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

Evaluate the use of the materials to make badminton racket frames.

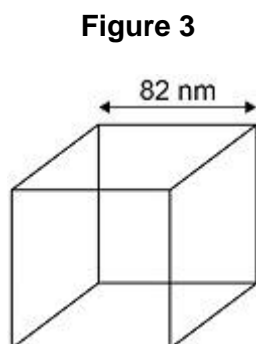
Use the table above.

(4)

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

- (c) A nanoparticle of zinc oxide is a cube of side 82 nm

Figure 3 represents a nanoparticle of zinc oxide.



Calculate the surface area of a nanoparticle of zinc oxide.

Give your answer in standard form. **(separate only)**

Surface area = _____ nm²

(1)

- (d) 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. **(separate only)**

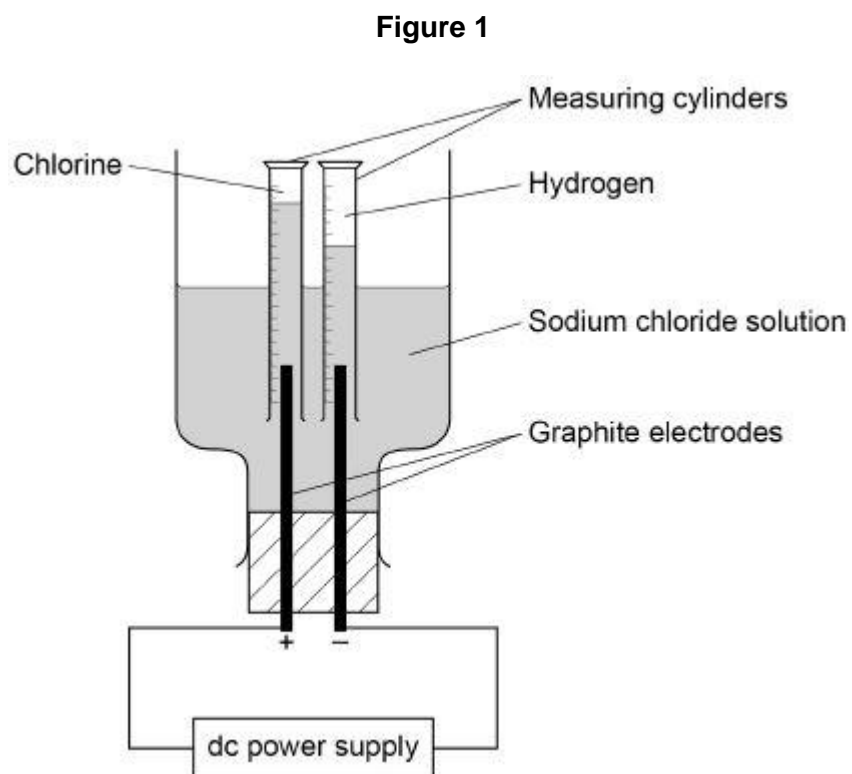
(1)

(Total 10 marks)

Q3.

A student investigated the electrolysis of sodium chloride solution.

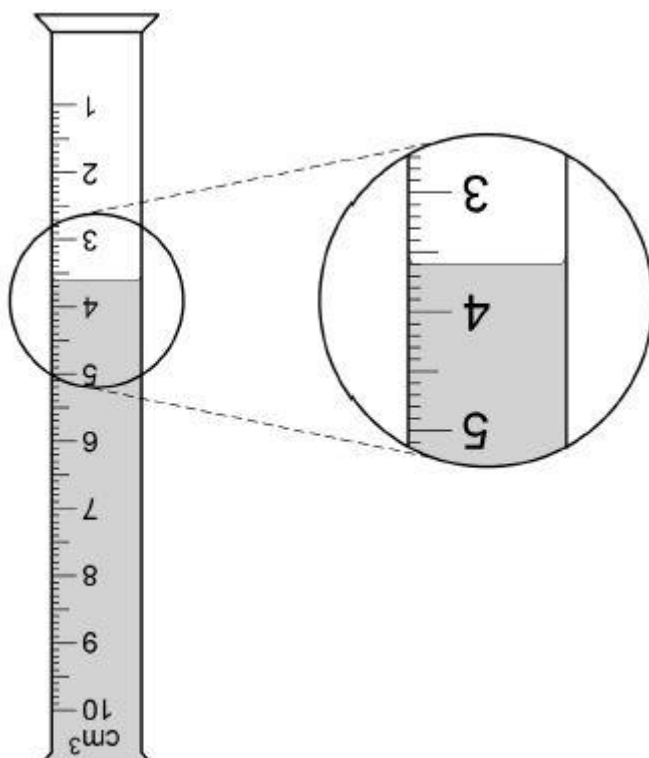
Figure 1 shows the apparatus.



The student measured the volume of gas collected in each measuring cylinder every minute for 20 minutes.

- (a) **Figure 2** shows the volume of hydrogen gas collected in the measuring cylinder after 8 minutes.

Figure 2



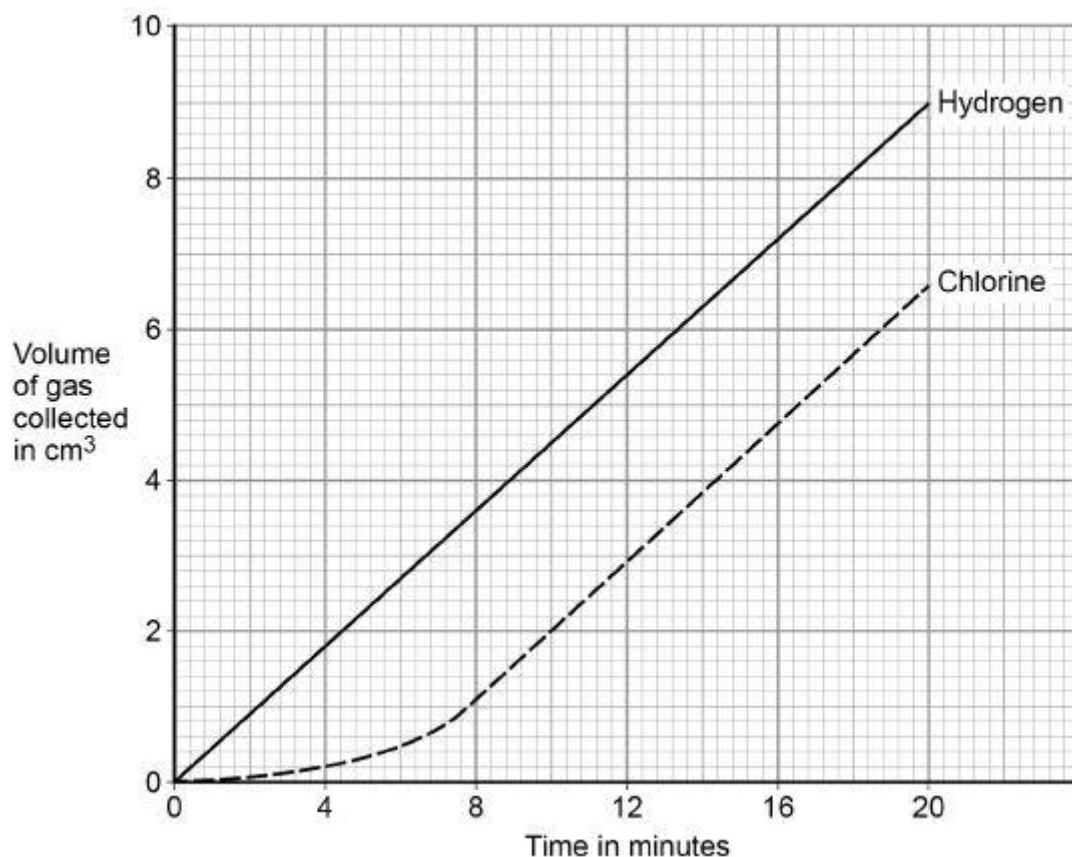
What is the volume of hydrogen gas collected?

Volume = _____ cm³

(1)

Figure 3 shows the results of the investigation.

Figure 3



- (b) Which of the lines on **Figure 3** show that the volume of gas collected is directly proportional to the time?

Tick **one** box.

Both lines

Chlorine line only

Hydrogen line only

Neither line

(1)

- (c) Which of the lines on **Figure 3** show a positive correlation between the volume of gas collected and time?

Tick **one** box.

Both lines

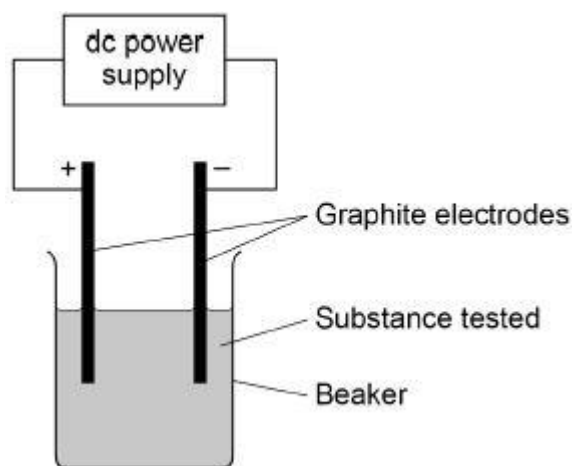
- Chlorine line only
- Hydrogen line only
- Neither line

(1)

A teacher demonstrates the electrolysis of different substances using graphite electrodes.

Figure 4 shows the apparatus used.

Figure 4



(d) Why can graphite conduct electricity?

Tick **one** box.

- Graphite exists in layers of atoms.
- Graphite has a giant structure.
- Graphite has a high melting point.
- Graphite has delocalised electrons.

(1)

(e) The teacher demonstrates the electrolysis of:

- molten zinc chloride
- potassium bromide solution.

Complete the table below to predict the products.

Choose answers from the box.

chlorine	bromine	hydrogen	oxygen	potassium	zinc
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Substance electrolysed	Product at cathode (negative electrode)	Product at anode (positive electrode)
Molten zinc chloride		
Potassium bromide solution		

(4)

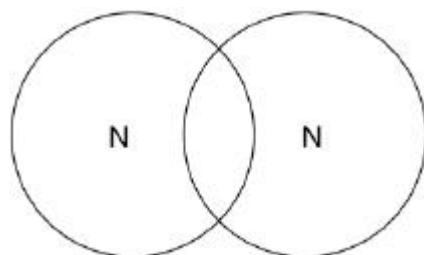
(Total 8 marks)

Q4.

This question is about structure and bonding.

- (a) Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule, N_2

Show only the electrons in the outer shell.



(2)

- (b) Explain why nitrogen is a gas at room temperature.

Answer in terms of nitrogen's structure.

(3)

- (c) Graphite and fullerenes are forms of carbon.

Graphite is soft and is a good conductor of electricity.

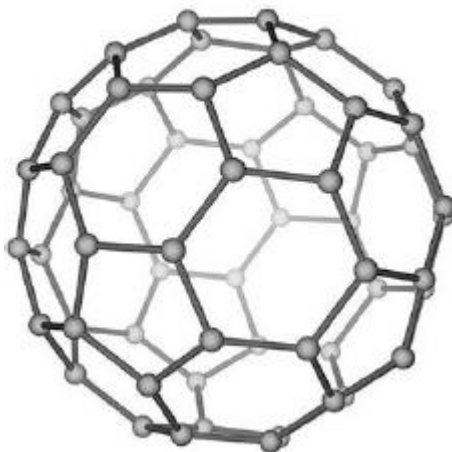
Explain why graphite has these properties.

Answer in terms of structure and bonding.

(4)

- (d) **Figure 1** shows a model of a Buckminsterfullerene molecule.

Figure 1



A lubricant is a substance that allows materials to move over each other easily.

Suggest why Buckminsterfullerene is a good lubricant.

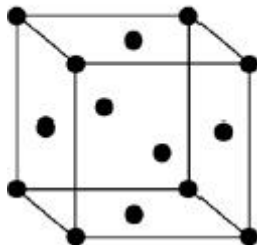
Use **Figure 1**.

(2)

Silver can form cubic nanocrystals.

Figure 2 represents a silver nanocrystal.

Figure 2



- (e) A silver nanocrystal is a cube of side 20 nm

Calculate the surface area to volume ratio of the nanocrystal. **(separate only)**

Surface area to volume ratio = _____

(3)

- (f) Silver nanoparticles are sometimes used in socks to prevent foot odour.

Suggest why it is cheaper to use nanoparticles of silver rather than coarse particles of silver. **(separate only)**

(2)

(Total 16 marks)

Q5.

This question is about different substances and their structures.

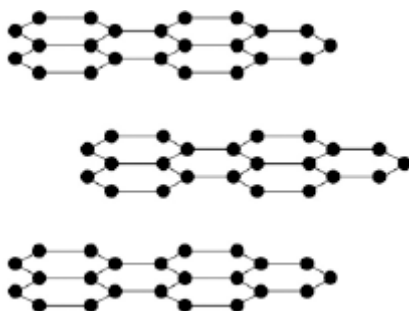
- (a) Draw **one** line from each statement to the diagram which shows the structure.

Statement	Structure
The substance is a gas	
The substance is a liquid	
The substance is ionic	
The substance is a solid metal	

(4)

(b) **Figure 1** shows the structure of an element.

Figure 1



What is the name of this element?

Tick **one** box.

Carbon

Chloride

Nitrogen

Xenon

(1)

(c) Why does this element conduct electricity?

Tick **one** box.

It has delocalised electrons

It contains hexagonal rings

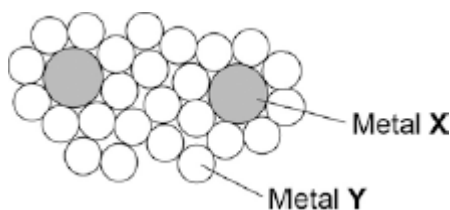
It has weak forces between the layers

It has ionic bonds

(1)

(d) **Figure 2** shows the structure of an alloy.

Figure 2



Explain why this alloy is harder than the pure metal Y.

(2)

(e) What percentage of the atoms in the alloys are atoms of **X**?

(2)

(f) What type of substance is an alloy?

Tick **one** box.

Compound

Element

Mixture

(1)

(Total 11 marks)

Q6.

This question is about substances containing carbon atoms.

(a) Diamond is made of carbon atoms.

(i) Diamond is used for tips of drills.

Figure 1 shows a drill.

Figure 1



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Give **one** reason why diamond is used for tips of drills.

(1)

(ii) Diamond nanoparticles can be made.

Use the correct answer from the box to complete the sentence.

hundred

million

thousand

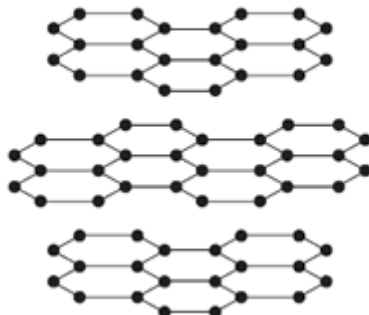
Nanoparticles contain a few _____ atoms.

(1)

- (b) Graphite is made of carbon atoms.

Figure 2 shows the structure of graphite.

Figure 2



- (i) What type of bonding does graphite have?

Tick (✓) **one** box.

Covalent

Ionic

Metallic

(1)

- (ii) How many carbon atoms does each carbon atom bond to in graphite?

Tick (✓) **one** box.

1

2

3

4

(1)

- (iii) What is a property of graphite?

Tick (✓) **one** box.

Dissolves in water

Has a low melting point

Soft and slippery



(1)

(c) Poly(ethene) is made of carbon and hydrogen atoms.

Poly(ethene) is a thermosoftening polymer.

Figure 3 shows the structure of a thermosoftening polymer.

Figure 3



(i) Complete the sentence. **(separate only)**

Between the polymer chains in a thermosoftening polymer there are no _____.

(1)

(ii) Use the correct answer from the box to complete the sentence. **(separate only)**

condense	dissolve	melt
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Heating would cause a thermosoftening polymer to

_____.

(1)

(iii) Many ethene molecules react together to make poly(ethene).

Different types of poly(ethene) can be made by changing the conditions for the reaction.

Suggest **two** conditions that could be changed. **(separate only)**

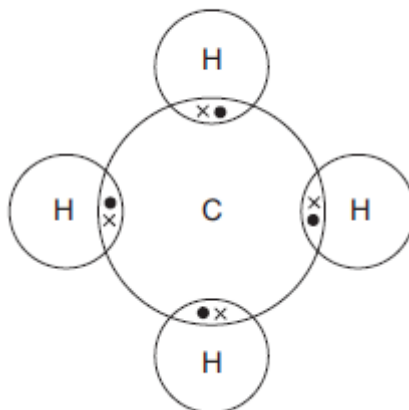
1.

2.

(2)

- (d) **Figure 4** shows how the atoms are bonded in methane.

Figure 4



- (i) What is the formula for methane?

Tick (✓) **one** box.

C₄H

CH₄

C₄H₄

(1)

- (ii) Methane has a low boiling point.

What does methane consist of?

Tick (✓) **one** box.

Charged ions

A giant lattice

Small molecules

(1)

(Total 11 marks)

Q7.

This question is about the properties and uses of materials.

Use your knowledge of structure and bonding to answer the questions.

- (a) Explain how copper conducts electricity.

(2)

(b) Explain why diamond is hard.

(2)

(c) Explain why thermosetting polymers are better than thermosoftening polymers for saucepan handles. **(separate only)**

(2)

(Total 6 marks)