1 The article gives some information about graphene.

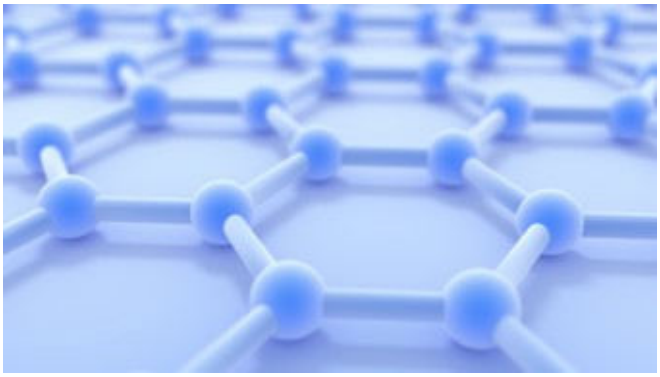
Nanotunes!

Carbon can be made into nano-thin, strong sheets called graphene.

A graphene sheet is a single layer of graphite.

Graphene conducts electricity and is used in loudspeakers.

The picture shows the structure of graphene.



(a) Use the picture and your knowledge of bonding in graphite to:

(i) explain why graphene is strong;

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.....

(3)

(ii) explain why graphene can conduct electricity.

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(2)

(b) Graphite is made up of layers of graphene.

Explain why graphite is a lubricant.

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.....

(2)
(Total 7 marks)

2 This question is about diamonds.

Draw a ring around the correct answer to complete each sentence.

(a) Diamonds are found in meteorites.

(i) Meteorites get very hot when they pass through the Earth's atmosphere, but the diamonds do not melt.

Diamond has a [high / low / very low] melting point.

(1)

(ii) Most diamonds found in meteorites are nanodiamonds.

A nanodiamond contains a few [hundred / thousand / million.] atoms

(1)

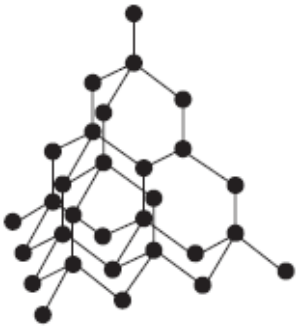
(b) Diamonds are used for the cutting end of drill bits.

Diamonds can be used for drill bits because they are

hard.
shiny.
soft.

(1)

(c) The figure below shows the arrangement of atoms in diamond.



(i) Diamond is made from

carbon
nitrogen
oxygen

atoms.

(1)

(ii) Each atom in diamond is bonded to

three
four
five

other atoms.

(1)

(iii) Diamond has a giant

covalent
ionic
metallic

structure.

(1)

(iv) In diamond

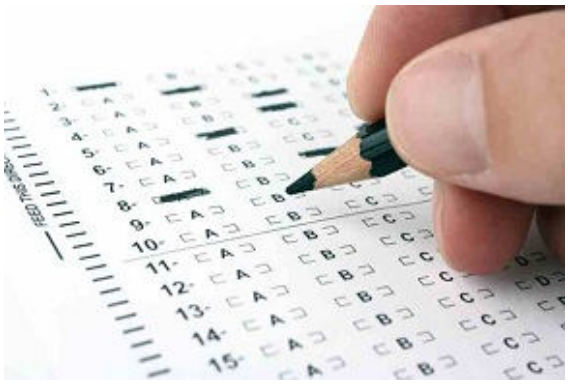
all
none
some

of the atoms are bonded together.

(1)

(Total 7 marks)

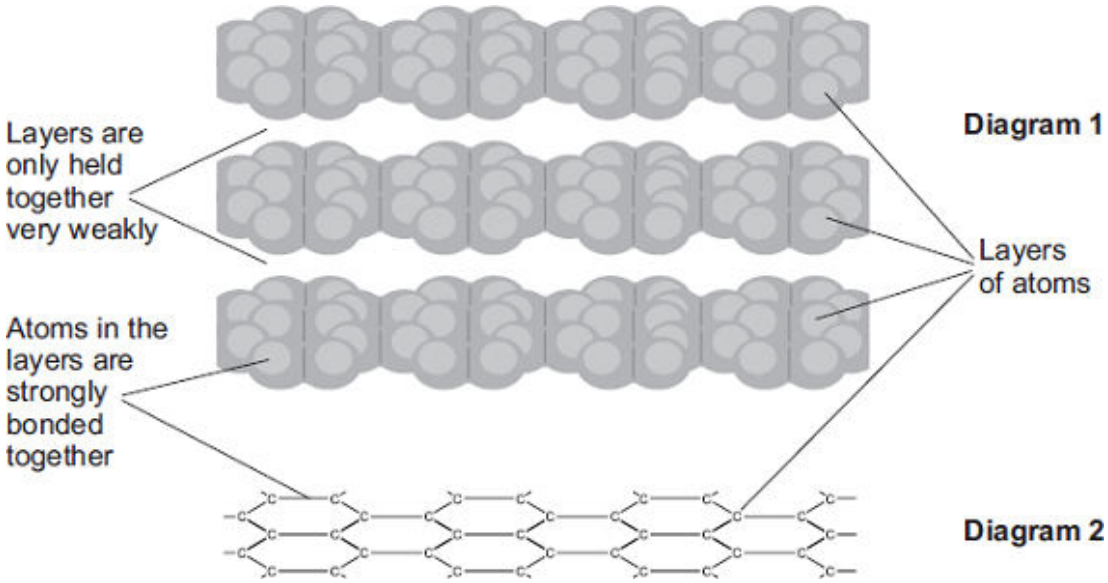
3 The picture shows a student filling in a multiple choice answer sheet using a pencil.



© Cihan Ta?k?n/iStock

The pencil contains graphite. Graphite rubs off the pencil onto the paper.

Diagrams **1** and **2** show how the atoms are arranged in graphite.



(a) Use the diagrams to help you explain why graphite can rub off the pencil onto the paper.

.....

.....

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.....

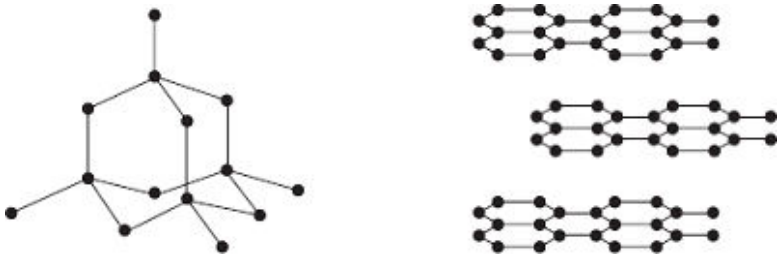
(2)

(b) Draw a ring around the type of bond which holds the atoms together in each layer.

covalent **ionic** **metallic**

(1)
(Total 3 marks)

4 The diagrams show the structures of diamond and graphite.



Diamond **Graphite**

(a) Diamond and graphite both contain the same element.

What is the name of this element? .....

(1)

(b) Use the diagrams above and your knowledge of structure and bonding to explain why:

(i) graphite is very soft

.....

.....

.....

.....

(2)

(ii) diamond is very hard

.....

.....

.....

.....

(2)

(iii) graphite conducts electricity.

.....

.....

.....

.....

(2)

(Total 7 marks)

5 Oil rigs are used to drill for crude oil.

(a) Drill heads are made from steel. Steel is an alloy.

Explain why alloys are harder than pure metals.

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(3)

(b) Drill heads also contain diamonds.

Describe, as fully as you can, the structure and bonding in diamond.

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(4)

(c) Polymers are produced from crude oil.

Describe the structure and bonding in a thermosoftening polymer and explain why thermosoftening polymers melt when heated.

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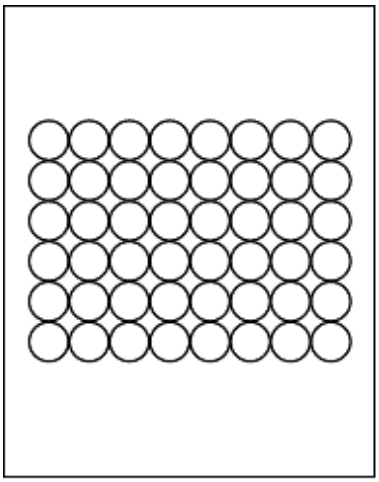
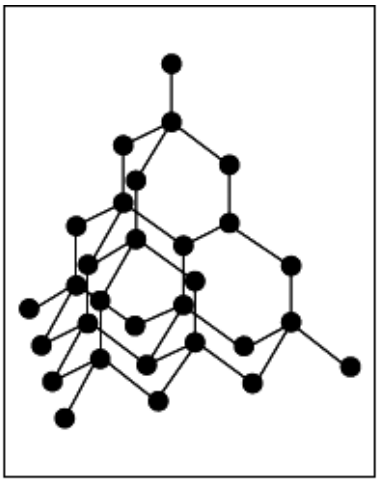
(4)
(Total 11 marks)

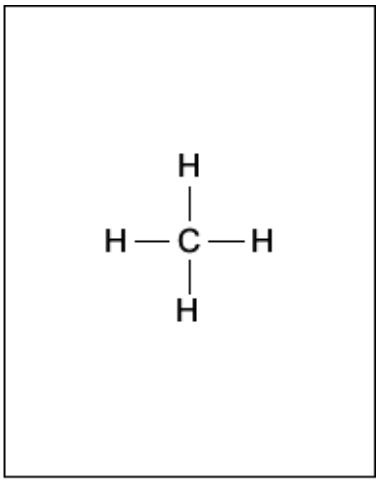
6 The diagrams represent the structures of five substances, **A**, **B**, **C**, **D** and **E**.



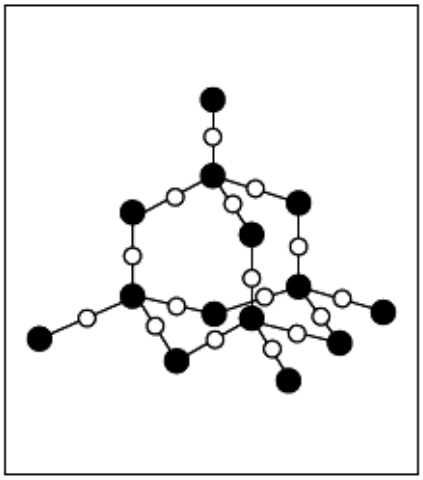
A



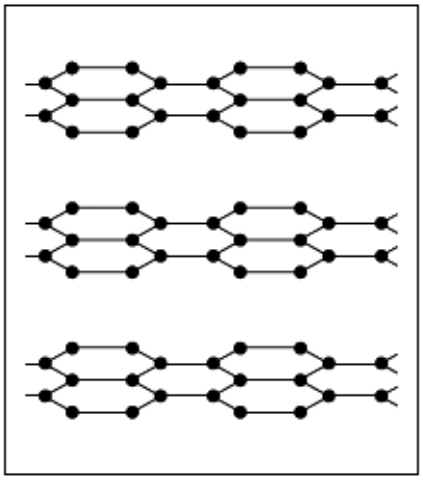
B



C



D



E

(a) Give **one** substance, **A**, **B**, **C**, **D** or **E**, that:

(i) has a very low boiling point

(1)

(ii) is a compound

(1)

(iii) is a metal.

(1)

(b) Draw a ring around the type of bonding holding the atoms together in substance **C**.

covalent **ionic** **metallic**

(1)

(c) Explain why substance **E** is soft and slippery.

.....

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.....

.....

(2)
(Total 6 marks)

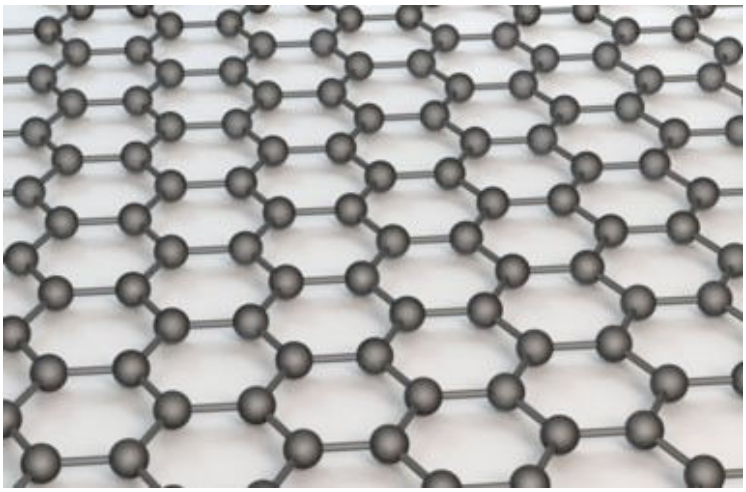
7 Scientists have recently developed a method to produce large sheets of a substance called graphene.
Graphene is made from carbon and is a single layer of graphite just one atom thick.

The properties of graphene include:

- it conducts electricity
- it is transparent since it is only one atom thick
- it is strong and durable.

These properties make it suitable to overlay a monitor screen to make it a touchscreen.

The photograph below shows the structure of graphene.



Photographs supplied by iStockphoto/Thinkstock

Use your knowledge of the bonding in graphite and the photograph of the structure to help you to explain, as fully as you can:

(a) (i) why graphene is strong;

.....

.....

.....

.....

.....

.....

(3)

(ii) why graphene conducts electricity.

.....

.....

.....

.....

.....

(2)

(b) Suggest why a sheet of graphite which has a large number of carbon layers would not be suitable for the touchscreen.

.....

.....

(1)
(Total 6 marks)

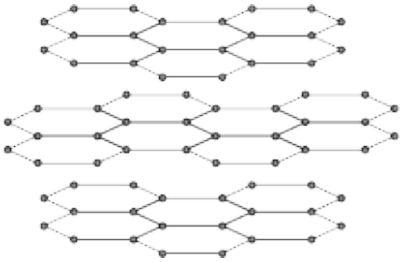
8 Read the information

Graphene

Scientists have made a new substance called graphene.
The bonding and structure of graphene are similar to graphite.

Graphene is made of a single layer of the same atoms as graphite.

Graphene



Graphite

Use the information above and your knowledge of graphite to answer the questions.

(a) This part of the question is about graphene.

Choose the correct answer to complete each sentence.

(i)

ionic	**covalent**	**metallic**

The bonds between the atoms in graphene are .....

(1)

(ii)

chromium	**carbon**	**chlorine**

Graphene is made of ..... atoms.

(1)

(iii)

2	**3**	**4**

In graphene each atom bonds to ..... other atoms.

(1)

(b) This part of the question is about graphite.

Graphite is used in pencils.

Explain why. Use the diagrams to help you.

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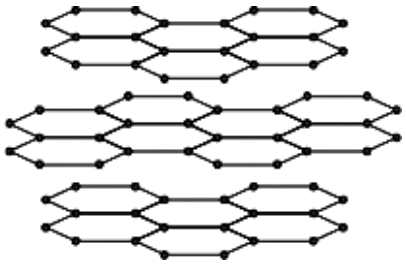
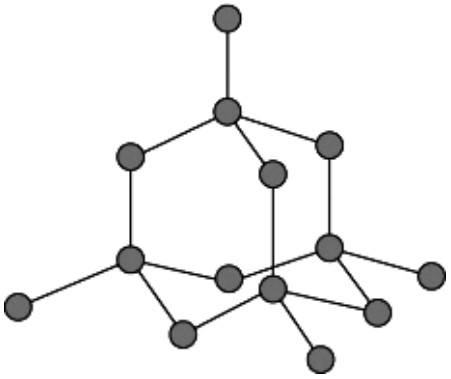
(2)
(Total 5 marks)

9 Graphite and diamond are different forms of the element carbon.
Graphite and diamond have different properties.

The structures of graphite and diamond are shown below.



Graphite



Diamond

(a) Graphite is softer than diamond.

Explain why.

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(4)

(b) Graphite conducts electricity, but diamond does not.

Explain why.

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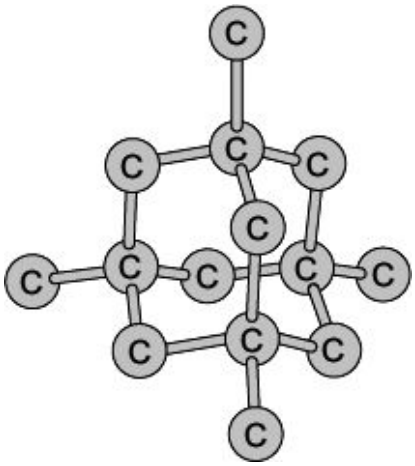
(3)
(Total 7 marks)

10 Liquids containing nanoparticles of diamond are used as abrasives.
Nanoparticles of diamond can be used to grind down surfaces to give them a very smooth polished finish.

Abrasive liquid containing nanoparticles of diamond



Model of part of the diamond structure

(a) Diamond is made of one element.
Draw a ring around the name of this element.

calcium **carbon** **chromium** **cobalt**

(1)

(b) Tick (✓) **two** statements in the table which explain why diamond is hard.

Statement	Tick (✓)
It is made of layers.	
It has weak covalent bonds.	
Each atom is joined to four other atoms.	
It has a giant structure.	
It has strong ionic bonds.	

(2)

(c) Draw a ring around the correct answer to complete the sentence.

Nanoparticles of diamond are

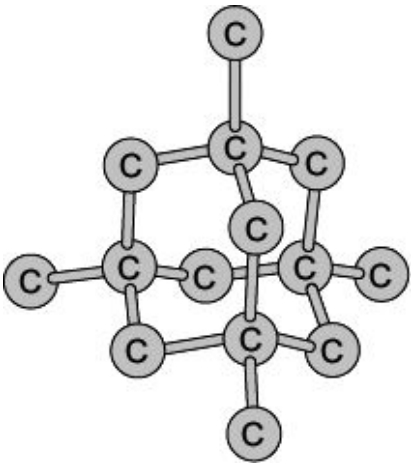
very small.

large.

very large.

(1)
(Total 4 marks)

11 Diamonds are used as abrasives.



Model of part of the diamond structure

Diamonds are very hard.
Explain why.

A good answer will include information on the structure and bonding in diamonds.

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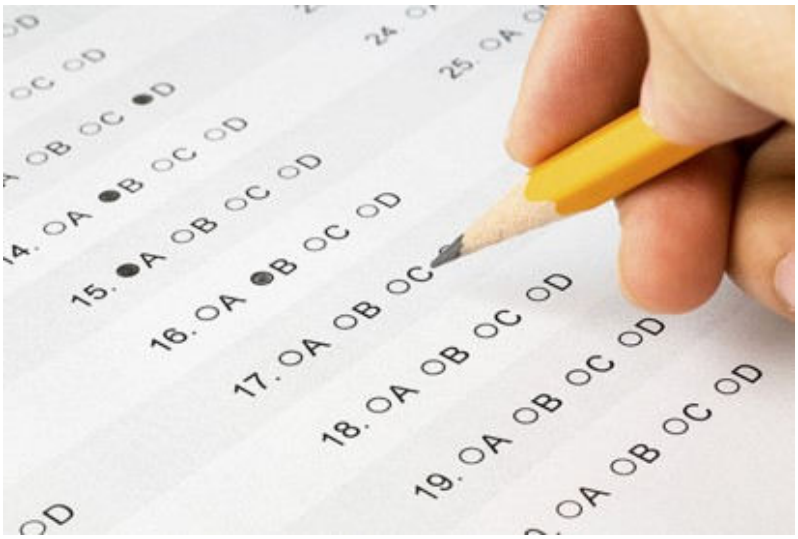
(3)
(Total 3 marks)

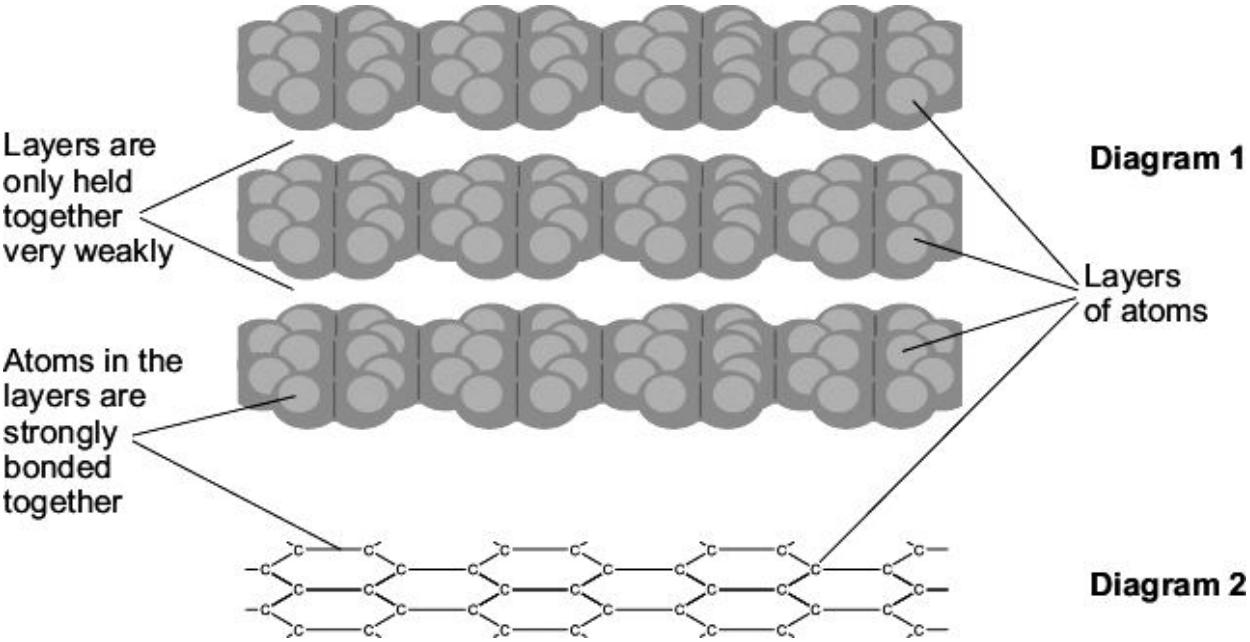
12 The picture shows a student using a pencil to complete a multiple choice answer sheet.



By albertogp123 [CC BY 2.0] , via Flickr

The pencil contains graphite. Graphite rubs off the pencil onto the paper.

Diagrams 1 and **2** show how the atoms are arranged in graphite.



(a) Use **Diagram 2** and your Data Sheet to help you to name the element from which graphite is made.

.....

(1)

(b) Use **Diagram 1** to help you explain why graphite can rub off the pencil onto the paper.

.....

.....

.....

.....

(2)

(c) Draw a ring around the type of bond which holds the atoms together in each layer.

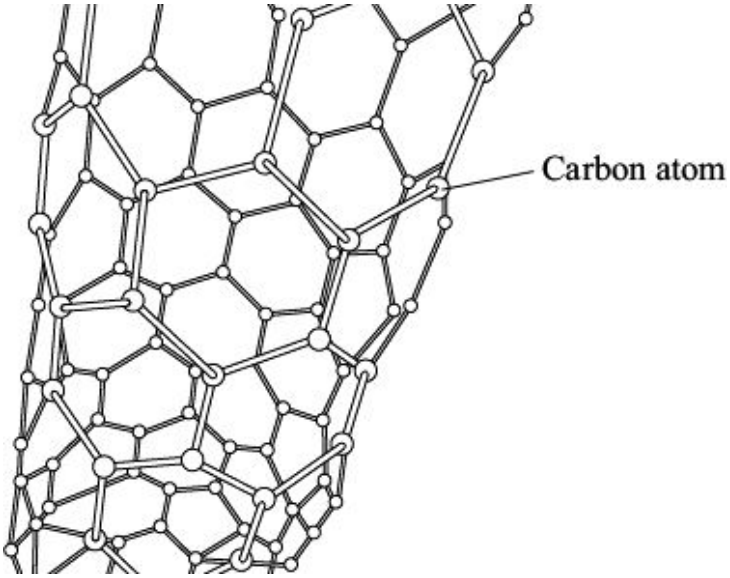
covalent **ionic** **metallic**

(1)
(Total 4 marks)

13 Lightweight handlebars for bicycles are made from materials containing carbon nanotubes.

Carbon nanotubes are lightweight but very strong.

The diagram shows the structure of a carbon nanotube.



(a) What does the term 'nano' tell you about the diameter of carbon nanotubes?

Tick (✓) the correct answer in the table.

Answer	Tick (✓)
The diameter of the tube is very small.	
The diameter of the tube is large.	
The diameter of the tube is very large	

(1)

(b) Look at the diagram and then draw a ring around the correct word to complete each sentence.

(i) Carbon nanotubes are similar to graphite because each carbon atom is joined to

two
three
four

other carbon atoms.

(1)

(ii) The carbon atoms are joined by | covalent / ionic / metallic | bonds.

(1)

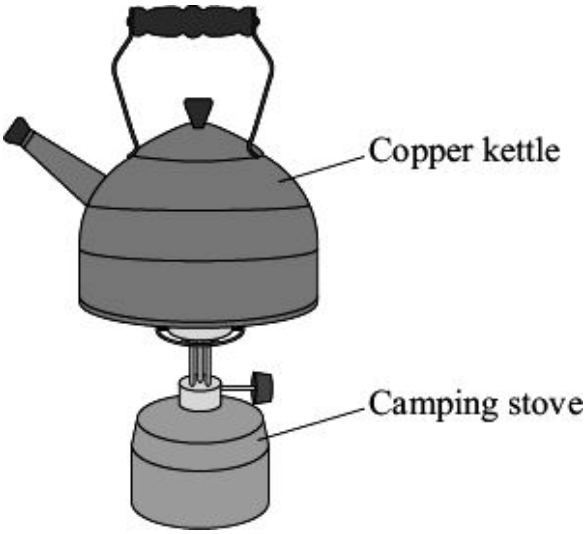
(iii) Carbon nanotubes are very strong because the | atoms / bonds / electrons | are hard to break.

(1)
(Total 4 marks)

14 The picture shows a copper kettle being heated on a camping stove.

Copper is a good material for making a kettle because:

- it has a high melting point
- it is a very good conductor of heat.



(a) Explain why copper, like many other metals, has a high melting point.
You should describe the structure and bonding of a metal in your answer.

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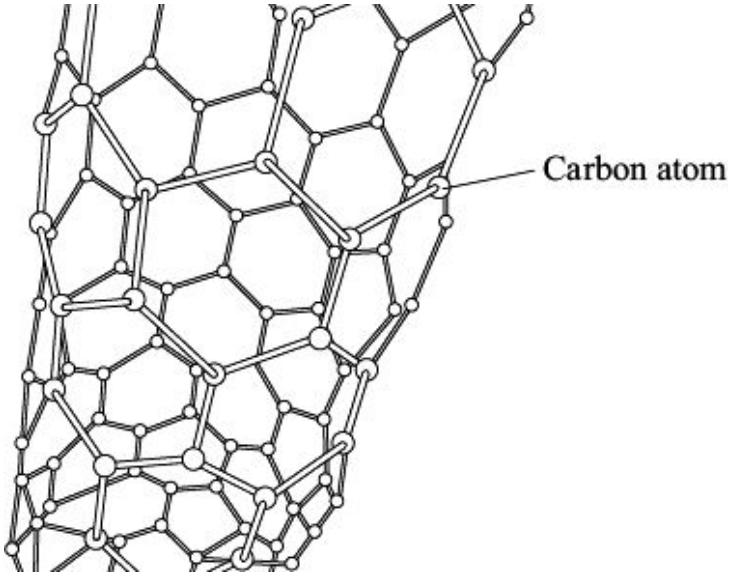
(4)

(b) An aeroplane contains many miles of electrical wiring made from copper. This adds to the mass of the aeroplane.

It has been suggested that the electrical wiring made from copper could be replaced by lighter carbon nanotubes.

The diagram shows the structure of a carbon nanotube.



(i) What does the term 'nano' tell you about the carbon nanotubes?

.....

.....

(1)

(ii) Like graphite, each carbon atom is joined to three other carbon atoms.

Explain why the carbon nanotube can conduct electricity.

.....

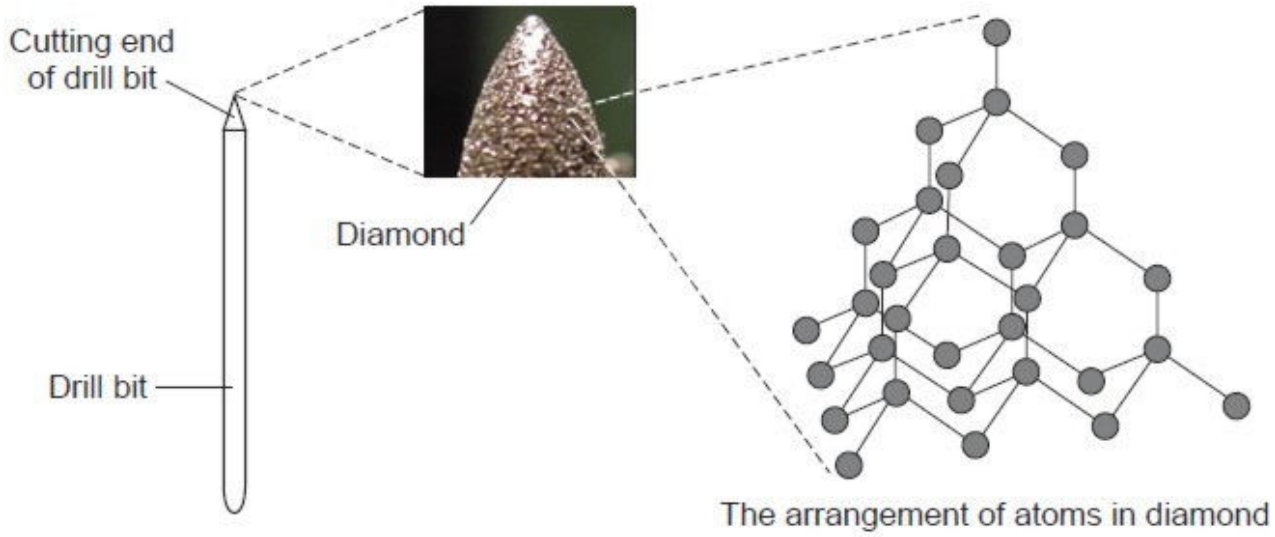
.....

.....

.....

(2)
(Total 7 marks)

15 A drill bit is used to cut holes through materials. The cutting end of this drill bit is covered with very small diamonds.



By Wanderlinse [CC By 2.0], via Flickr

Draw a ring around the correct word in each box.

(a) Diamond is made from [carbon / nitrogen / oxygen] atoms.

(1)

(b) Diamond has a giant structure in which [none / some / all] of the atoms are joined together.

(1)

(c) The atoms in diamond are joined together by [covalent / ionic / metallic] bonds.

(1)

(d) In diamond each atom is joined to [two / three / four] other atoms.

(1)

(e) Diamond is suitable for the cutting end of a drill bit because it is

hard.
shiny.
soft

(1)

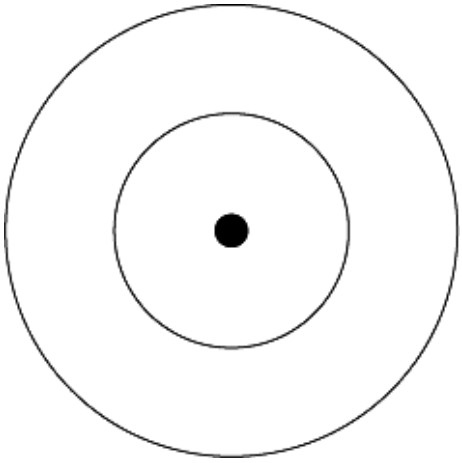
(Total 5 marks)

16 Pure carbon can exist in two forms, diamond and graphite.

(a) Complete the diagram to show the electronic structure of a carbon atom.

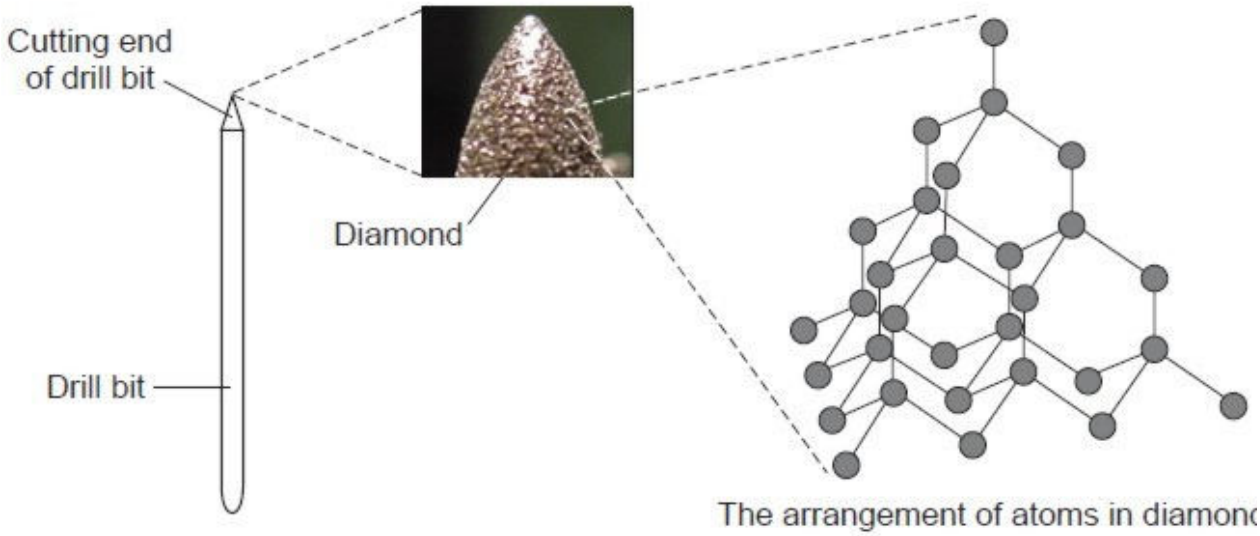
A carbon atom has 6 electrons.

Show the electrons as crosses (x).



(1)

(b) A drill bit is used to cut holes through materials. The cutting end of this drill bit is covered with very small diamonds.



By Wanderlinse [CC By 2.0], via Flickr

(i) What property of diamond makes it suitable for use on the cutting end of a drill bit?

.....

(1)

(ii) Explain, as fully as you can, why diamond has this property. Use your knowledge of the structure and bonding of diamond and the information shown opposite to help you to answer this question.

.....

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(3)

(c) Explain why graphite is a good conductor of electricity and why diamond does **not** conduct electricity.

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.....

(3)
(Total 8 marks)

17 This label was on a container of graphite lubricant.

> ***Super G***
> **Graphite Lubricant**
>
> ***Super G*** forms a thin anti-friction film on metal surfaces. It provides good lubrication when metal parts rub against each other.

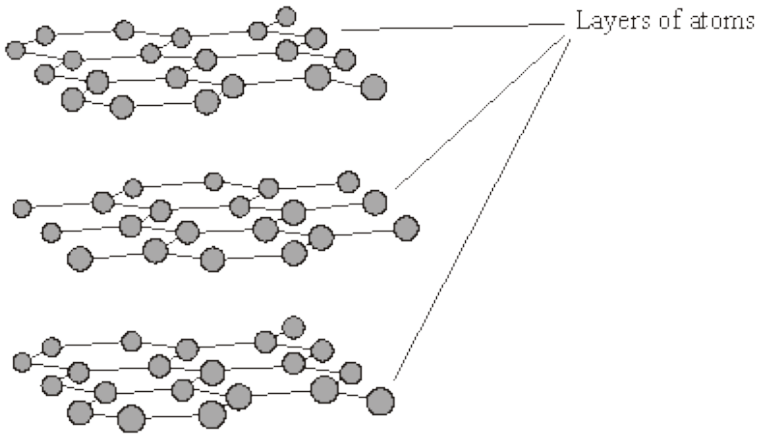
(a) Give **one** reason why a lubricant is used when metal parts rub against each other.

.....

.....

(1)

(b) The diagram shows the arrangement of atoms in graphite.



(i) Draw a ring around the type of atoms in graphite.

aluminium **carbon** **silicon**

(1)

(ii) Graphite is a good lubricant because it is slippery. Use the diagram to explain why graphite is slippery.

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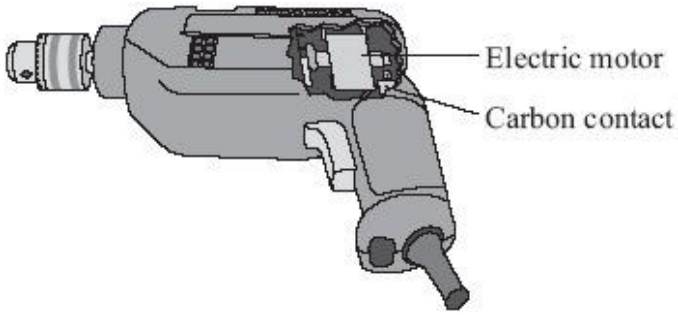
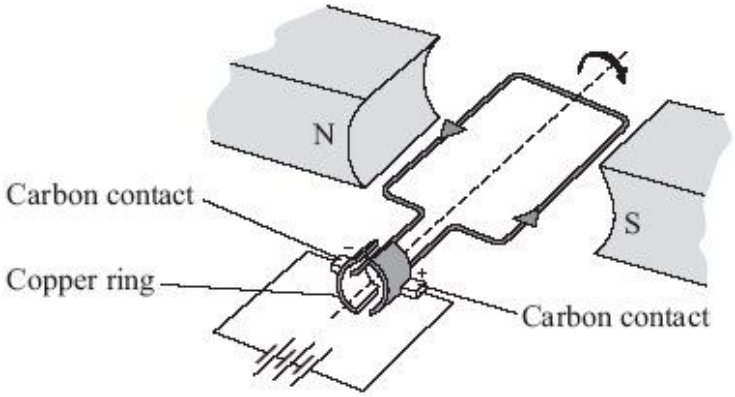
.....

(2)
(Total 4 marks)

18 This drill contains an electric motor.



The diagram below shows the main parts of an electric motor.



The carbon contacts are made of graphite. Springs push the contacts against the copper ring. The carbon contacts conduct electricity to the copper ring. The copper ring rotates rapidly but does not stick or become worn because the graphite is soft and slippery.

(a) Using this information give **two** properties that make graphite suitable for making the carbon contacts.

1 .....

.....

2 .....

.....

(2)

(b) (i) Draw a ring around the correct word in each box to complete the sentence.

Each carbon atom in graphite is joined to

two three four	other carbon atoms by	covalent ionic metallic	bonds.

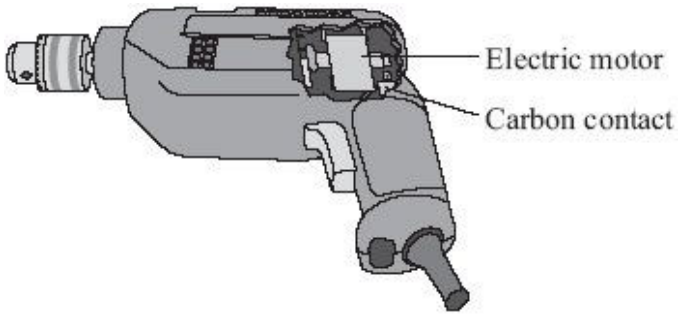
(2)

(ii) Tick (✓) the statement which explains why graphite is soft and slippery.

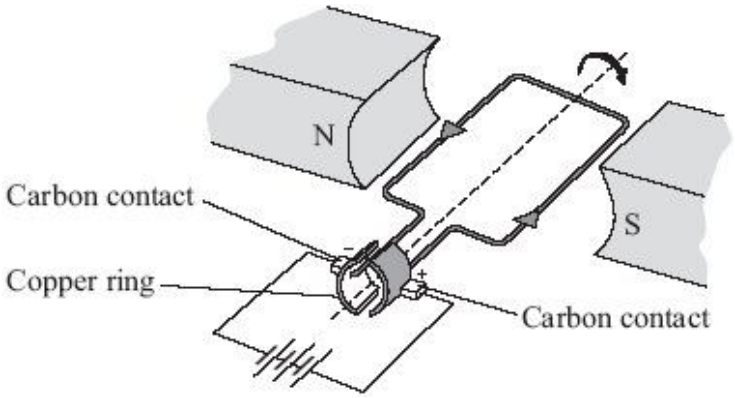
Statement	**Tick (✓)**
It is made of layers of atoms.	
It is made of small molecules.	
It is an ionic compound.	

(1)
(Total 5 marks)

19 This drill contains an electric motor.



The diagram below shows the main parts of an electric motor.



The carbon contacts are made of graphite. Springs push the contacts against the copper ring. The contacts conduct electricity to the copper ring. The copper ring rotates rapidly but does not stick or become worn because the graphite is soft and slippery.

Graphite has properties which are ideal for making the contacts in an electric motor.

Explain, in terms of structure and bonding, why graphite has these properties.

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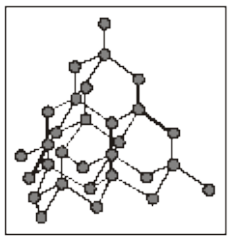
.....

(Total 5 marks)

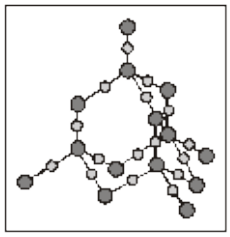
20 This question is about giant structures. Diamond, graphite and silicon dioxide all have giant structures.

(a) The diagrams show the structures of these three substances.

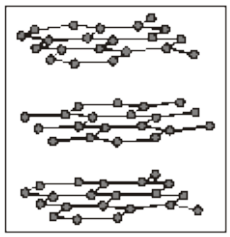
Draw a line from each structure to its name.



Silicon dioxide



Graphite



Diamond

(2)

(b) Complete the sentences using words from the box.

covalent	**four**	**hard**	**ionic**
shiny	**soft**	**three**	**two**

(i) Diamond, graphite and silicon dioxide have high melting points because all the atoms in their structures are joined by strong ..... bonds.

(1)

(ii) In diamond each atom is joined to ..... other atoms.

(1)

(iii) Diamond can be used to make cutting tools because it has a rigid structure which makes it very .....

(1)

(iv) In graphite each atom is joined to ..... other atoms.

(1)

(v) Graphite can be used to make pencils because it has a structure which makes it

.....

(1)

(c) When a diamond is heated to a high temperature and then placed in pure oxygen it burns. Carbon dioxide is the only product.

Name the element in diamond. .....

(1)

(Total 8 marks)

21 The *electrolysis* of sodium chloride solution produces useful substances.

(a) Explain the meaning of *electrolysis*.

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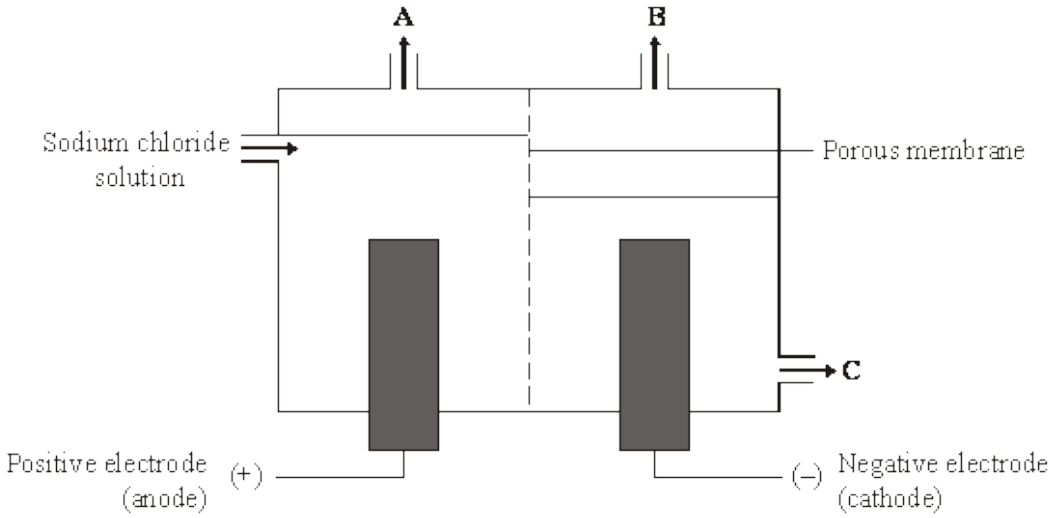
(2)

(b) The diagram shows an apparatus used for the electrolysis of sodium chloride solution.



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The electrolysis produces two gases, chlorine and Gas **A.**

Name Gas **A** .....

(1)

(c) The electrodes used in this process can be made of graphite. Explain why graphite conducts electricity.

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(2)
(Total 5 marks)

22 Silicon is an important element used in the electronics industry.

(a) Silicon can be made by heating a mixture of sand (silicon dioxide) with magnesium powder.

The equation for this reaction is shown below.

$$SiO_2\ (s) + 2Mg\ (s) \rightarrow 2MgO\ (s) + Si\ (s)$$

Calculate the mass of silicon dioxide needed to make 1 g of silicon.

Relative atomic masses: O = 16; Si = 28

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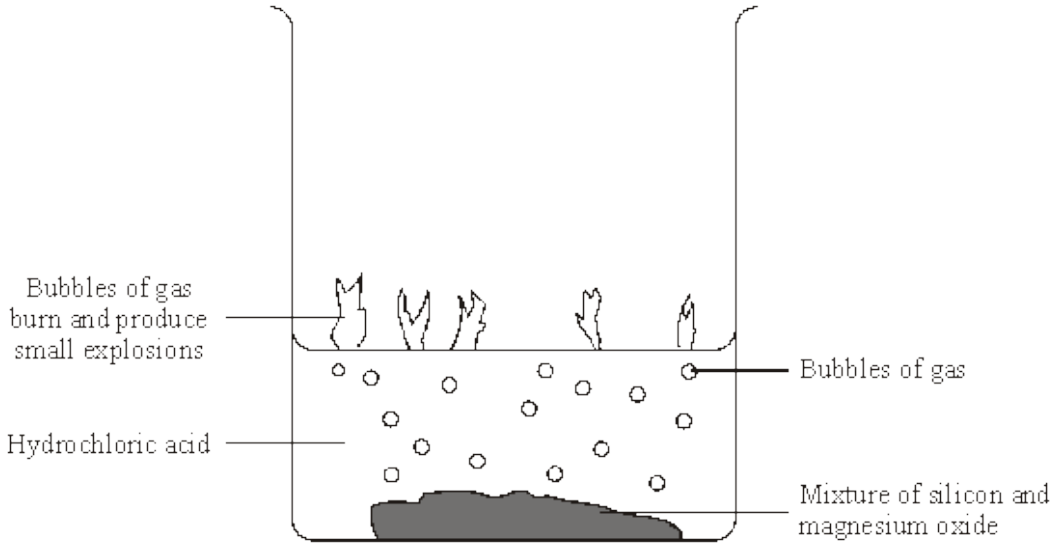
Mass = ...g

(3)

(b) The resulting mixture of magnesium oxide and silicon is added to a beaker containing hydrochloric acid. The silicon is then filtered from the solution.



(i) The magnesium oxide reacts with the hydrochloric acid and forms magnesium chloride ($MgCl_2$) solution and water.

magnesium oxide + hydrochloric acid → magnesium chloride solution + water

Write a balanced symbol equation for this reaction, including state symbols.

.....

(2)

(ii) The gases produced are a mixture of several silicon hydrides.

One of the gases produced in the reaction is the silicon hydride with the formula SiH_4. The structure of this molecule is similar to methane, CH_4.

Draw a diagram to show the bonding in a molecule of SiH_4. Represent the electrons as dots and crosses and only show the outer shell (energy level) electrons.

(1)

(iii) A sample of a different silicon hydride was found to contain 1.4 g of silicon and 0.15 g of hydrogen.

Calculate the formula of this silicon hydride. You must show all your working to gain full marks.

Relative atomic masses: H = 1; Si = 28

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(4)

(iv) The silicon hydrides react immediately they come into contact with oxygen in the air. They burst into flames with a small explosion and give out energy.

Which letter, **A** to **H**, best describes this reaction?

Energy involved in breaking and forming bonds	Activation energy	Rate of reaction	Letter
The energy released from forming new bonds is greater than the energy needed to break existing bonds	high	fast	**A**
		slow	**B**
	low	fast	**C**
		slow	**D**
The energy needed to break existing bonds is greater than the energy released from forming new bonds	high	fast	**E**
		slow	**F**
	low	fast	**G**
		slow	**H**

Letter .....

(1)

(c) The structure of silicon is similar to the structure of diamond.

Describe the structure of silicon and explain why it has a high melting point. You may draw a diagram if this helps.

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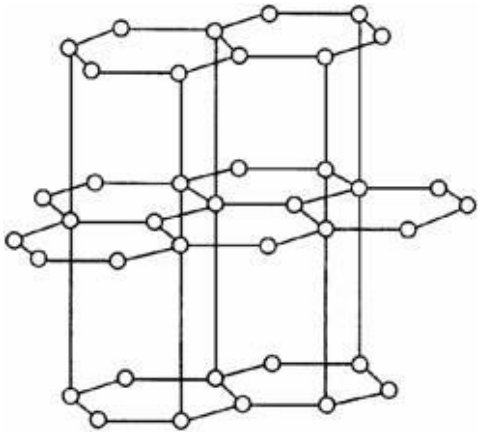
(4)

(Total 15 marks)

23 The diagram represents the structure of graphite.



Use your knowledge and understanding of the structure of graphite to explain why graphite can be used:

(a) in the 'leads' of pencils;

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(b) as an electrical conductor.

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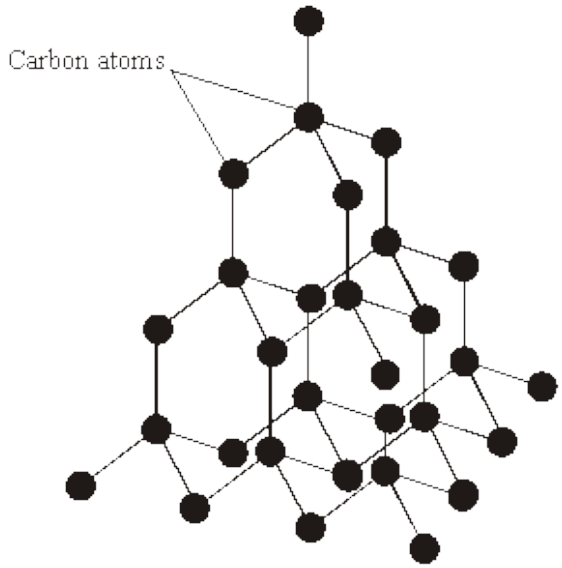
(Total 5 marks)

24 The diagram shows the structure of diamond.



(a) *To gain full marks for this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

Explain, as fully as you can, why diamond has a high melting point.

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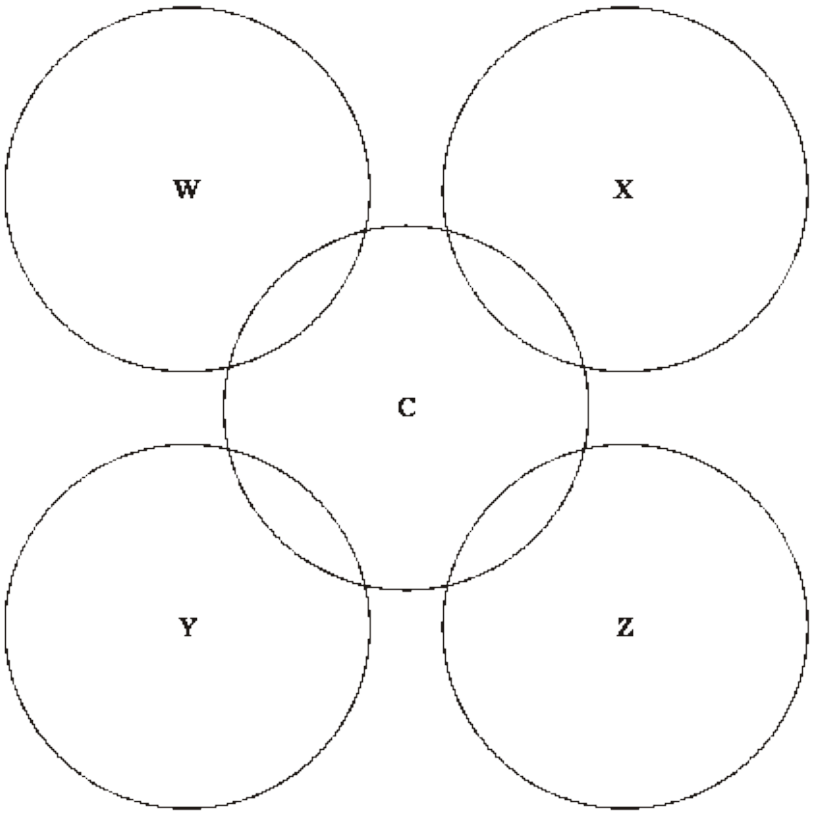
(3)

(b) The diagram below shows the outer electron shells of five carbon atoms in the giant lattice of diamond.

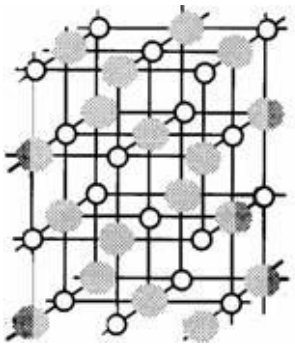
Carbon atom **C** forms bonds with each of the carbon atoms **W**, **X**, **Y** and **Z**.

Draw the positions of all the electrons in the outer shells of each of carbon atoms **C**, **W**, **X**, **Y** and **Z**.



(3)
(Total 6 marks)

25 The diagrams show the giant structures of sodium chloride and diamond.



sodium chloride (melting point 801°C)

diamond (melting point 4800°C)

(a) The equation shows how sodium choride could be formed.

Balance the equation.

$$Na + Cl_2 \rightarrow Na\,Cl$$

(1)

(b) By reference to the detailed structure of sodium chloride explain fully why:

(i) sodium chloride has a quite high melting point,

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(1)

(ii) solid sodium chloride melts when it is heated strongly,

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(2)

(iii) molten sodium chloride will conduct electricity.

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(1)

(c) By reference to the detailed structure of diamond, explain why the melting point of diamond, is higher than that of sodium chloride.

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(2)

(Total 7 marks)

26 (a) Copper is a metal.
Explain how it conducts electricity.

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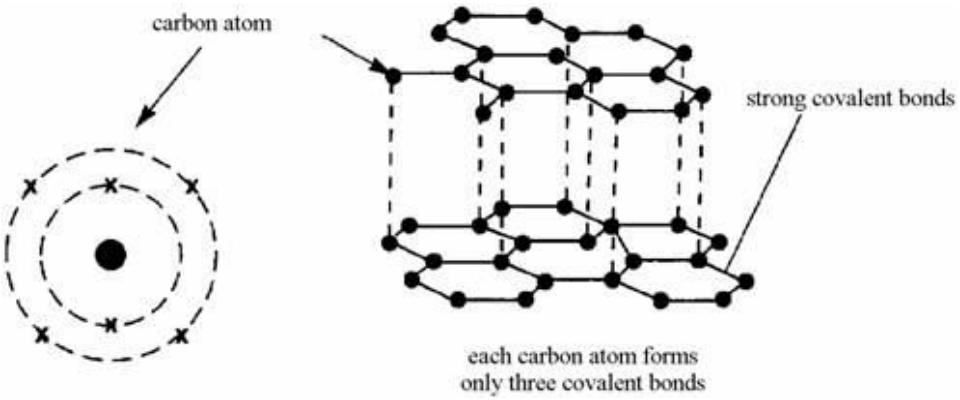
(2)

(b) Graphite is a non-metal.



Use the information to explain why graphite conducts electricity.

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(3)
(Total 5 marks)