

Bonding Part 3

Q1.

Calamine lotion is used to treat itching. The main ingredients are two metal oxides.



- (a) One of the metal oxides has a relative formula mass (M_r) of 81.

The formula of this metal oxide is MO .
(M is **not** the correct symbol for the metal.)

The relative atomic mass (A_r) of oxygen is 16.

- (i) Calculate the relative atomic mass (A_r) of metal M .

Relative atomic mass (A_r) = _____

(2)

- (ii) Use your answer to part (a)(i) and the periodic table on the Data Sheet to name metal M .

The name of metal M is _____ .

(1)

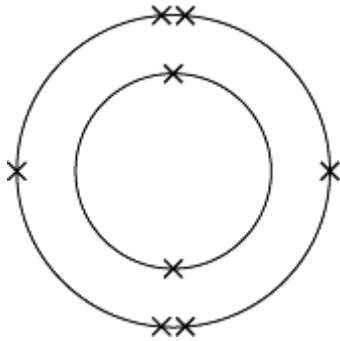
- (b) The other metal oxide is iron(III) oxide.

This contains iron(III) ions (Fe^{3+}) and oxide ions (O^{2-}).

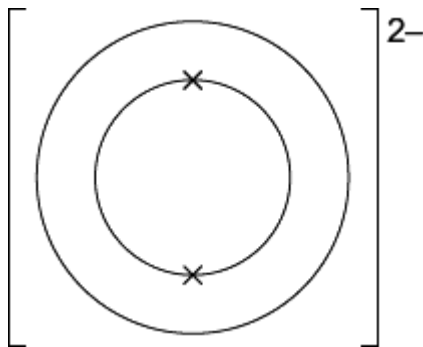
- (i) Explain in terms of electrons how an iron atom (Fe) can change into an iron(III) ion (Fe^{3+}).

(2)

(ii) The diagram below represents the electronic structure of an oxygen atom (O).



Complete the diagram below to show the electronic structure of an oxide ion (O^{2-}).

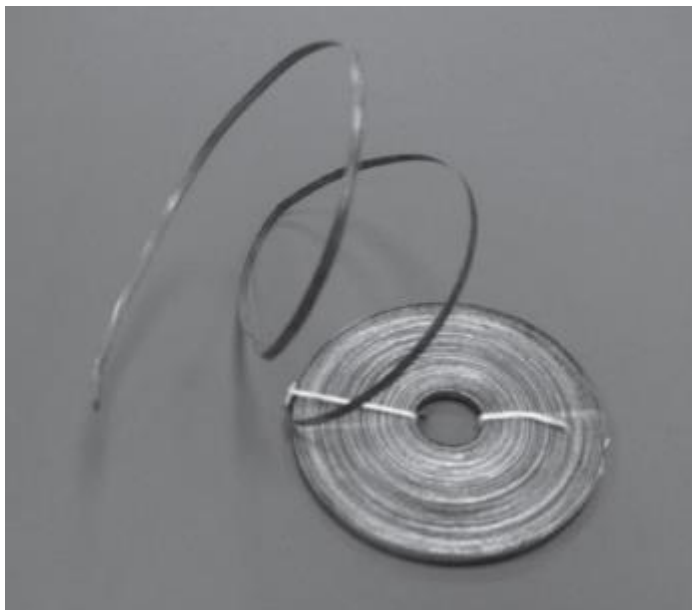


(1)

(Total 6 marks)

Q2.

(a) Magnesium metal is shaped to make magnesium ribbon.

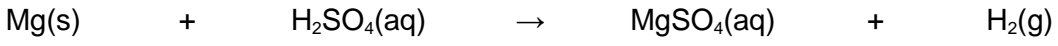


Explain why metals can be shaped.

(2)

(b) Magnesium sulfate is a salt of magnesium.

It can be prepared by the reaction of magnesium metal with an acid. The equation for the reaction of magnesium with this acid is:



(i) Name the acid used to make magnesium sulfate.

_____ acid

(1)

(ii) Use the equation to help you to describe what you would **observe** when magnesium reacts with the acid.

(2)

(iii) The magnesium sulfate is in solution.

How could you obtain solid magnesium sulfate from this solution?

(1)

(Total 6 marks)

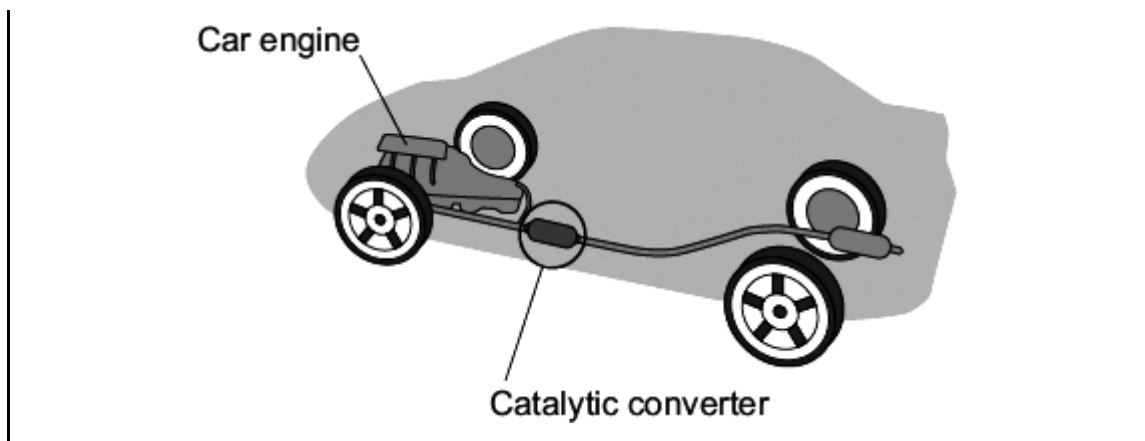
Q3.

Read the information about car engines.

Burning petrol in air is an *exothermic* reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

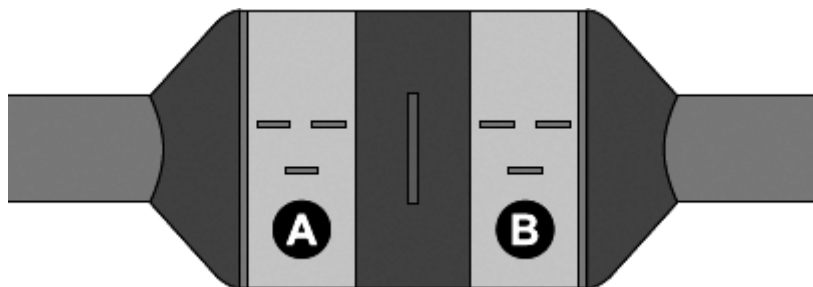
A catalytic converter stops these harmful substances being released into the air.



- (a) The reaction is *exothermic*. What is the meaning of *exothermic*?

(1)

- (b) The catalytic converter has two parts shown as **A** and **B** in the diagram.



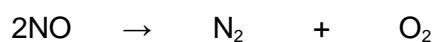
Part **A** contains a catalyst made from platinum and rhodium.

Part **B** contains a catalyst made from platinum and palladium.

- (i) Why are catalysts used in chemical reactions?

(1)

- (ii) One reaction in part **A** is shown by this equation.

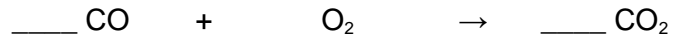


Suggest why this reaction helps the environment.

(1)

- (iii) The equation for one of the reactions in part **B** is shown below.

Balance this equation.



(1)

- (iv) The catalytic converter works for many years without replacing the catalyst.

Explain why the catalyst does not need to be replaced.

(1)

- (v) Suggest why different catalysts are used in parts **A** and **B**.

(1)

- (c) Modern catalytic converters contain nanosized particles of catalyst. Using nanosized particles reduces the cost of the catalytic converter.

Suggest and explain why the use of nanosized catalyst particles reduces the cost of the catalytic converter.

Your answer should include information about the size and surface area of the particles.

(3)

(Total 9 marks)

Q4.

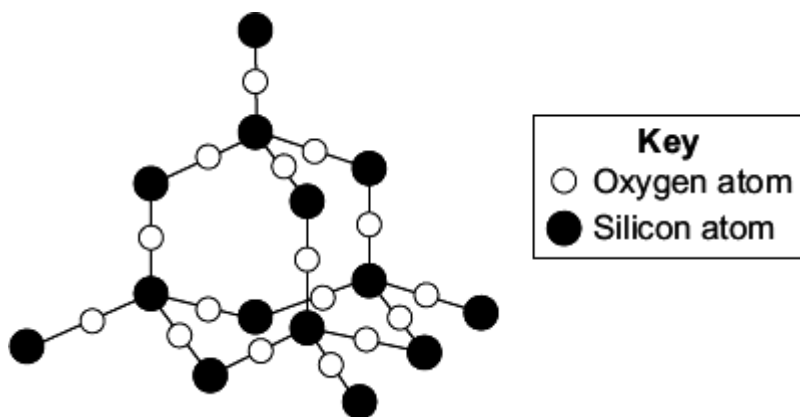
Welding blankets are placed under metals being welded. They protect the area under the welding.



Welding blanket

Some welding blankets are made from silicon dioxide which does not melt when hit by sparks or molten metal.

The diagram shows a small part of the structure of silicon dioxide.

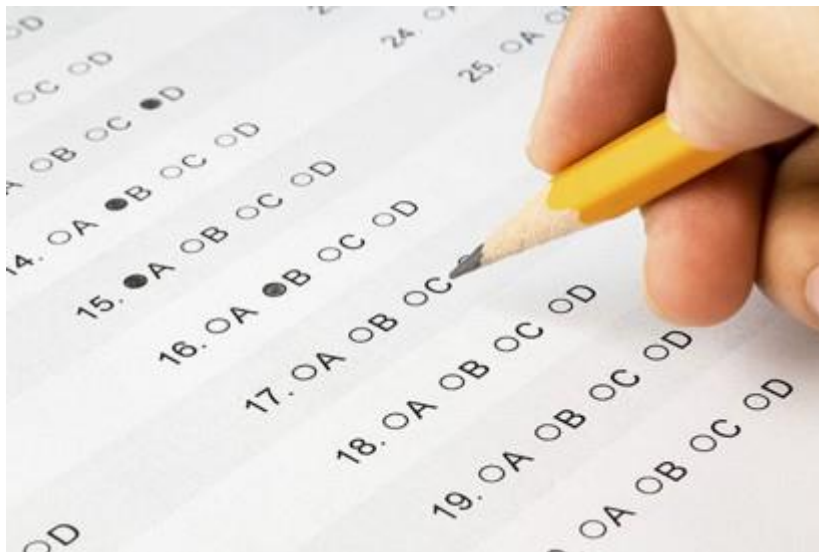


Describe the structure and bonding in silicon dioxide **and** explain why it is a suitable material for making welding blankets.

(3)
(Total 3 marks)

Q5.

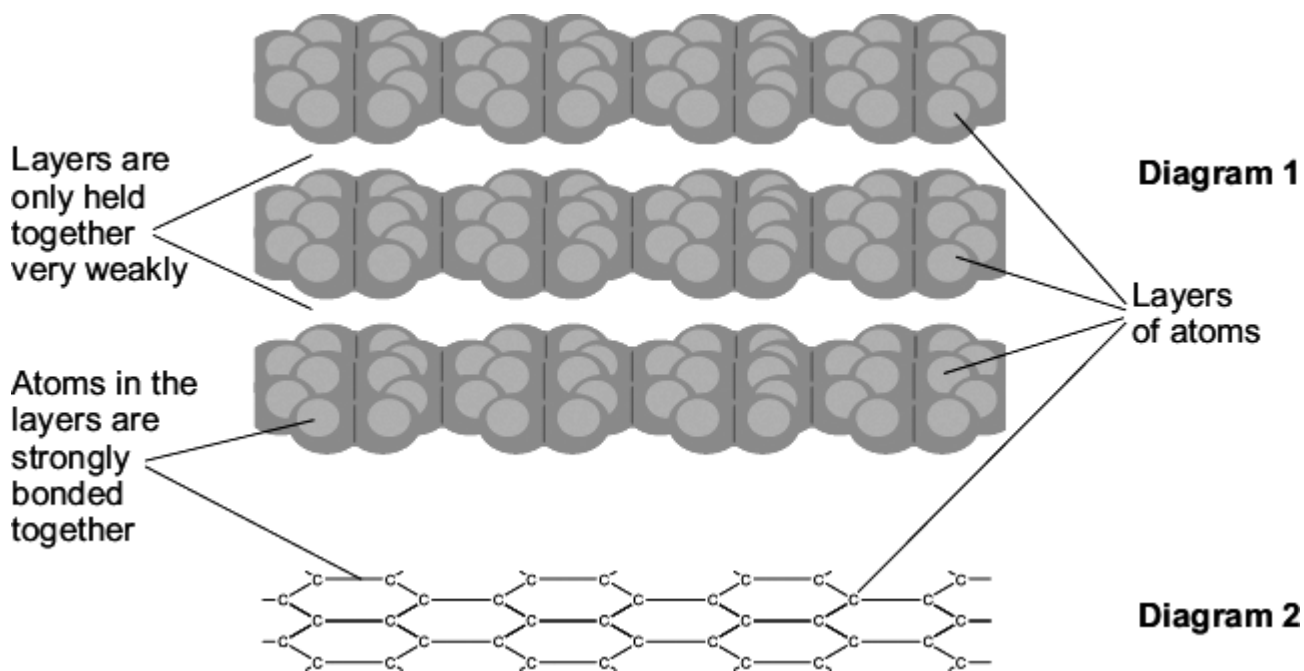
The picture shows a student using a pencil to complete a multiple choice answer sheet.



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)

Q6.

Read the information in the box.

Flash powder is used to produce special effects at pop concerts.



Flash powder contains aluminium. The powder burns with a bright white flame and gives out lots of heat and light. It also produces white smoke.

The flash powder is placed on stage in a special container. At the bottom of the container there is a thin piece of wire. When the flash is needed, electricity is passed through the wire. The wire gets hot and starts the aluminium burning.

By russellsmith [CC BY 2.0], via Flickr

- (a) When aluminium burns the reaction is exothermic.

Give **one** piece of information from the box which shows that the reaction is exothermic.

(1)

- (b) The hot wire provides energy to start the aluminium burning.

Draw a ring around the name given to the energy needed to start a chemical reaction.

activation energy

potential energy

solar energy

(1)

(c) When aluminium burns it reacts with oxygen to make aluminium oxide.

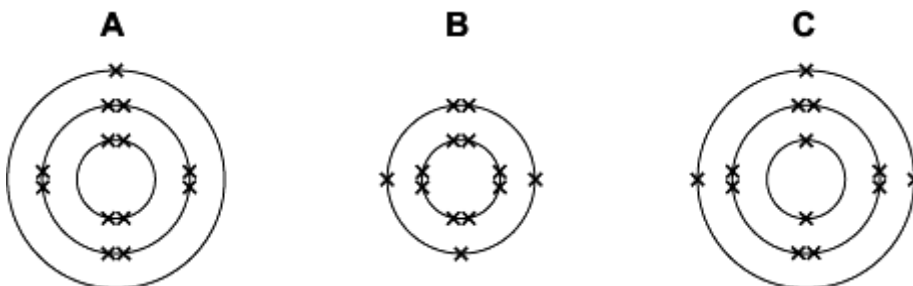
Complete the word equation for this reaction.

aluminium + _____ → _____

(1)

(d) An aluminium atom has 13 electrons.

Which diagram, **A**, **B** or **C**, represents the electronic structure of an aluminium atom?



The electronic structure of an aluminium atom is diagram



(1)

(e) The white smoke produced is aluminium oxide.

Aluminium oxide contains aluminium ions (Al^{3+}) and oxide ions (O^{2-}).

Draw a ring around the correct word in each box to complete each sentence.

(i) Electrons have

a negative

no

a positive

charge.

(1)

(ii) When an aluminium atom (Al) turns into an aluminium ion (Al^{3+})

gains

it

loses

shares

three electrons.

(1)

(iii) When an oxygen atom (O) turns into an oxide ion (O^{2-})

it

gains
loses
shares

one
two
three

 electrons.

(2)
(Total 8 marks)

Q7.

Read the article and then answer the questions.

TOXIC SOCKS?

Silver nanoparticles are added to the fibres used to make some socks. Silver has the special property that it can kill bacteria. As a result there are no unpleasant smells when wearing these socks.



Some scientists are concerned about the use of silver nanoparticles in socks.

The silver can be released from the socks when they are washed. This silver may end up in rivers. Silver in rivers may kill fish.

Scientists found that some makes of socks release the silver more easily than others. Socks in which the silver nanoparticles are trapped in the fibres released very little silver when washed.

By tfkrawksmysocks [CC BY-SA 2.0], via Flickr

(a) Suggest why silver stops unpleasant smells when wearing the socks.

(1)

(b) How is the size of silver nanoparticles different from normal sized silver particles?

(1)

- (c) The silver nanoparticles are more effective at preventing unpleasant smells than normal sized silver particles.

Suggest why.

(1)

- (d) The silver nanoparticles should be trapped in the sock fibres.

Use the information in the article to explain why.

(2)

(Total 5 marks)

Q8.

Read the information in the box.

Flash powder is used to produce special effects at pop concerts.



Flash powder contains aluminium. The powder burns with a bright white flame and gives out lots of heat and light. It also produces white smoke.

The flash powder is placed on stage in a special container. At the bottom of the container there is a thin piece of wire. When the flash is needed, electricity is passed through the wire. The wire gets hot and starts the aluminium burning.

- (a) When aluminium burns the reaction is *exothermic*.

What is the meaning of *exothermic*?

(1)

- (b) The hot wire provides energy to start the aluminium burning.

What is the name given to the heat energy needed to start a chemical reaction?

_____ energy

(1)

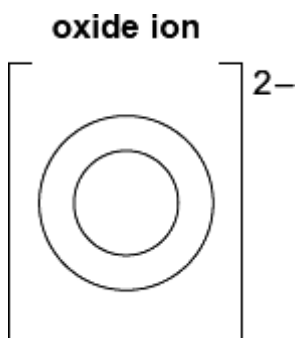
- (c) The white smoke produced is aluminium oxide.

Aluminium oxide contains aluminium ions (Al^{3+}) and oxide ions (O^{2-}).

- (i) Complete the diagram to show the electronic structure of an oxide ion.

The atomic number of oxygen = 8

Use crosses (x) to represent the electrons.



(1)

- (ii) The bonding in aluminium oxide is ionic.

What causes the aluminium ions and oxide ions to be held together strongly?

(1)

(Total 4 marks)

Q9.

Lead compounds have been used for thousands of years as colours in paint.



Johannes Vermeer [Public domain], via Wikimedia Commons

- (a) A sample of a red oxide used in paint was found to contain 6.21 g of lead and 0.64 g of oxygen.

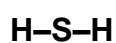
Calculate the empirical (simplest) formula of this compound.

You **must** show all your working to gain full marks.

Relative atomic masses: O = 16; Pb = 207.

(4)

- (b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.
- (i) Hydrogen sulfide has the formula H₂S. The bonding in a molecule of hydrogen sulfide can be represented as:

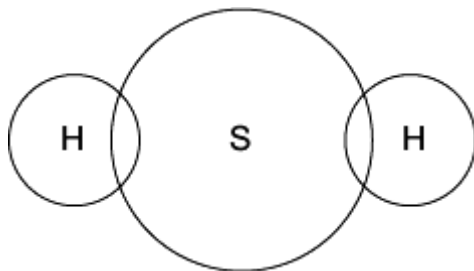


Complete the diagram below to show the arrangement of the outer electrons of the hydrogen and sulfur atoms in hydrogen sulfide.

Use dots (•) and crosses (x) to represent the electrons.

You need only show the outer shell electrons.

(Atomic numbers: H = 1; S = 16.)



(1)

- (ii) Hydrogen sulfide has a low boiling point.

Explain why.

(2)

- (iii) Lead white is also used in paint. The white colour slowly darkens when lead sulfide is produced.

The painting can be restored with hydrogen peroxide. This converts the black lead sulfide into white lead sulfate.

Balance the equation for the reaction between lead sulfide and hydrogen peroxide (H_2O_2).



(1)

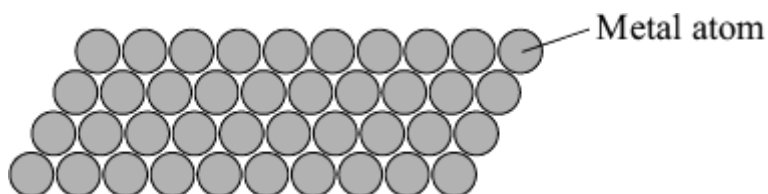
(Total 8 marks)

Q10.

Metal is bent and shaped to make a car body.



The diagram below represents how atoms are arranged in a metal.



Which **two** statements in the table best explain why the metal can be bent and shaped?

Tick (✓) the **two** statements.

Statement	Tick (✓)
The atoms are in layers.	
The metal is shiny.	
The atoms can slide over each other.	
All the atoms are linked by strong covalent bonds.	

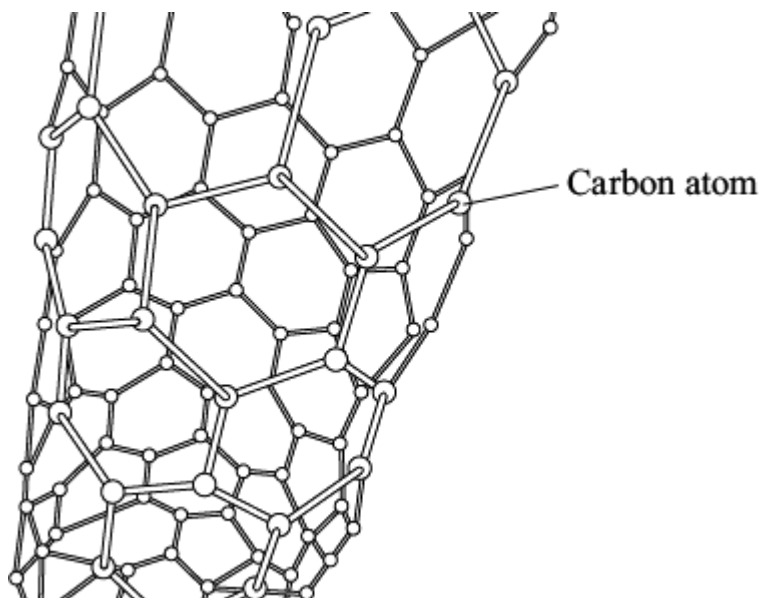
(2)
(Total 2 marks)

Q11.

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

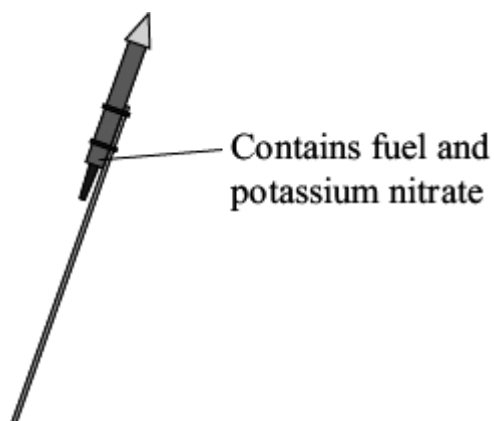
are hard to break.

(1)

(Total 4 marks)

Q12.

Firework rockets contain fuel and potassium nitrate.



The potassium nitrate provides oxygen for the fuel to react.

(a) The table shows how a student worked out the relative formula mass (M_r) of potassium nitrate.

Some of the numbers are missing.

Relative atomic masses (A_r): N = 14; O = 16; K = 39.

Name of atom (symbol)	Number of atoms	A_r	Mass
potassium (K)	1	39	39
nitrogen (N)	1	14	14
oxygen (O)		16	
The M_r of potassium nitrate =			101

- (i) The mass of oxygen is not shown in the table.

Draw a ring around the correct mass of oxygen.

16

32

48

(1)

- (ii) Draw a ring around the number of oxygen atoms in the formula of potassium nitrate.

1

2

3

(1)

- (b) When the fuel reacts with the oxygen an *exothermic* reaction takes place.

What does *exothermic* mean?

(2)

- (c) The fuel contains carbon. Carbon reacts with oxygen to make carbon dioxide.

Which **two** statements in the table explain why carbon dioxide is a gas at room temperature?

Tick (✓) the **two** statements.

Statement	Tick (✓)
It has a giant structure	
It has a low boiling point.	

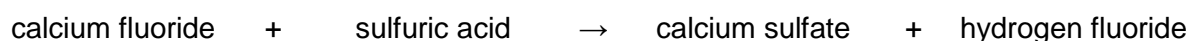
It is made of small molecules.	
It is made of ions.	

(2)
(Total 6 marks)

Q13.

Hydrogen fluoride is used to make hydrofluoric acid.

- (a) A company makes hydrogen fluoride by reacting solid calcium fluoride with sulfuric acid. The reaction takes place in a rotating kiln.



The company want this reaction to take place quickly.

- (i) Rotating the kiln makes the reaction take place faster.

Suggest why.

(1)

- (ii) Draw a ring around the correct word in each box.

To make the reaction take place **faster**:

the temperature should be

higher
lower

 so that the particles have

less
more

 energy

the solid calcium fluoride should be

powder
lumps

 to give a

small
big

 surface area

the sulfuric acid solution should be

dilute
concentrated

 to give

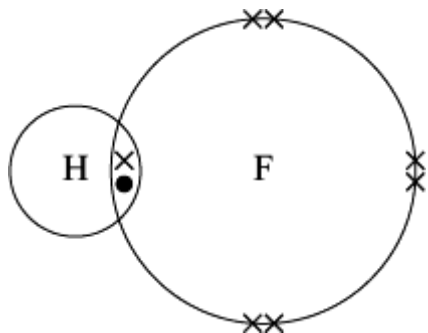
less
more

 collisions

between the particles each second.

(3)

- (b) The diagram represents a molecule of hydrogen fluoride.



The hydrogen and fluorine atoms are joined by a covalent bond.

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

electrons	neutrons	protons
------------------	-----------------	----------------

In a covalent bond the atoms share _____.

(1)

- (c) Hydrogen fluoride is dissolved in water to make an acidic solution of hydrofluoric acid.

Draw a ring around the symbol of the ion that makes the solution acidic.



(1)

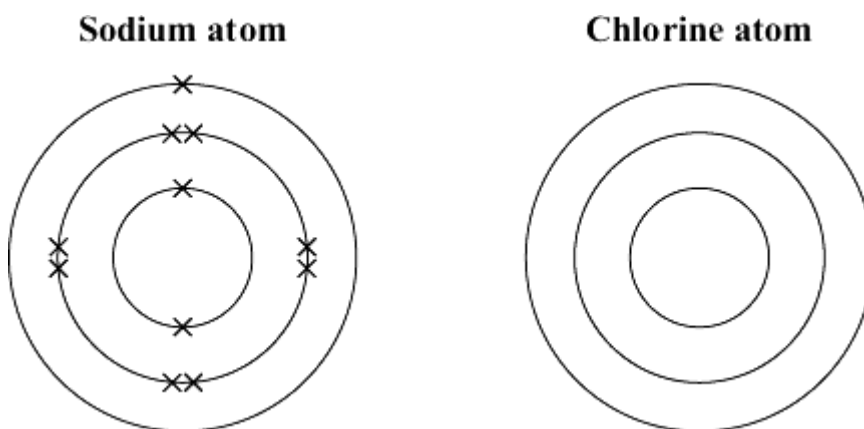
(Total 6 marks)

Q14.

Sodium chloride is a raw material.

- (a) The electronic structure of a sodium atom is shown below.

Complete the diagram for the electronic structure of a chlorine atom. A chlorine atom has 17 electrons.



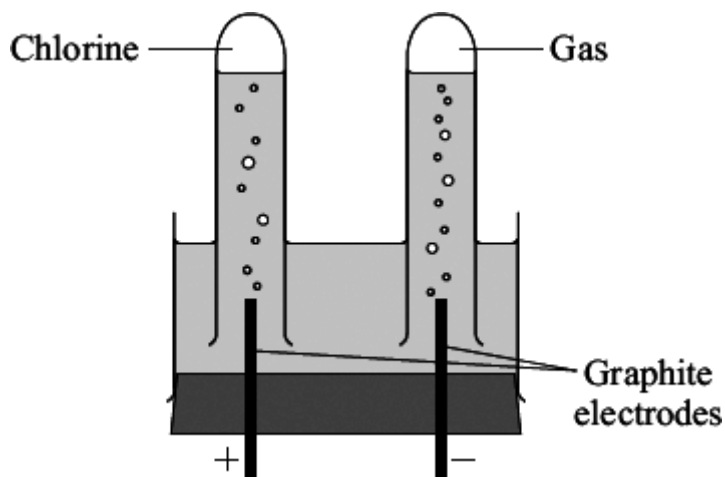
(1)

- (b) When sodium and chlorine react to form sodium chloride they form sodium ions (Na^+) and chloride ions (Cl^-).

How does a sodium atom change into a sodium ion?

(2)

- (c) The diagram shows apparatus used in a school laboratory for the electrolysis of sodium chloride solution.



The solution contains sodium ions (Na^+), chloride ions (Cl^-), hydrogen ions (H^+) and hydroxide ions (OH^-).

- (i) Why do chloride ions move to the positive electrode?

(1)

- (ii) Name the gas formed at the negative electrode.

(1)

- (d) Chlorine and chlorine compounds are used to bleach wood pulp that is used to make paper.

The article below is from a newspaper.

Local people have been protesting outside a paper factory. They say:
'We want the company to stop using chlorine compounds. Chlorine compounds release poisons into the environment. The company should use safer compounds.'

The company replied:
'Chlorine has been used safely for many years to treat drinking water. Only tiny amounts of chlorine are released, which cause no harm. Using other compounds will be more expensive and may put us out of business.'

- (i) Why are some local people worried about the use of chlorine compounds?

_____ (1)

- (ii) Why might other local people want the company to continue to use chlorine compounds?

_____ (1)

- (iii) It is decided to have an inquiry.
Why should this be done by independent scientists?

_____ (1)

(Total 8 marks)

Q15.

- (a) The table gives information about two isotopes of hydrogen, hydrogen-1 and hydrogen-2.

	Hydrogen-1	Hydrogen-2
Atomic number	1	1
Mass number	1	2

An atom of hydrogen-1 is represented as: ${}^1_1\text{H}$

Show how an atom of hydrogen-2 is represented.

(1)

- (b) (i) Calculate the relative formula mass (M_r) of water, H_2O

Relative atomic masses: H = 1; O = 16.

Relative formula mass (M_r) = _____

(1)

- (ii) Simple molecules like water have low boiling points.

Explain why, in terms of molecules.

(2)

- (c) Molecules of heavy water contain two atoms of hydrogen-2 instead of two atoms of hydrogen-1.

Explain why a molecule of heavy water has more mass than a normal water molecule.

You should refer to the particles in the nucleus of the two different hydrogen atoms in your answer.

(2)

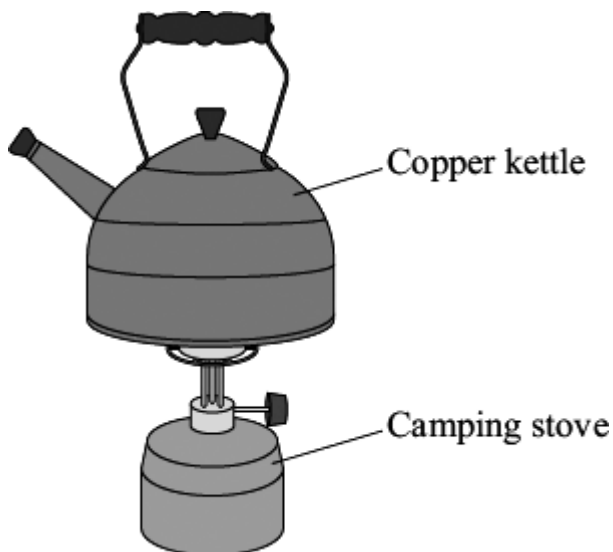
(Total 6 marks)

Q16.

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.



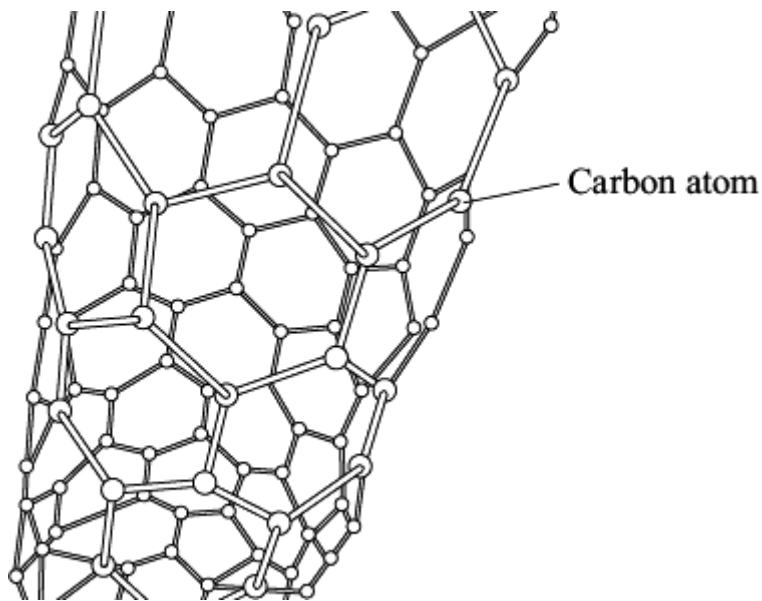
- (a) Explain why copper, like many other metals, has a high melting point. You should describe the structure and bonding of a metal in your answer.

(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?

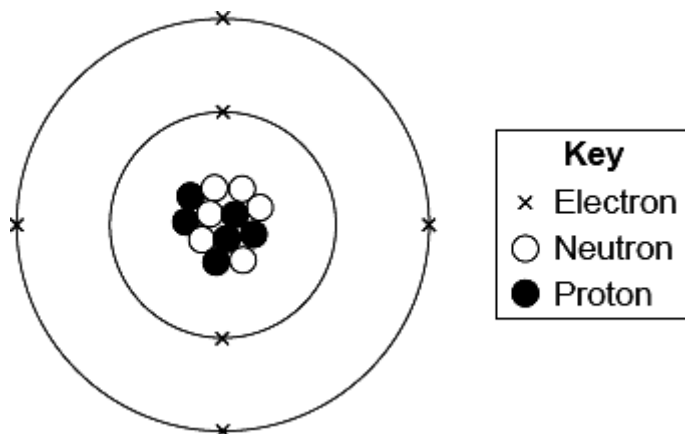
(1)

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

Explain why the carbon nanotube can conduct electricity.

Q17.

The diagram represents a carbon atom.



(a) Use words from the box to answer the questions.

electron	neutron	nucleus	proton
----------	---------	---------	--------

(i) What is the name of the central part of the atom?

_____ (1)

(ii) What is the name of the particle with no charge?

_____ (1)

(iii) What is the name of the particle with a negative charge?

_____ (1)

(b) Use the diagram above to help you to answer these questions.

(i) Draw a ring around the atomic (proton) number of this carbon atom.

6 12 18

(1)

(ii) Draw a ring around the mass number of this carbon atom.

6 12 18

(1)

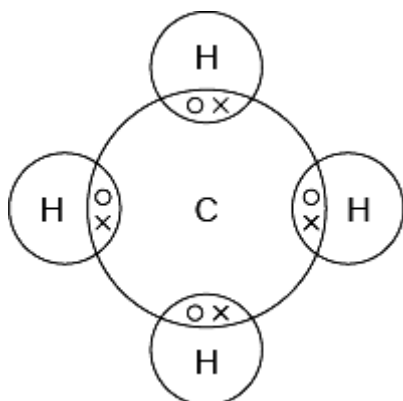
(c) A different carbon atom has 6 protons and 8 neutrons.

Draw a ring around the symbol that represents this atom.



(1)

(d) The diagram shows the bonding in a methane molecule.



(i) Draw a ring around the chemical formula of a methane molecule.



(1)

(ii) Draw a ring around the word that describes methane.

compound

element

mixture

(1)

(iii) Draw a ring around the type of bonding in a methane molecule.

covalent

ionic

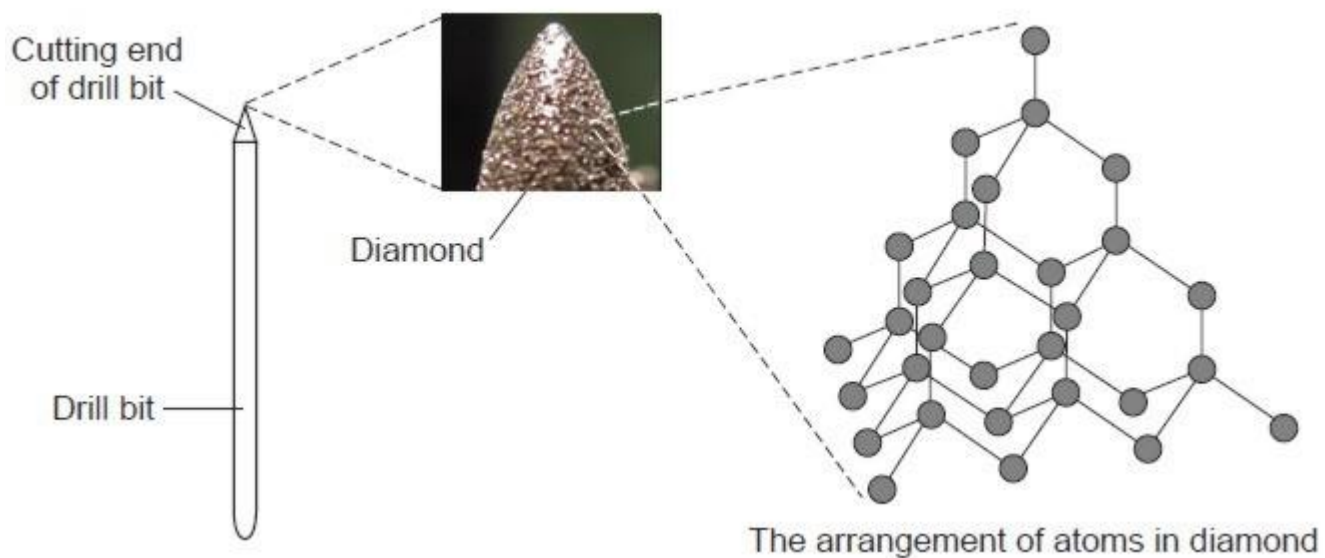
metallic

(1)

(Total 9 marks)

Q18.

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



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)

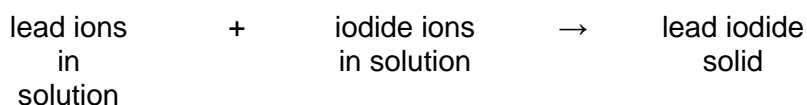
(Total 5 marks)

Q19.

This question is about lead iodide and magnesium iodide.

(a) Lead iodide can be made by mixing a solution containing lead ions with a solution containing iodide ions.

Lead iodide is formed as a solid.



(i) Draw a ring around the name given to this type of reaction.

electrolysis

neutralisation

precipitation

(1)

(ii) Tick (✓) the method used to separate solid lead iodide from the solution.

Method	Tick (✓)
distillation	
evaporation	
filtration	

(1)

(iii) The table below gives information about the solubility of some compounds.

Soluble compounds	Insoluble compounds
all sodium and potassium salts	
all nitrates	
most chlorides, bromides and iodides	silver and lead chlorides, bromides and iodides

Use the table to help you to:

draw a ring around a soluble compound which contains lead ions

lead bromide

lead chloride

lead nitrate

draw a ring around a soluble compound which contains iodide ions.

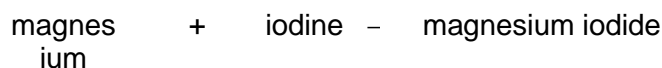
lead iodide

silver iodide

sodium iodide

(2)

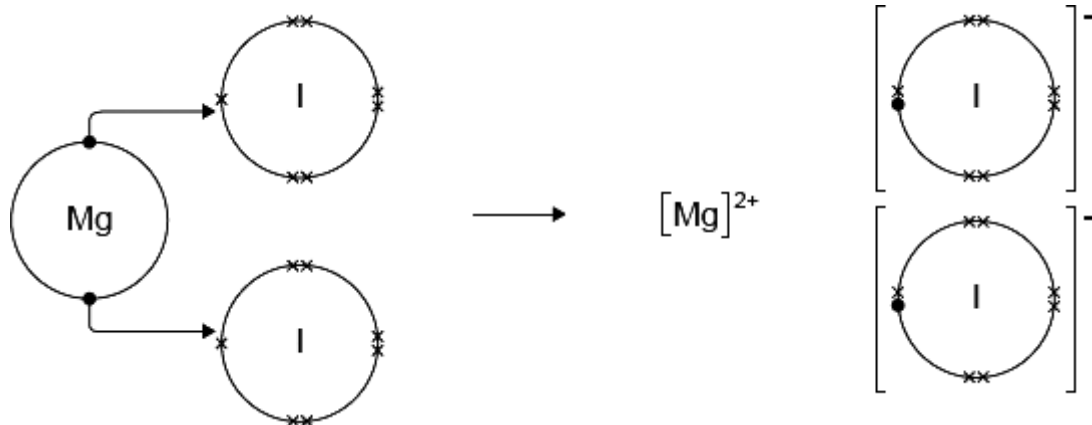
(b) Magnesium iodide can be made by reacting magnesium with iodine.



The diagram shows how this takes place.

Only the outer electrons are shown.

The dots (•) and crosses(×) are used to represent electrons.



Use the diagram to help you to answer this question.

Describe, as fully as you can, what happens when magnesium reacts with iodine to make magnesium iodide.

To gain full marks you should use the words atom, electron and ion in your answer.

(4)

(Total 8 marks)

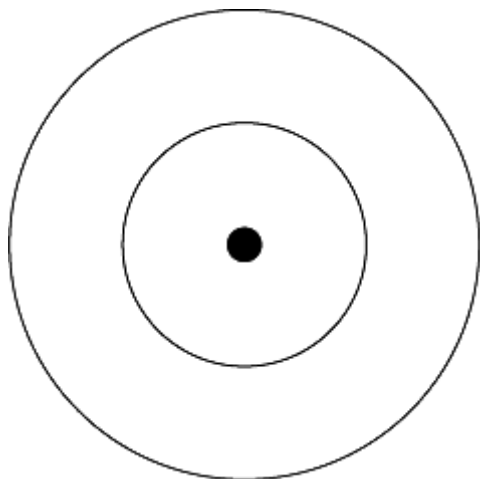
Q20.

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

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

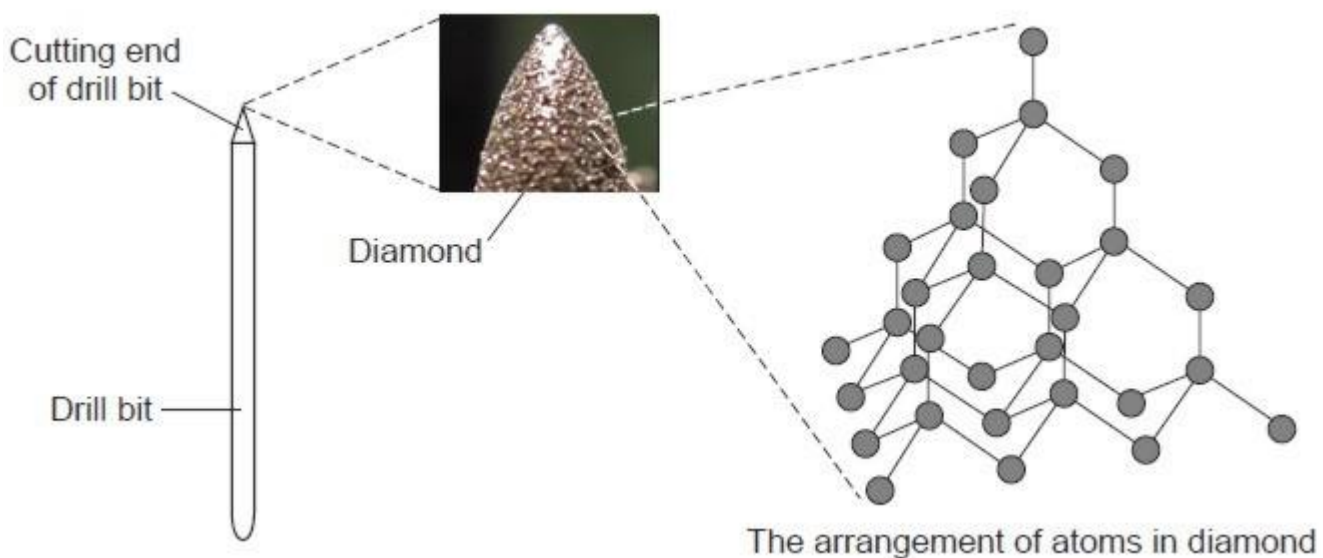
A carbon atom has 6 electrons.

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.

(3)

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

(3)

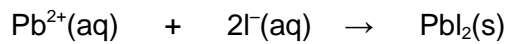
(Total 8 marks)

Q21.

This question is about some compounds of iodine.

- (a) Lead iodide can be made by mixing a solution containing lead ions with a solution containing iodide ions.

Lead iodide is formed as a precipitate.



- (i) The table below gives information about the solubility of some compounds.

Soluble compounds	Insoluble compounds
all sodium and potassium salts	
all nitrates	
most chlorides, bromides and iodides	silver and lead chlorides, bromides and iodides

Use the table to help you name:

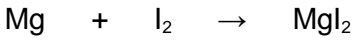
a soluble compound which contains lead ions _____

a soluble compound which contains iodide ions _____

(2)

- (ii) Suggest a method of separating the lead iodide from the solution.

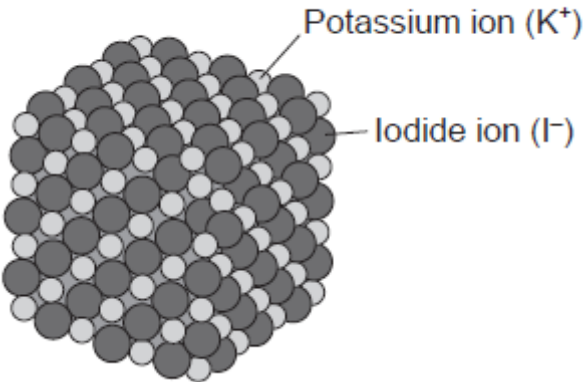
(b) Magnesium iodide can be made by reacting magnesium with iodine.



Magnesium iodide is an ionic compound. It contains magnesium ions (Mg²⁺) and iodide ions (I⁻).

Describe, in terms of electrons, what happens when magnesium reacts with iodine.

(c) The diagram shows the structure of potassium iodide.

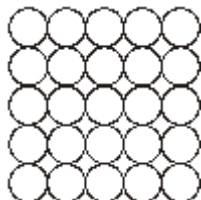


Explain why a high temperature is needed to melt potassium iodide.

Q22.

Iron is the main structural metal used in the world.

- (a) The diagram represents the particles in iron, Fe.



Draw a ring around the correct word in the box to complete the sentence.

Iron is described as an element because all the

atoms

compounds

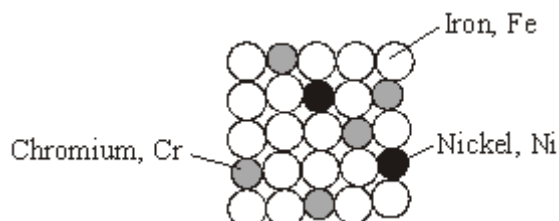
metals

are the same.

(1)

- (b) Stainless steel is mostly iron.

The diagram represents the particles in stainless steel.



Use the correct words from the box to complete the sentences about alloys.

metal mixture molecule polymer smart structure

Stainless steel is an alloy because it is a _____ of iron, chromium and nickel.

An alloy is made up of more than one type of _____.

Stainless steel alloys are harder than iron because the different sized atoms added change the _____.

An alloy that can return to its original shape after being deformed is called a _____ alloy.

(4)

- (c) In the UK, we use about 1.8 billion steel cans every year but only 25% are recycled.

Used steel cans are worth about £100 per tonne.

Recycling saves raw materials and reduces waste that would end up in landfill. Producing steel by recycling used cans saves 75% of the energy that would be needed to produce steel from iron ore. This also reduces carbon dioxide emissions.

- (i) Give **two** reasons, from the information above, to explain why recycling used steel cans is a good idea.

1. _____

2. _____

(2)

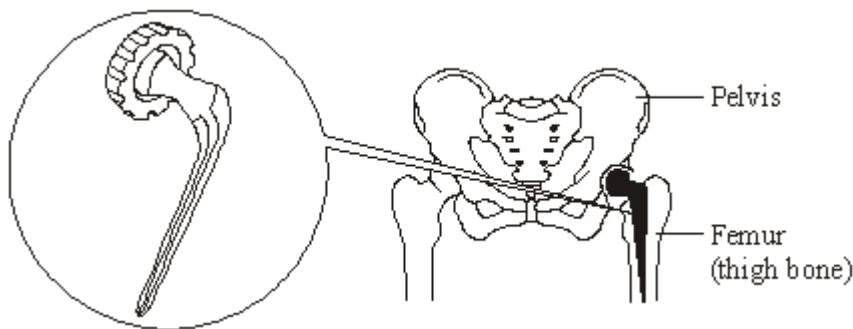
- (ii) Suggest how the local council could increase the percentage of used steel cans that are recycled.

(1)

(Total 8 marks)

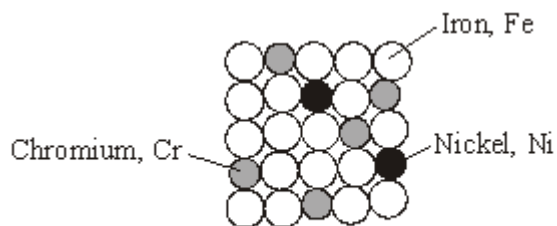
Q23.

The hip joint between the femur and pelvis sometimes has to be replaced. Early hip replacement joints were made from stainless steel.



Stainless steel is an alloy of iron, chromium and nickel.

The diagram below represents the particles in stainless steel.



Particle diagram of stainless steel

- (a) Use the particle diagram to complete the percentages of metals in this stainless steel.

The first one has been done for you.

Element	Percentage (%)
Iron, Fe	72
Chromium, Cr	
Nickel, Ni	

(2)

(b) Pure iron is a relatively soft, metallic element.

(i) Why is iron described as an *element*?

(1)

(ii) Suggest why pure iron would **not** be suitable for a hip replacement joint.

(1)

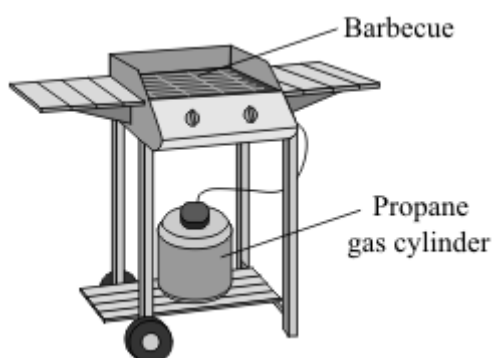
(iii) Use the particle diagram to help you to explain why stainless steel is harder than pure iron.

(2)

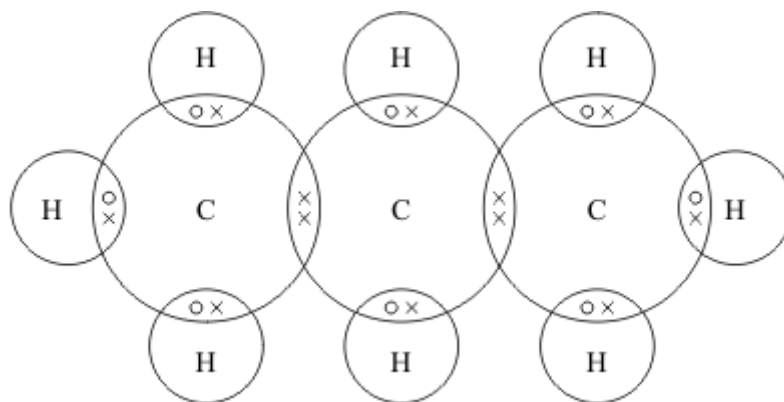
(Total 6 marks)

Q24.

This barbecue burns propane gas.



The diagram represents a propane molecule.



(a) What is the formula of propane?

(1)

(b) (i) Draw a ring around the name of the particle represented by the symbols \circ and \times in the diagram.

electron

neutron

proton

(1)

(ii) Draw a ring around the type of bonding that holds the atoms together in a propane molecule.

covalent

ionic

metallic

(1)

(c) Under high pressure in the cylinder propane is a liquid. Liquid propane evaporates easily to form a gas when the tap on the cylinder is opened.

Draw a ring around the correct answer in each box to explain why propane evaporates easily.

Propane has a

high
low

 boiling point because it consists of

large
small

 molecules.

(1)

(Total 4 marks)

Q25.

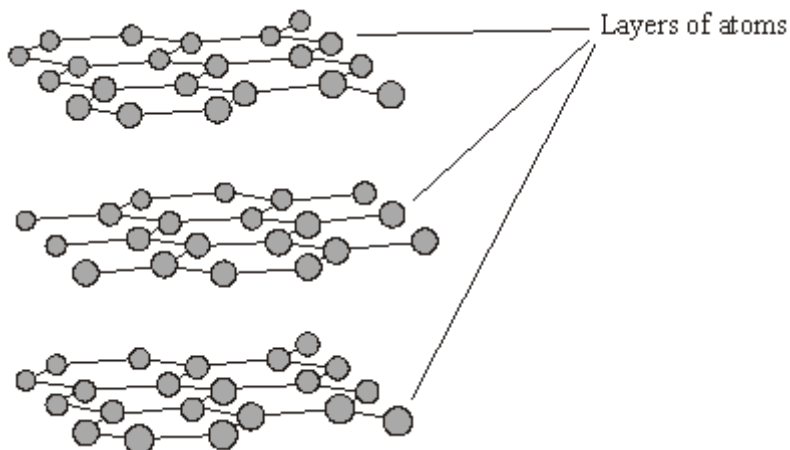
This label was on a container of graphite lubricant.

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

(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.

(2)

(Total 4 marks)

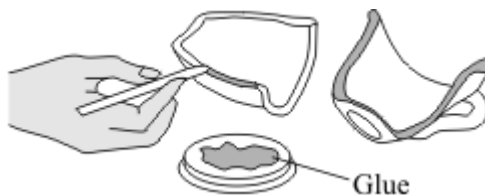
Q26.

The following steps show how to use a type of glue.

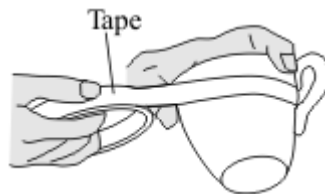
Step 1 Measure out equal amounts of the liquids from tubes **A** and **B**.



Step 2 Mix the liquids to make the glue.
Put a thin layer of the glue onto each of the surfaces to be joined.



Step 3 Assemble the pieces to be joined and then hold them together with tape.



Step 4 Leave the glue to set.

(a) When liquids **A** and **B** are mixed a chemical reaction takes place.

(i) This reaction is exothermic.

Complete the sentence below using a word or phrase from the box.

decrease increase stay the same

During the reaction the temperature of the mixture will _____ .

(1)

(ii) When the glue sets it forms a giant covalent structure.

Draw a ring around **one** property that you would expect the set glue to have.

good conductor of electricity low melting point high melting point

(1)

(b) The time taken for the glue to set at different temperatures is given in the table below.

Temperature in °C	Time taken for the glue to set
20	3 days
60	6 hours
90	1 hour

(i) Complete the sentences below using words or phrases from the box.

decrease increase stay the same

When the temperature is increased the time taken for the glue to set

When the temperature is increased the rate of the setting reaction

(2)

- (ii) Put a tick (✓) next to the **two** reasons why an increase in temperature affects the rate of reaction.

Reason	(✓)
It gives the particles more energy.	<input type="checkbox"/>
It increases the concentration of the particles.	<input type="checkbox"/>
It increases the surface area of the particles.	<input type="checkbox"/>
It makes the particles move faster.	<input type="checkbox"/>

(2)

(Total 6 marks)

Q27.

Read the article and then answer the questions that follow.

Nanotennis!

Tennis balls contain air under pressure, which gives them their bounce. Normal tennis balls are changed at regular intervals during tennis matches because they slowly lose some of the air. This means that a large number of balls are needed for a tennis tournament, using up a lot of materials.



'Nanocoated' tennis balls have a 'nanosize' layer of butyl rubber. This layer slows down the escape of air so that the ball does not lose its pressure as quickly. The 'nanocoated' tennis balls last much longer and do not need to be replaced as often.

(a) How does the 'nanosize' layer make the tennis balls last longer?

(1)

(b) Put a tick (✓) next to the best description of a 'nanosize' layer.

Description	(✓)
A layer one atom thick.	
A layer a few hundred atoms thick.	
A layer millions of atoms thick.	

(1)

(c) Suggest why using 'nanocoated' tennis balls would be good for the environment.

(2)

(Total 4 marks)

Q28.

Read the article and then answer the questions.

Nanotennis!

Tennis balls contain air under pressure, which gives them their bounce. Normal tennis balls are changed at regular intervals during tennis matches because they slowly lose some of the air.



'Nanocoated' tennis balls have a 'nanosize' layer of butyl rubber. This layer slows down the escape of air so that the ball does not lose its pressure as quickly.

- (a) What is the meaning of *nanosize*?

(1)

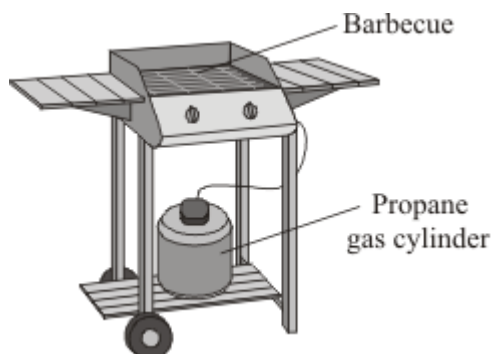
- (b) Suggest why using 'nanocoated' tennis balls would be good for the environment.

(2)

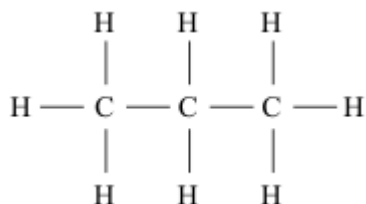
(Total 3 marks)

Q29.

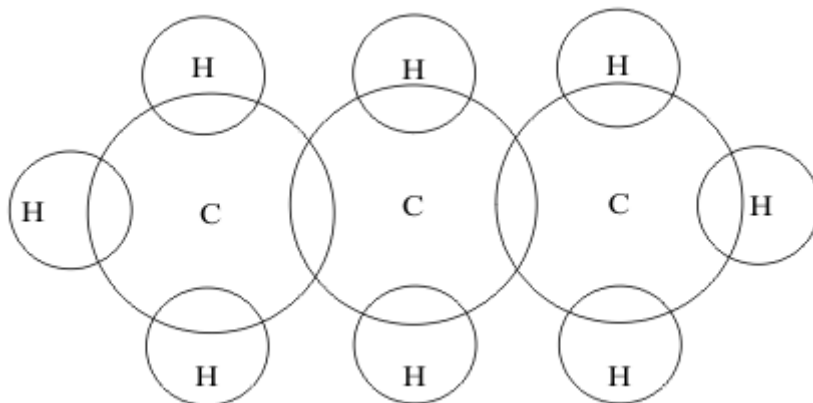
This barbecue burns propane gas.



The structure of propane is shown below.



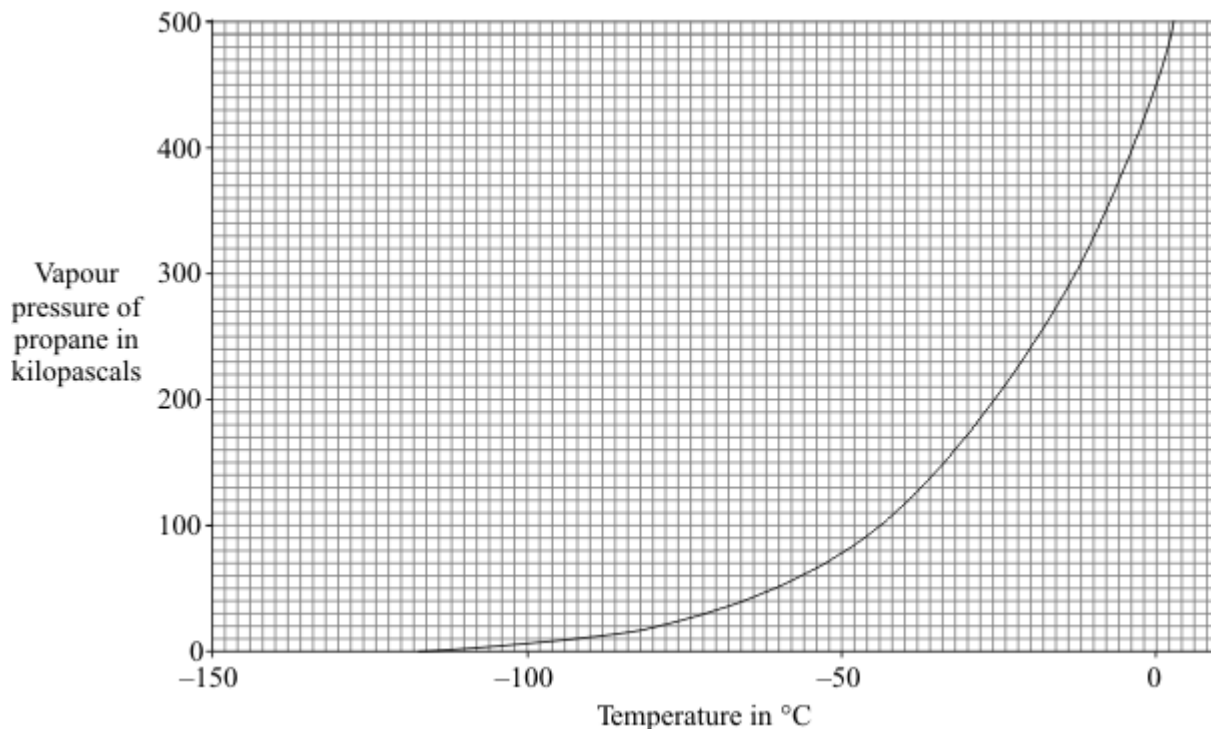
- (a) Complete the diagram to show how the outer energy level (shell) electrons of hydrogen and carbon are arranged in a molecule of propane.



(1)

- (b) The graph shows how the vapour pressure of propane changes with temperature.

The vapour pressure of a liquid is the pressure of the vapour above the liquid.



- (i) Describe, as fully as you can, how the vapour pressure of propane changes with temperature.

(2)

- (ii) The boiling point of a liquid is the temperature at which its vapour pressure is equal to the air pressure above the liquid.

Use the graph to find the boiling point of propane when the air pressure is 100 kilopascals.

Boiling point _____ °C

(1)

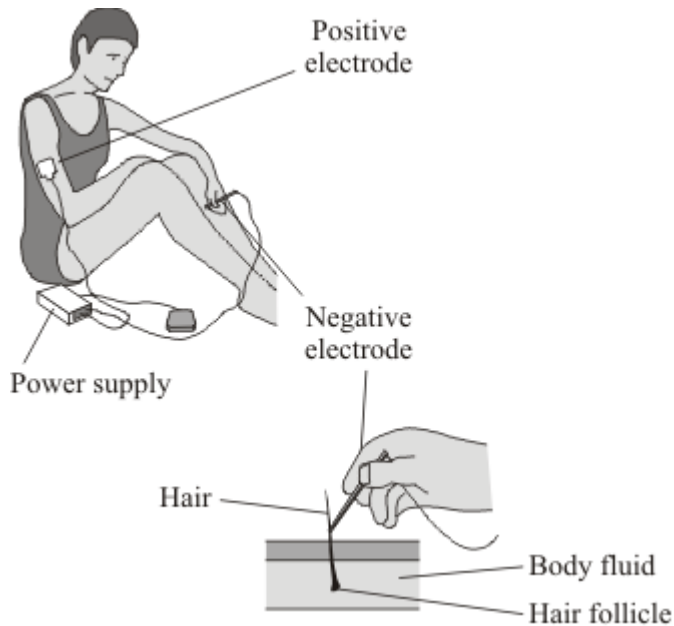
- (c) Explain, in terms of molecules, why propane has a low boiling point.

(2)

(Total 6 marks)

Q30.

Electrolysis can be used to remove unwanted hair from the skin.



The hair is first coated with a layer of gel containing ions in solution.

The positive electrode is connected by a patch to the skin.

The negative electrode is connected to the hair. Electricity flows through the gel and causes electrolysis of the body fluid around the hair follicle.

- (a) Metal wires conduct electricity to the electrodes.

Explain how metals conduct electricity.

(2)

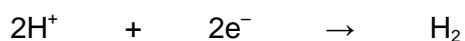
- (b) Explain why the gel containing ions in solution can conduct electricity.

(1)

- (c) The body fluid is a solution that contains sodium chloride. The electricity causes the electrolysis of a small amount of this solution.

This solution contains hydrogen ions that move to the negative electrode.

- (i) The half equation represents the reaction at the negative electrode.



Explain why this reaction is a reduction.

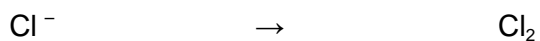
(1)

- (ii) As a result of the electrolysis of sodium chloride solution, an alkali forms which kills the hair follicle.

What is the name of this alkali? _____

(1)

- (iii) Complete the half equation for the reaction at the positive electrode.

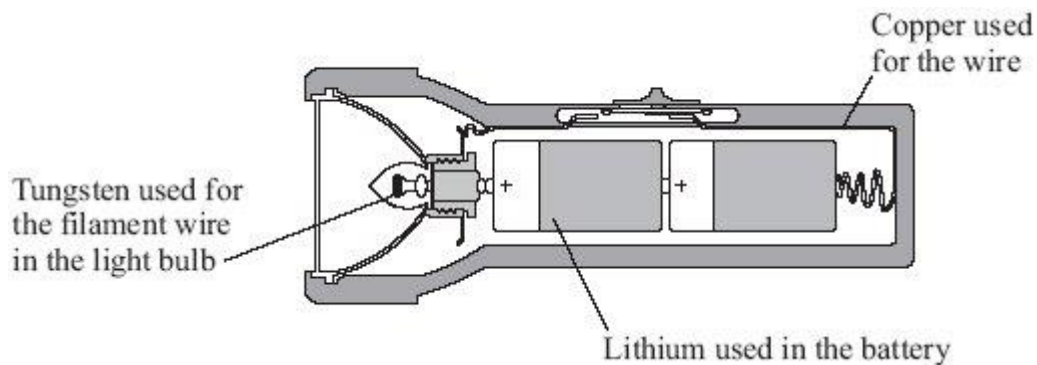


(1)

(Total 6 marks)

Q31.

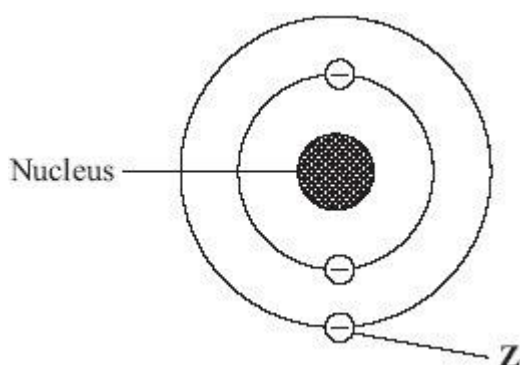
The diagram shows a circuit that is used in a torch. Electrons flow through this circuit.



(a) Why is copper used for the wire?

_____ (1)

(b) The diagram shows the structure of an atom of lithium.



Name the particle labelled Z.

_____ (1)

(c) The table shows some properties of the metals used in the electrical circuit.

Metal	Melting point in °C	Boiling point in °C	Reaction with oxygen
Copper	1083	2582	Reacts slowly to form a thin oxide layer on surface
Lithium	179	1317	Reacts rapidly to form oxide
Tungsten	3370	5930	Reacts only when very hot to form oxide

(i) Use information from the table to suggest the order of reactivity for copper, lithium and tungsten.

most reactive _____

least reactive _____

(2)

- (ii) The filament wire glows because it gets very hot.

Use information from the table to suggest **one** reason why tungsten is used for the filament wire in the light bulb.

(1)

- (d) The gas used in the light bulb is argon.

Draw a ring around the correct word in the box to complete the sentence.

Argon is used in the light bulb because it is

dense.

solid.

unreactive.

(1)

(Total 6 marks)

Q32.

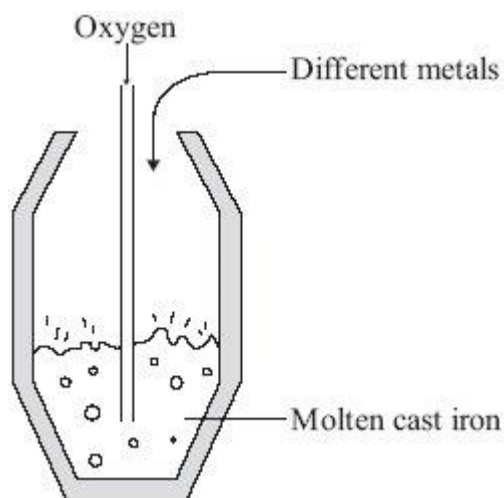
The demand for iron and steel is high.

- (a) Iron that is extracted from its oxide by carbon reduction in a blast furnace is called cast iron. Cast iron contains about 4% carbon. This carbon makes cast iron very brittle.

Carbon steels can be made by the following processes.

- Blowing oxygen into molten cast iron to remove most of the carbon.
- Adding a calculated amount of carbon.

Sometimes different metals may also be added to the molten carbon steels.



- (i) Suggest how blowing oxygen into molten cast iron removes most of the carbon.

(2)

(ii) Why are different metals sometimes added to molten carbon steels?

(1)

(b) The percentage of iron and steel recycled in the UK has been increasing.

Year	%iron and steel recycled
1998	25
2000	35
2002	42
2004	46
2006	57

The UK government has set targets for the percentage of iron and steel to be recycled.

In 2006 the target was exceeded.

Suggest **two** reasons why the UK government wants to encourage recycling of iron and steel.

1. _____

2. _____

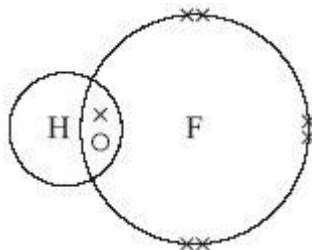
(2)

(Total 5 marks)

Q33.

This question is about fluorine and some of its compounds.

(a) The diagram represents a molecule of hydrogen fluoride.



Draw a ring around the type of bonding that holds the hydrogen and fluorine atoms together in this molecule.

covalent

ionic

metallic

(1)

- (b) Fluorine is made in industry by the electrolysis of a mixture of potassium fluoride and hydrogen fluoride.

- (i) Use **one** word from the box to complete the sentence.

gas	liquid	solid
------------	---------------	--------------

To allow electrolysis to take place the mixture of potassium fluoride and hydrogen fluoride must be _____.

(1)

- (ii) The mixture of potassium fluoride and hydrogen fluoride contains fluoride ions (F^-), hydrogen ions (H^+) and potassium ions (K^+).

Use **one** word from the box to complete the sentence.

fluorine	hydrogen	potassium
-----------------	-----------------	------------------

During electrolysis the element formed at the **positive** electrode is _____.

(1)

- (c) Fluoride ions are sometimes added to drinking water. It is thought that these ions help to reduce tooth decay.

- (i) Tick (✓) **one** question that **cannot** be answered by scientific investigation alone.

Question	Tick (✓)
Do fluoride ions in drinking water reduce tooth decay?	
Are fluoride ions in drinking water harmful to health?	
Should fluoride ions be added to drinking water?	

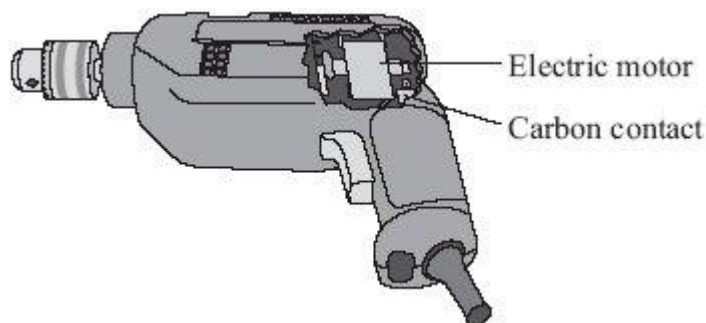
(1)

- (ii) Explain why you have chosen this question.

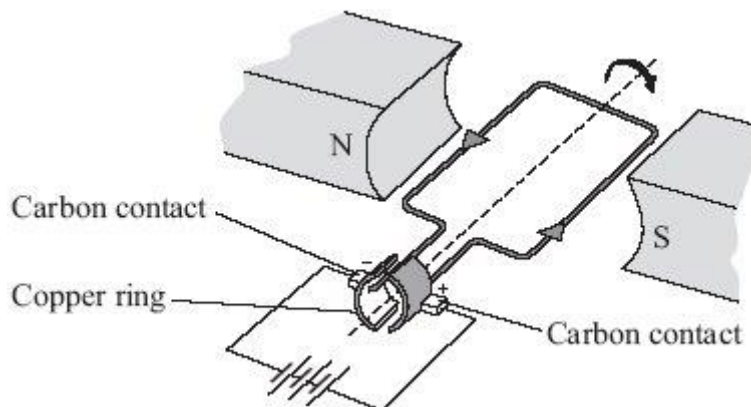
(1)
(Total 5 marks)

Q34.

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.

(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

covalent

three	other carbon atoms by	ionic	bonds.
four		metallic	

(2)

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

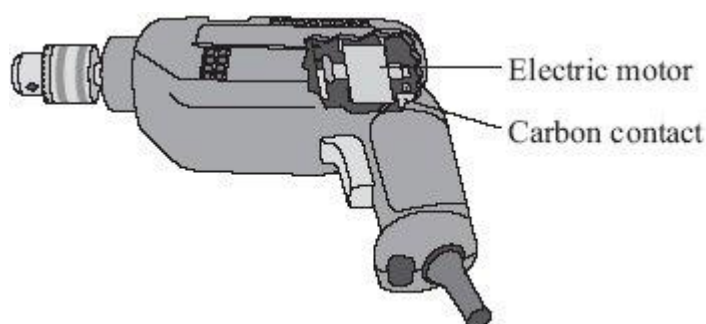
Statement	Tick (✓)
It is made of layers of atoms.	<input type="checkbox"/>
It is made of small molecules.	<input type="checkbox"/>
It is an ionic compound.	<input type="checkbox"/>

(1)

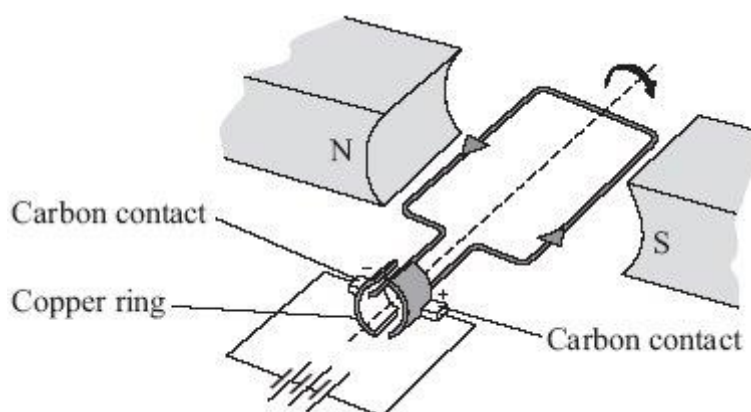
(Total 5 marks)

Q35.

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.

(Total 5 marks)

Q36.

Read the article and then answer the questions that follow.

Hydrogen fuel for cars?

The diagram shows a side profile of a car. On the left side, there is a rectangular box labeled 'Hydrogen storage'. A line with an arrow points from this box towards the right. The word 'Hydrogen' is written along this line. On the right side of the car, there is a component labeled 'Fuel cell'. An arrow points from the 'Hydrogen' line into the 'Fuel cell'. From the 'Fuel cell', another arrow points to a component labeled 'Electric motor'.

Hydrogen is an excellent fuel. It can be made by the electrolysis of potassium hydroxide solution.

Hydrogen gas can be stored under pressure in a cylinder but a leak of the gas could cause an explosion.

It has been found that lithium nitride can absorb and then release large volumes of hydrogen. A chemical reaction takes place between the hydrogen and the lithium nitride. The hydrogen is held in the resulting compounds by chemical bonds.

The problem is that the rate at which hydrogen is absorbed and then released from normal sized particles of lithium nitride is slow.

Recently scientists have made ‘nanosized’ particles of lithium nitride. These particles absorb hydrogen in the same way as normal sized lithium nitride particles. The ‘nanosized’ particles have the advantage that they absorb and release the hydrogen much faster when needed in the fuel cell.

It is hoped that 'nanosized' particles of lithium nitride may provide a safe method of storing hydrogen in the future.

- (a) Hydrogen is produced at the negative electrode during the electrolysis of potassium hydroxide solution.

- (i) Why are hydrogen ions attracted to the negative electrode?

(1)

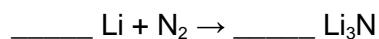
- (ii) Potassium ions are also attracted to the negative electrode.

Explain why hydrogen gas is formed but not potassium.

(1)

- (b) Lithium nitride is made by reacting lithium with nitrogen.

Balance the equation for this reaction.



(1)

- (c) (i) The equation for the reaction of lithium nitride with hydrogen is:



What feature of this reaction allows the hydrogen to be released?

(1)

- (ii) Hydrogen stored in a fuel tank filled with lithium nitride would be safer in an accident than a cylinder full of hydrogen.

Suggest and explain why.

(2)

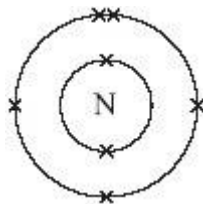
(d) Lithium nitride is an ionic compound which contains lithium ions (Li^+) and nitride ions (N^{3-}).

(i) The formation of a lithium ion from a lithium atom is an oxidation reaction.

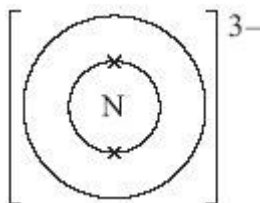
Explain why.

(1)

(ii) The diagram shows the electronic structure of a nitrogen atom.



Complete the diagram below to show the electronic structure of a nitride ion (N^{3-}).



(1)

(Total 8 marks)

Q37.

Perfumes contain a mixture of chemicals.



The main ingredients of perfumes are a solvent and a mixture of fragrances.

(a) A sample of the solvent used in one perfume contained 0.60 g of carbon, 0.15 g of hydrogen and 0.40 g of oxygen.

Relative atomic masses: H = 1; C = 12; O = 16.

Calculate the empirical (simplest) formula of the solvent.

You must show all of your working to gain full marks for this question.

(4)

(b) Solvent molecules evaporate easily.

Explain why substances made of simple molecules evaporate easily.

(2)

(c) Most companies claim that their perfumes have been tested on skin. A study was made of the tests they used. The study found that each company used different tests.

The perfumes were tested in the companies' own laboratories and **not** by independent scientists.

Some companies did not give any information about the tests that they had used.

(i) Suggest why companies test their perfumes on skin.

(1)

(ii) Did the study show that the tests made by the different companies were valid and reliable?

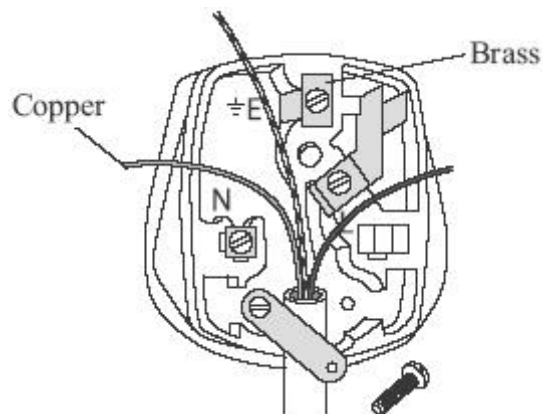
Explain your answer.

(2)
(Total 9 marks)

Q38.

Copper metal is used for electric wires.

An alloy of copper, called brass, is used for pins and terminals of electric plugs.



- (a) Copper metal is relatively soft and flexible.

Give another reason why copper is used for electric wires.

(1)

- (b) Brass is an *alloy*.

What is an *alloy*?

(1)

- (c) Open-cast mining of copper ore makes a very large hole.

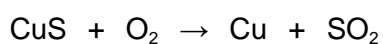


- (i) Suggest **one** environmental problem that is caused by open-cast mining of copper ore.

(1)

- (ii) Some copper ores contain copper sulfide, CuS.

Copper sulfide is heated in air to produce copper and sulfur dioxide.



Suggest **one** environmental problem caused by heating copper sulfide in air.

(1)

- (d) The amount of copper-rich ores is estimated to last only a few more years. New houses need several kilometres of copper wire.

- (i) Explain why the need to use so much copper will cause a problem in the future.

(1)

- (ii) Suggest **two** ways in which society could overcome this problem.

1. _____

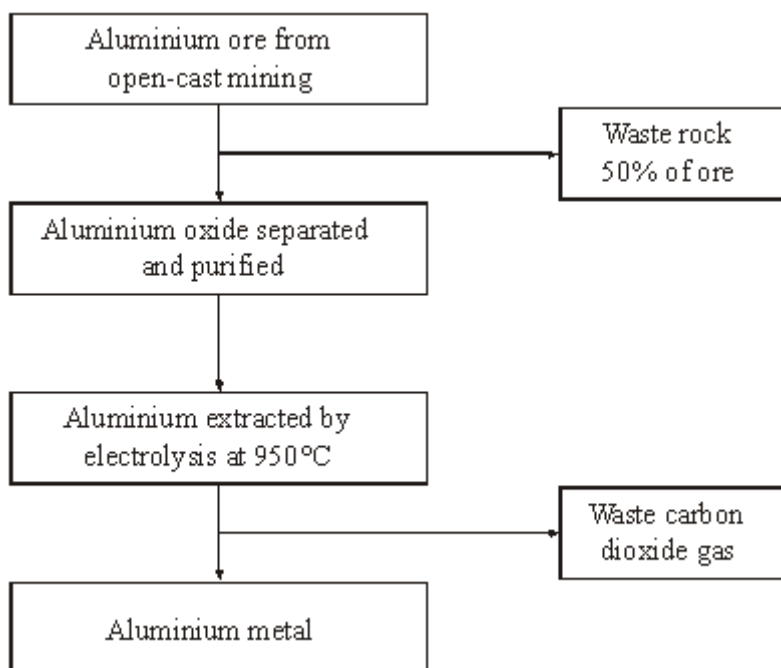
2. _____

(2)
(Total 7 marks)

Q39.

Aluminium has many uses because of its low density, good electrical conductivity, flexibility and resistance to corrosion.

The main steps in the extraction of aluminium are shown in the flow chart.



(a) Use the information in the flow chart to suggest the benefits of recycling aluminium.

(3)

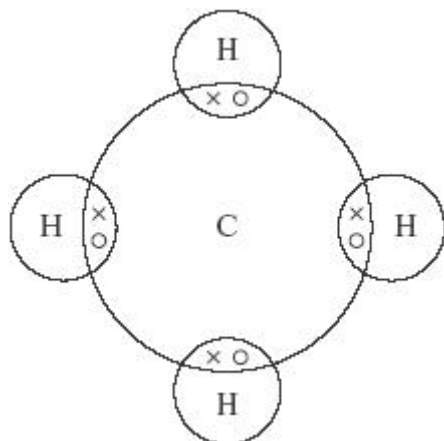
(b) Pure aluminium is rarely used for the construction of large objects. Small amounts of other metals are usually mixed with aluminium.

Explain why.

(2)
(Total 5 marks)

Q40.

The diagram represents a particle of methane.



(a) What is the formula of methane? _____

(1)

(b) Choose a word from the box to answer the question.

atom	ion	molecule
------	-----	----------

Which of the words best describes the methane particle shown in the diagram?

(1)

(c) Choose a word from the box to answer the question.

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

What is the type of bonding shown in the diagram?

(1)

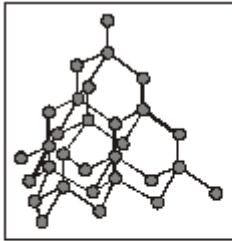
(Total 3 marks)

Q41.

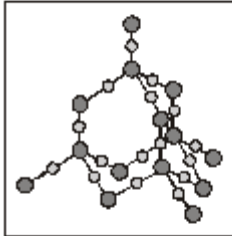
This question is about giant structures. Diamond, graphite and silicon dioxide all have giant structures.

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

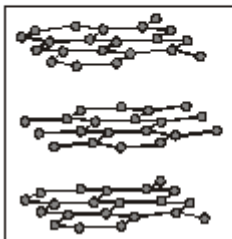
Draw a line from each structure to its name.



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)

Q42.

Distress flares are used to attract attention in an emergency.



Flares often contain magnesium. Magnesium burns to form magnesium oxide.

- (a) The distress flare burns with a bright flame because the reaction is very *exothermic*.

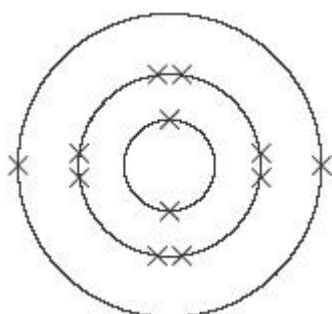
Complete the following sentence using the correct words from the box.



An *exothermic* reaction is one which _____

(1)

- (b) The diagram shows the electronic structure of a magnesium atom.
The atomic (proton) number of magnesium is 12.



Magnesium atom

The atomic (proton) number of oxygen is 8.

Which diagram, **A**, **B**, **C** or **D**, shows the electronic structure of an oxygen atom?

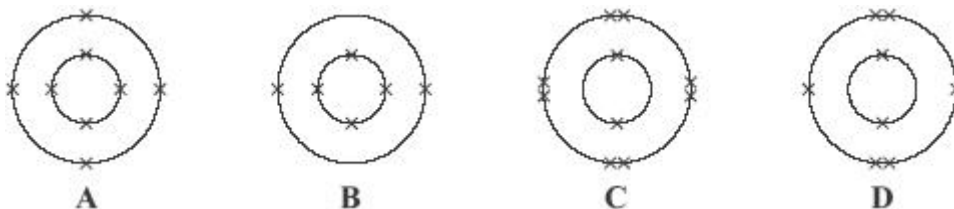
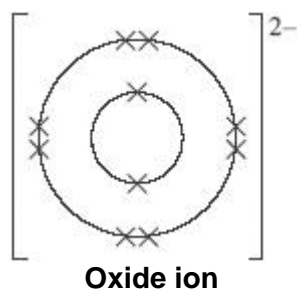


Diagram _____

(1)

- (c) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen. The diagram shows the electronic structure of an oxide ion.



Which diagram, **J**, **K**, **L** or **M**, shows the electronic structure of a magnesium ion?

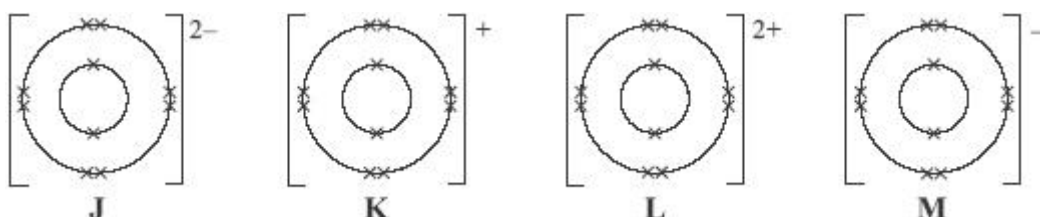


Diagram _____

(1)

- (d) Indigestion tablets can be made from magnesium oxide. The magnesium oxide neutralises some of the hydrochloric acid in the stomach.

Draw a ring around the name of the salt formed when magnesium oxide reacts with hydrochloric acid.

magnesium chloride

magnesium hydroxide

magnesium sulfate

(1)

(Total 4 marks)

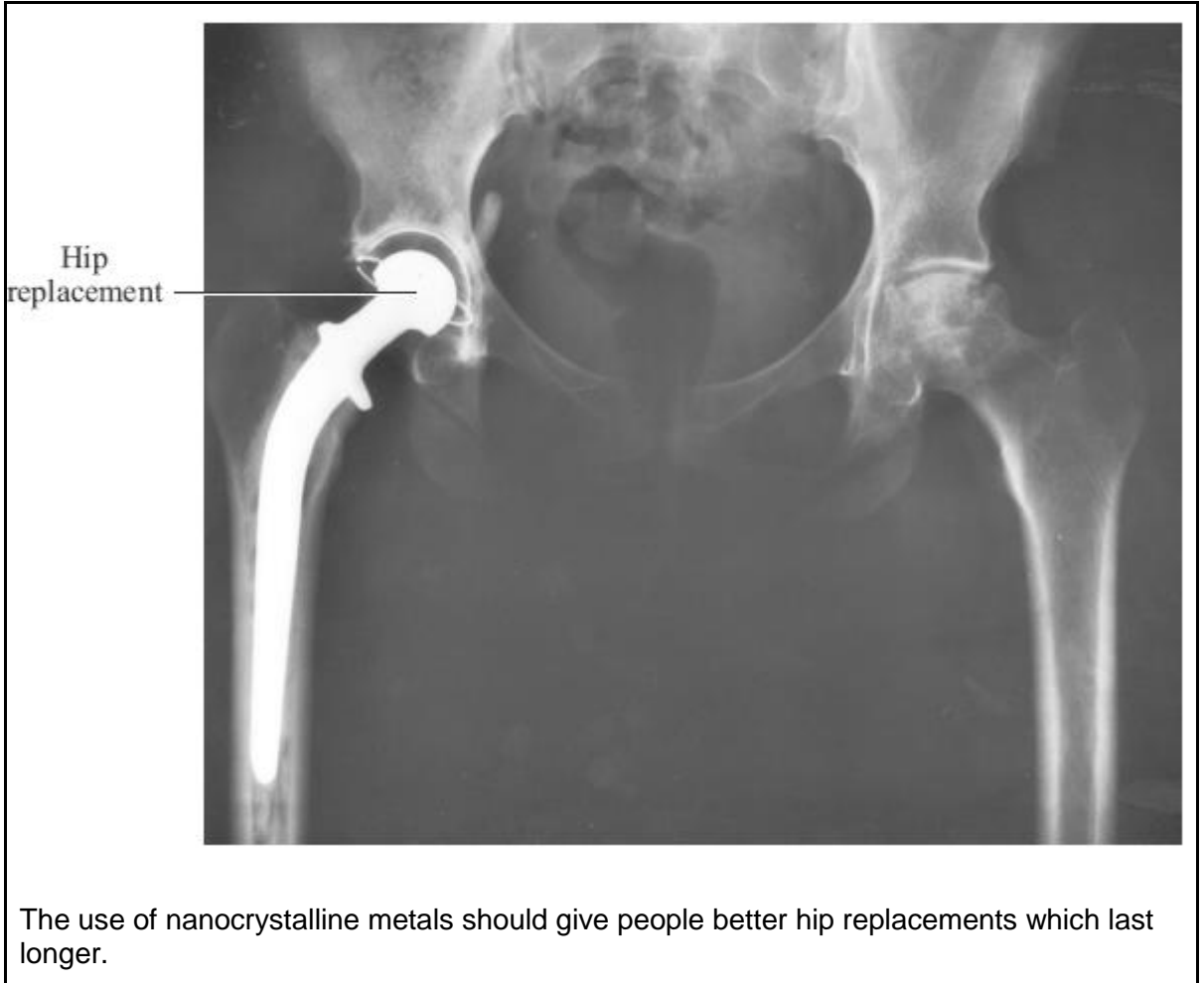
Q43.

Read this passage about metals.

Metals are crystalline materials. The metal crystals are normally about 20 000 nm (nanometres) in diameter. The atoms inside these crystals are arranged in layers.

A new nanoscience process produces nanocrystalline metals. Nanocrystalline metals are stronger and harder than normal metals.

It is hoped that nanocrystalline metals can be used in hip replacements.



(a) State why metals can be bent and hammered into different shapes.

(1)

(b) How is the size of the crystals in nanocrystalline metals different from the size of the crystals in normal metals?

(1)

(c) Hip joints are constantly moving when people walk.

Suggest and explain why the hip replacement made of nanocrystalline metal should last longer than one made of normal metals.

(2)

(Total 4 marks)

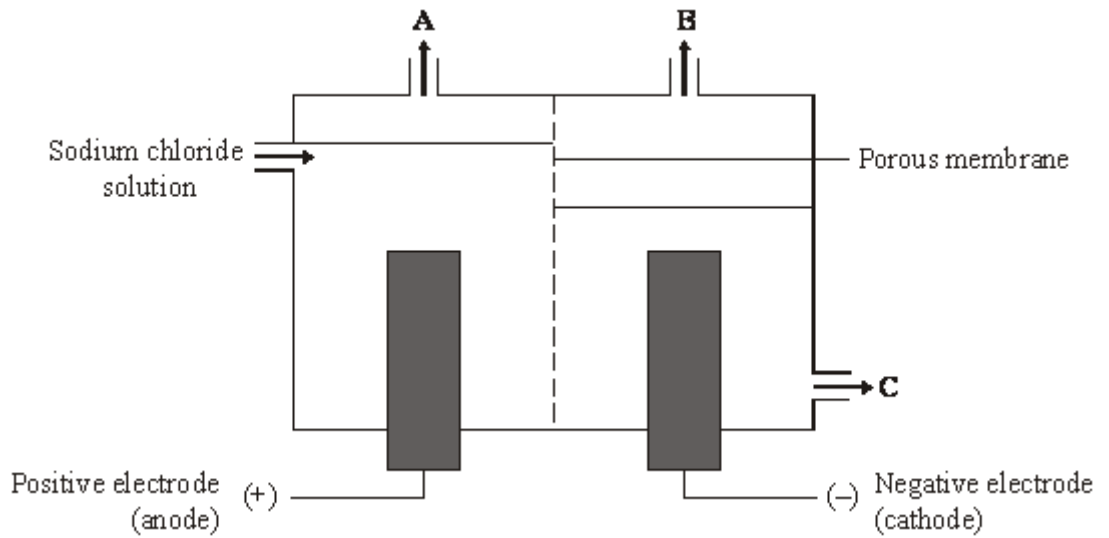
Q44.

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

- (a) Explain the meaning of *electrolysis*.

(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.

(2)

(Total 5 marks)

