Bonding part4

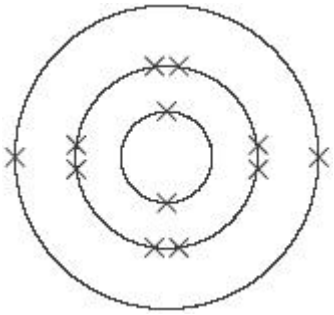
Q1.

(a) Write a balanced symbol equation for the reaction between magnesium (Mg) and oxygen (O_2) to form magnesium oxide (MgO).

_____

(1)

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



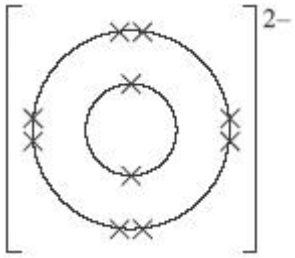
Magnesium atom

Draw a similar diagram to show the electronic structure of an oxygen atom.
The atomic (proton) number of oxygen is 8.

(1)

(c) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen.

The diagram shows the electronic structure of an oxide ion.



Oxide ion

Draw a similar diagram to show the electronic structure of a magnesium ion.

(1)

(d) Magnesium oxide is a white solid with a high melting point.

Explain how the ions are held together in solid magnesium oxide.

_____

_____

_____

_____

(2)

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

Complete the word equation for the reaction between magnesium oxide and hydrochloric acid.

hydrochloric acid + magnesium oxide → _____ + water.

(1)

(Total 6 marks)

Q2.

Metals and their alloys have many uses.

(a) Dentists use a smart alloy to make braces that gently push teeth into the right position.

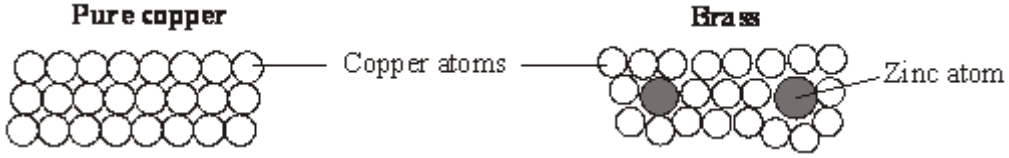
What is meant by a *smart alloy*?

_____

_____

(1)

(b) Pure copper is made up of layers of copper atoms. Brass is an *alloy* of copper and zinc.



Why are the physical properties of brass different from the physical properties of pure copper?

_____

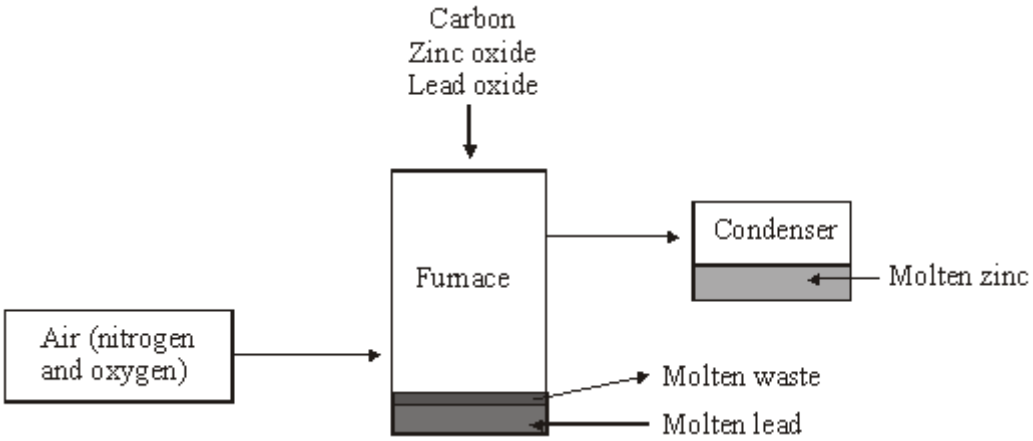
_____

_____

_____

(2)

(c) Nearly all zinc is obtained from ores that also contain lead. The metals zinc and lead can be extracted by reducing their oxides using carbon.



(i) Choose **one** element from the box below to complete the sentence about the reduction of zinc oxide.

lead	**nitrogen**	**oxygen**

Zinc oxide is reduced by carbon, which takes away _____ to leave zinc metal.

(1)

(ii) The melting points and boiling points of lead and zinc are given in the table.

Metal	**Lead**	**Zinc**
Melting point in °C	328	420
Boiling point in °C	1740	907

The furnace operates at a temperature of 1200 °C.

Suggest how the lead metal and zinc metal are separated in the furnace.

_____

_____

_____

_____

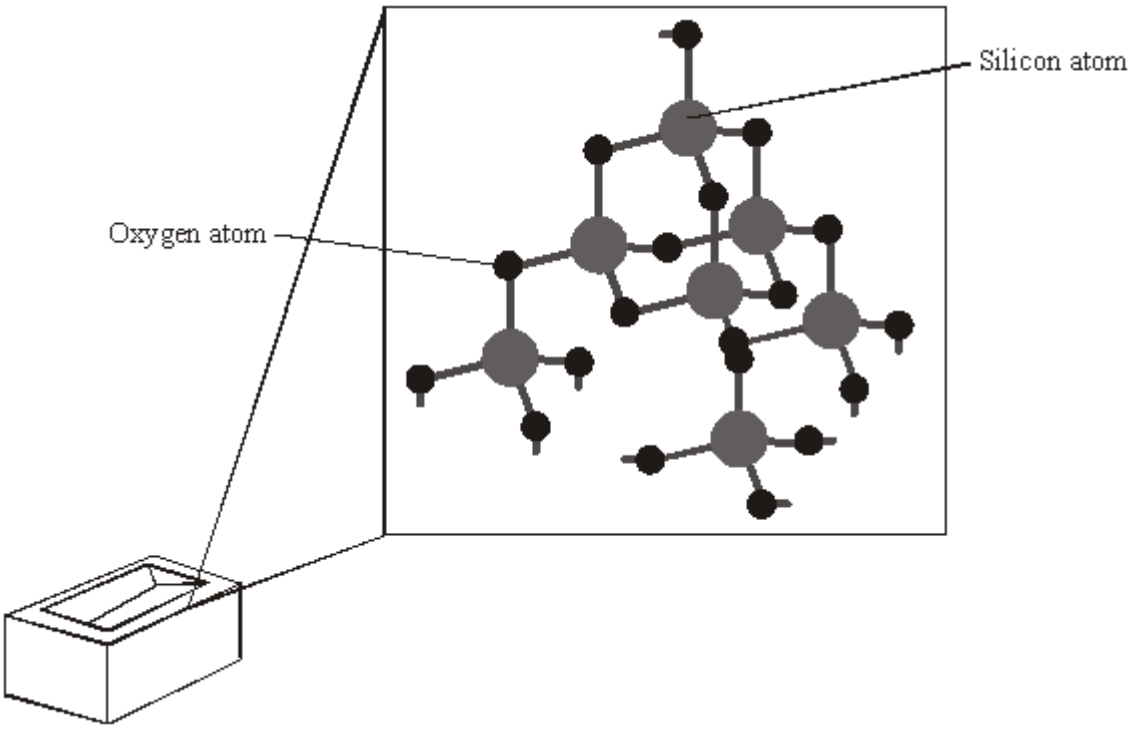
(2)

(Total 6 marks)

Q3.

Bricks made from silica (silicon dioxide) are used to line furnaces that operate at high temperatures.

Part of the structure of silica is shown in the diagram.



Use words from the box to complete the sentences.

covalent	**giant**	**low**	**small**
four	**high**	**six**	**weak**

One reason for using silica to make bricks for high-temperature furnaces is that silica has a _____ melting point.

Silica has this property because it is a _____ structure in which each silicon atom is joined to _____ oxygen atoms by _____ bonds.

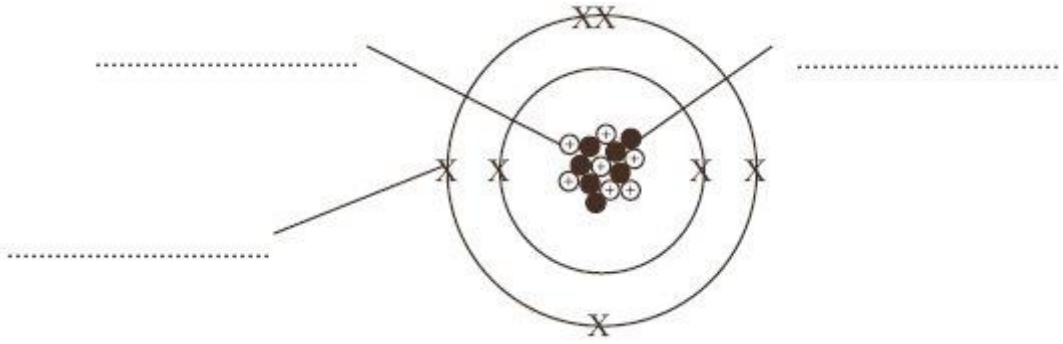
(Total 4 marks)

Q4.

(a) The diagram represents an atom of nitrogen.

(i) Use words from the box to label the diagram.

electron	**neutron**	**nucleus**	**proton**



(2)

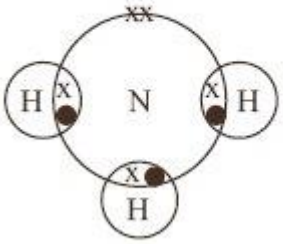
(ii) Draw a ring around the mass number of this atom.

5 **7** **14** **21**

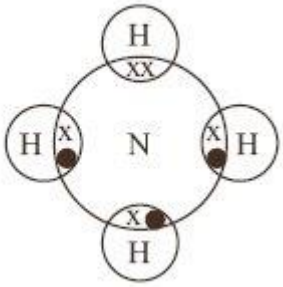
(1)

(b) Nitrogen can react with hydrogen to make ammonia, NH_3 .

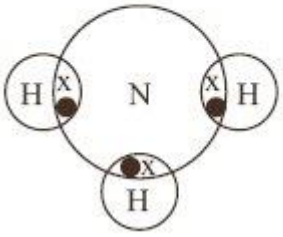
A



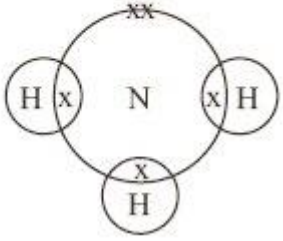
B



C



D



Which diagram, **A**, **B**, **C** or **D**, best represents an ammonia molecule? ☐

(1)

(Total 4 marks)

Q5.

Toothpastes often contain fluoride ions to help protect teeth from attack by bacteria.

Some toothpastes contain tin(II) fluoride.

This compound has the formula SnF_2 .

(a) Calculate the relative formula mass (M_r) of SnF_2.

Relative atomic masses: F = 19; Sn = 119

Relative formula mass (M_r) = _____

(2)

(b) Calculate the percentage by mass of fluorine in SnF_2.

Percentage by mass of fluorine = _____ %

(2)

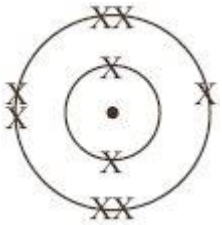
(c) A tube of toothpaste contains 1.2 g of SnF_2.

Calculate the mass of fluorine in this tube of toothpaste.

Mass of fluorine = _____ g

(1)

(d) The diagram represents the electron arrangement of a fluorine atom.



Explain how a fluorine atom can change into a fluoride ion, F^-.

_____

_____

_____

_____

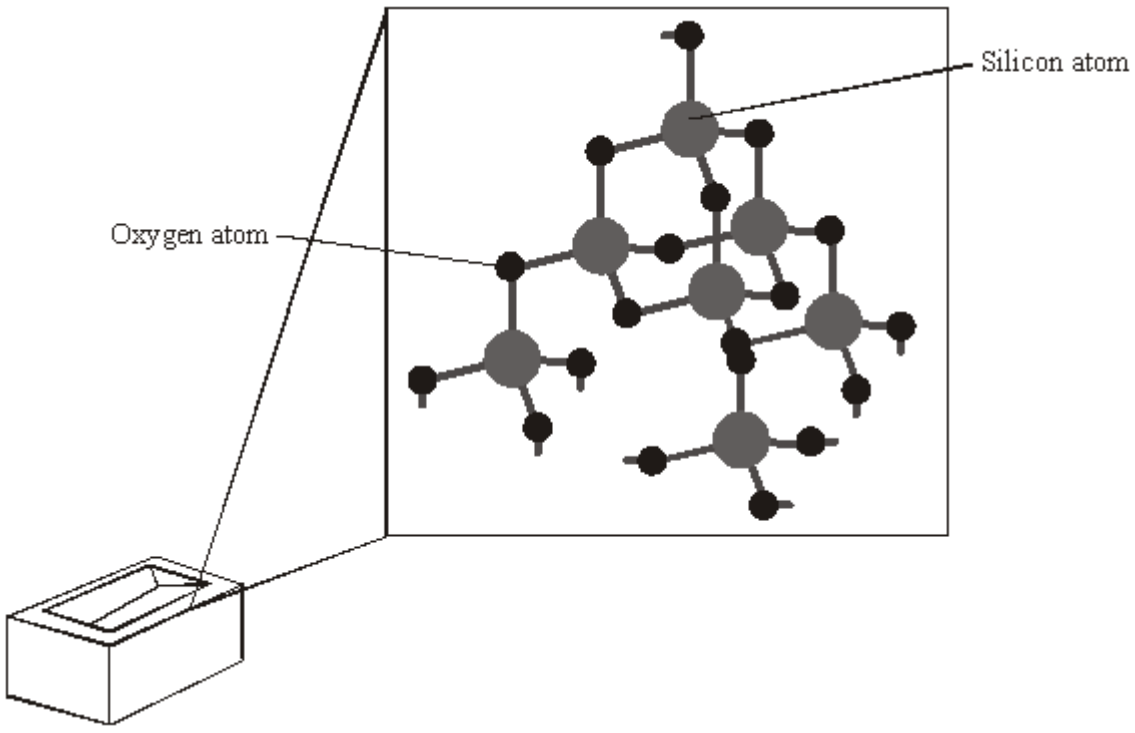
(2)

(Total 7 marks)

Q6.

Bricks made from silica (silicon dioxide) are used to line furnaces that operate at high temperatures.

Part of the structure of silica is shown in the diagram.



Suggest and explain why silica is used to make bricks for high-temperature furnaces. In your answer, you should refer to the structure of, and bonding in, silica.

_____

_____

_____

_____

_____

_____

_____

_____

(Total 4 marks)

Q7.

Read the article about the use of nanoparticles in sun creams.

Sun creams

Many sun creams use nanoparticles. These sun creams are very good at absorbing radiation, especially ultraviolet radiation. Owing to the particle size, the sun creams spread more easily, cover better and save money because you use less. The new sun creams are also transparent, unlike traditional sun creams which are white. The use of nanoparticles is so successful that they are now used in more than 300 sun cream products.

Some sun creams contain nanoparticles of titanium oxide. Normal-sized particles of titanium oxide are safe to put on the skin.

It is thought that nanoparticles can pass through the skin and travel around the body more easily than normal-sized particles. It is also thought that nanoparticles might be toxic to some types of cell, such as skin, bone, brain and liver cells.

(a) Explain why nanoparticles pass through the skin and travel around the body more easily than normal-sized particles of titanium oxide.

_____

_____

_____

_____

(2)

(b) Explain why sun creams containing nanoparticles should be tested further.

_____

_____

(1)

(c) Suggest why some companies that make sun creams might not want to do more tests.

_____

_____

_____

_____

(2)

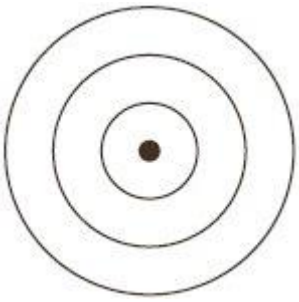
(Total 5 marks)

Q8.

Aluminium is a useful metal.

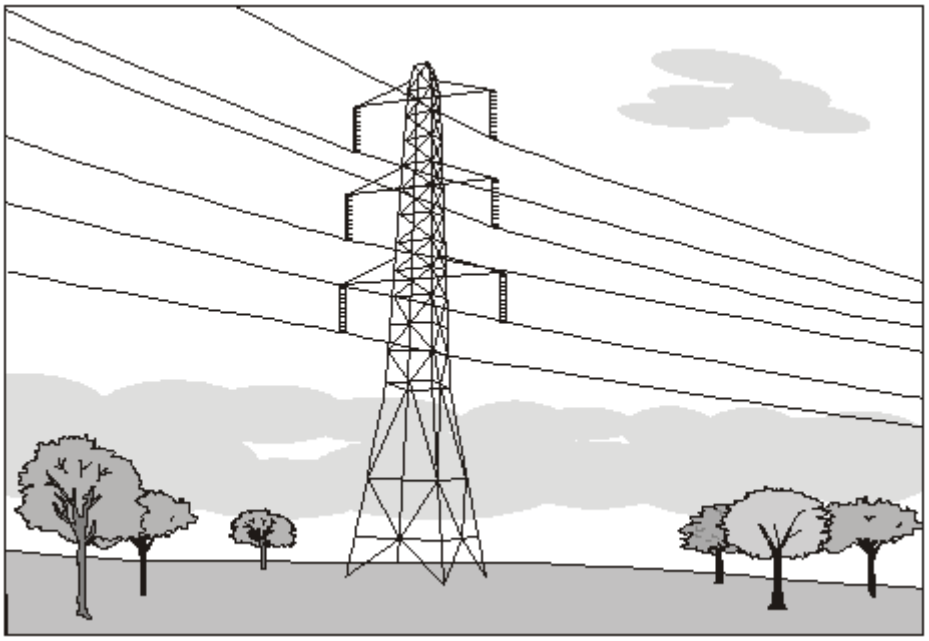
(a) The atomic number (proton number) of aluminium is 13.

Complete the diagram to show the electronic structure of an aluminium atom. Use crosses (x) to represent the electrons.



(1)

(b) Aluminium is used as the electrical conductor for overhead power cables.



Explain why metals are good conductors of electricity.

_____

_____

_____

_____

(2)

(Total 3 marks)

Q9.

Many everyday items are made from iron.

(a) Haematite is an *ore* of iron. Haematite contains iron oxide, Fe_2O_3.

(i) What is the meaning of the term *ore*?

_____

_____

(1)

(ii) Iron can be produced by reacting iron oxide with carbon in a blast furnace.

What type of reaction produces the iron?

_____

_____

(1)

(iii) The word equation for this reaction is:

iron oxide + carbon → iron + carbon dioxide

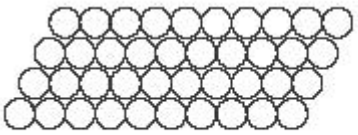
Complete and balance the symbol equation for this reaction.

___Fe_2O_3 + ___C → _____ + _____

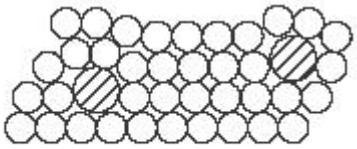
(2)

(b) Pure iron is relatively soft and not very strong.

The iron from the blast furnace is very hard and brittle. It contains about 4% carbon and is used as cast iron.



Pure iron



Cast iron

Explain the differences in the properties of pure iron and cast iron by referring to the diagrams.

_____

_____

_____

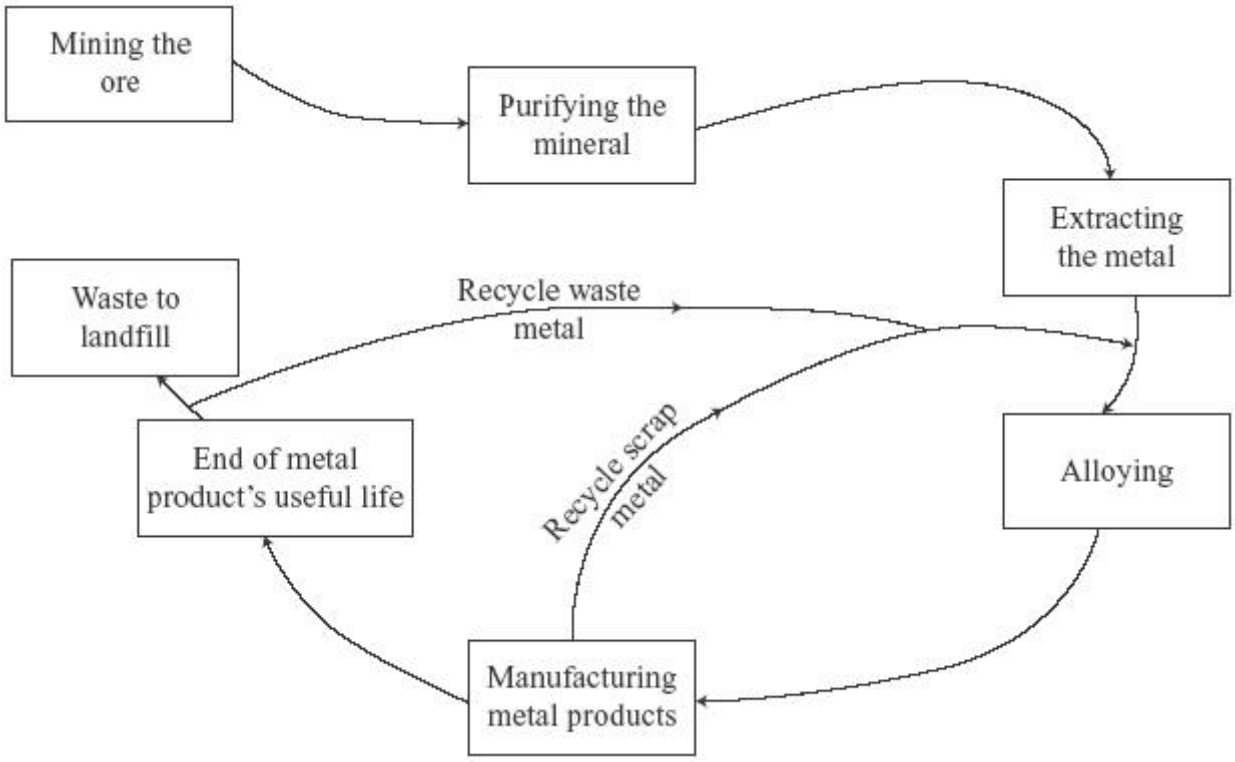
_____

_____

_____

(3)

(c) The diagram shows the way in which iron is extracted, used and recycled.



Explain why the recycling of iron is necessary for sustainable development.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

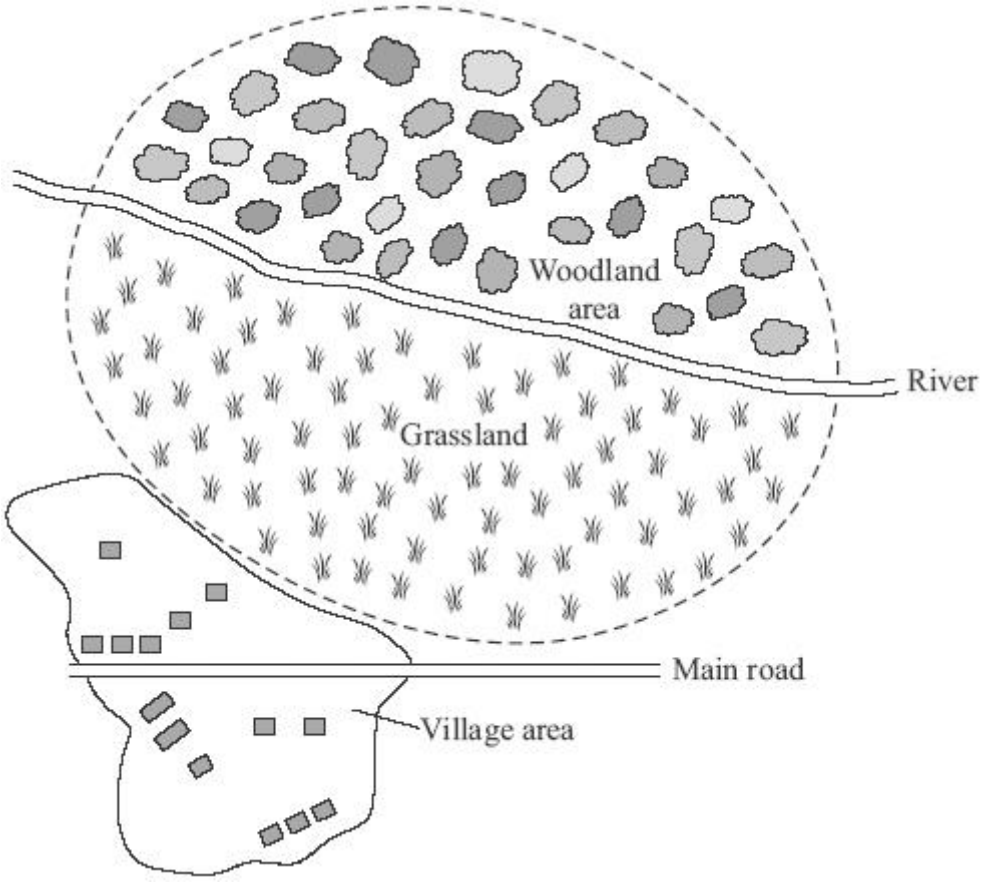
Q10.

Iron ore is the main source of iron.

(a) This was the headline in a newspaper.

'Village protests against quarry'

The dotted line (----) on the map is drawn around the area from which a company wants to quarry iron ore.



(i) Give **one** reason that the company could give for the need to quarry the iron ore.

_____

_____

(1)

(ii) The people who live in the village do not want the quarry because it would decrease the value of their homes.

Suggest **two** other reasons why the villagers do not want the quarry.

1. _____

_____

2. _____

_____

(2)

(b) Iron ore contains the compound iron oxide, Fe_2O_3.

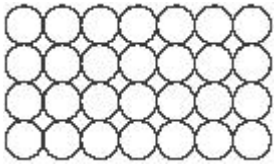
(i) Iron is extracted from its oxide in the blast furnace.

Complete the word equation for the extraction of iron.

iron oxide + _____ → iron + carbon dioxide

(1)

(ii) This diagram represents pure iron.



Use the diagram to explain why pure iron is described as an element.

_____

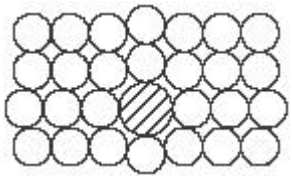
_____

_____

_____

(2)

(iii) Pure iron is relatively soft. The iron from the blast furnace is hard and brittle. The diagram below represents iron from the blast furnace.



Use the diagram to explain why iron from the blast furnace is hard and brittle.

_____

_____

_____

_____

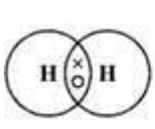
(2)

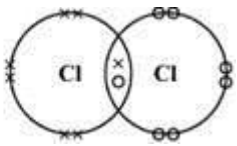
(Total 8 marks)

Q11.

Hydrogen chloride (HCl) can be made by the reaction of hydrogen (H_2) with chlorine (Cl_2).

(a) The diagrams represent molecules of hydrogen and chlorine.





Draw a similar diagram to represent a molecule of hydrogen chloride (HCl).
You need show only the outer energy level (shell) electrons.

(1)

(b) The word equation for the reaction of hydrogen with chlorine is shown below.

hydrogen + chlorine → hydrogen chloride

Write a balanced symbol equation for this reaction.

_____

(2)

(c) Hydrogen chloride gas reacts with magnesium to form the ionic compound called magnesium chloride. Use the table of ions on the Data Sheet to help you to write the formula of magnesium chloride.

_____

(1)

(d) Why does magnesium chloride have a much higher melting point than hydrogen chloride?

_____

_____

_____

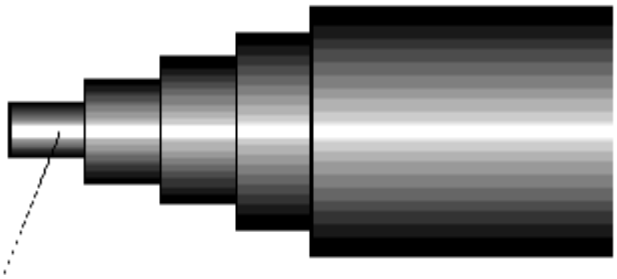
_____

(2)

(Total 6 marks)

Q12.

The drawing shows a high quality wire used to make electrical connections on a hi-fi system.



Multi-strand "OFC" copper
to maitain high signal purity

(a) Copper is used because it is a very good conductor of electricity. Copper is a typical metal.

(i) Describe the structure and bonding in a metal. You may wish to draw a diagram to help you to answer this question.

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

_____

_____

_____

_____

_____

_____

(3)

(ii) Explain, by reference to your answer to part (a)(i), why copper conducts electricity.

_____

_____

(1)

(iii) Explain, by reference to your answer to part (a)(i), why copper can be drawn into wires.

_____

_____

(1)

(b) The copper used to make this wire is “OFC” copper. This stands for ‘oxygen free copper’.

(i) It is thought that when molten copper is cooled and solidified it can take in some oxygen from the air. This may slightly decrease the conductivity of the copper.

Suggest why the conductivity might be decreased.

_____

_____

_____

_____

(2)

(ii) To make it oxygen free, the copper is heated in an atmosphere of hydrogen.

Explain how this will remove the oxygen.

_____

_____

_____

_____

(1)

(Total 8 marks)

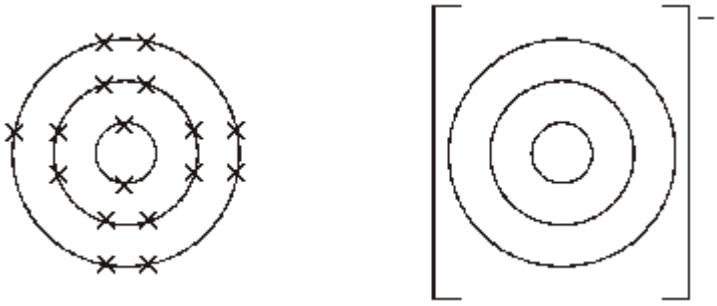
Q13.

(a) A tin of red kidney beans contains calcium chloride as a firming agent.

Calcium chloride is an ionic compound which contains calcium ions (Ca^{2+}) and chloride ions (Cl^-).

(i) The diagram on the left represents the electronic structure of a chlorine atom.

Complete a similar diagram on the right to represent a chloride ion.



(2)

(ii) Explain how a calcium **atom** changes into a calcium **ion** which has a 2+ charge.

_____

_____

_____

_____

(2)

(b) Cola drinks contain phosphoric acid, H_3PO_4. The two equations show how phosphoric acid can be made from phosphorus.

Balance these two equations.

(i) P_4 + _____ $O_2 \rightarrow P_4O_{10}$

(1)

(ii) P_4O_{10} + _____ $H_2O \rightarrow 4H_3PO_4$

(1)

(Total 6 marks)

Q14.

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

_____

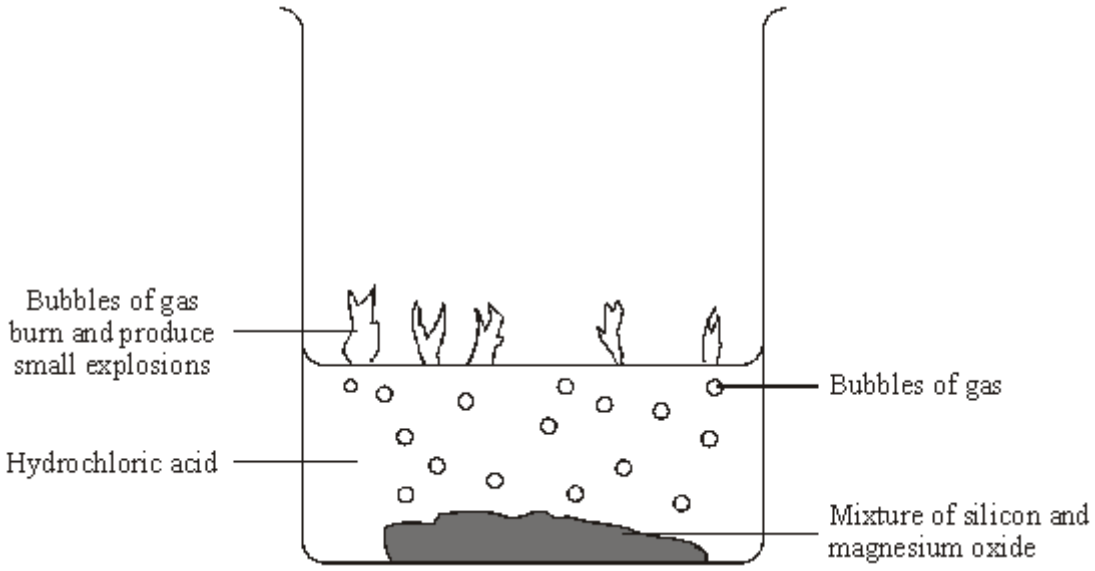
_____

_____

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

(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.

_____

_____

_____

_____

_____

_____

_____

_____

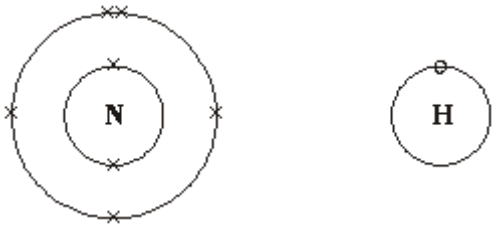
(4)

(Total 15 marks)

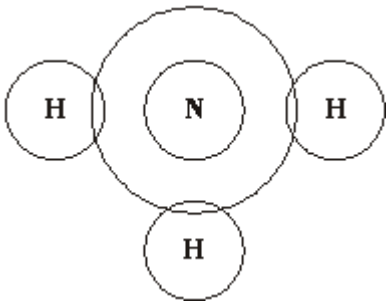
Q15.

Ammonia (NH_3) is an important chemical which is used to make fertilisers. Ammonia is made from nitrogen and hydrogen,

(a) The diagrams represent the electron arrangements in atoms of nitrogen and hydrogen.



Complete the diagram showing the arrangement of electrons in a molecule of ammonia.



(1)

(b) Name the type of bonding which holds the nitrogen and hydrogen atoms together in an ammonia molecule.

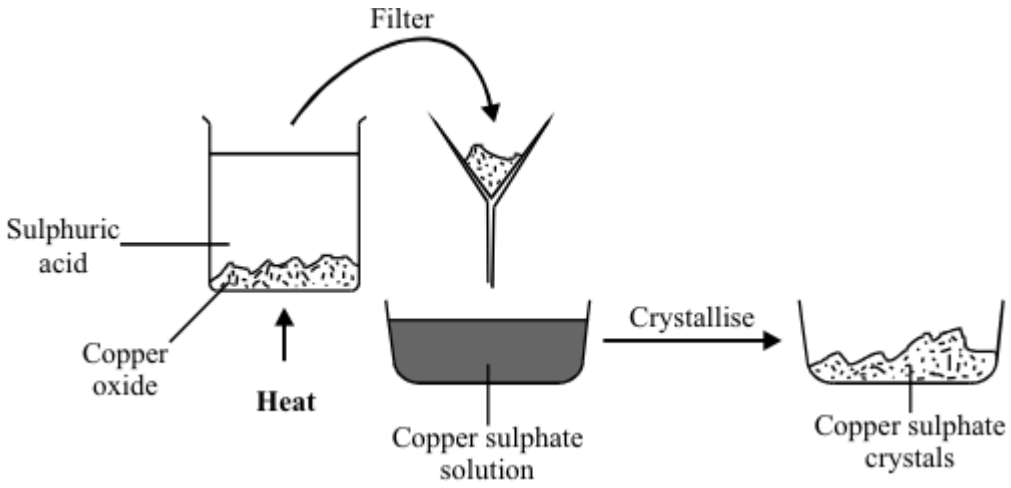
_____

(1)

(Total 2 marks)

Q16.

(a) The diagram shows one way of making crystals of copper sulphate.



(i) Why was the solution filtered?

_____

(1)

(ii) How could you make the crystals form faster from the copper sulphate solution?

_____

(1)

(iii) The chemical equation is shown for this reaction.

$$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$$

In the chemical equation what does (aq) mean?

_____

(1)

(b) Blue copper sulphate crystals go white when warmed. How could you use the white copper sulphate as a test for water?

_____

_____

_____

(2)

(Total 5 marks)

Q17.

Millions of years ago the Earth formed as a giant ball of molten rock. The outer surface cooled forming a thin, solid outer crust. Volcanic activity on the surface produced an atmosphere containing the compounds carbon dioxide, ammonia, methane and water vapour.

Describe the bonding in any **one** of these compounds. You must include electronic structures in your explanation.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(Total 4 marks)

Q18.

Transition metals are useful as catalysts. Iron is used as a catalyst in the manufacture of ammonia.

$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$

(i) What is meant by $\rightleftharpoons$ in the chemical equation?

_____

_____

(1)

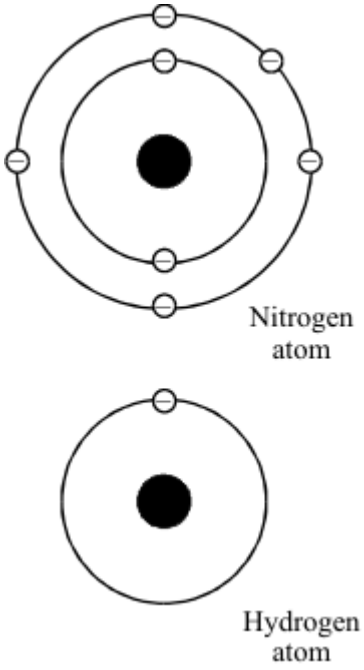
(ii) What would be the effect on the yield of ammonia if the pressure was increased?

_____

_____

(1)

(iii) Draw a diagram to show the arrangement of the electrons in a molecule of ammonia. The electron arrangement of each atom is shown.

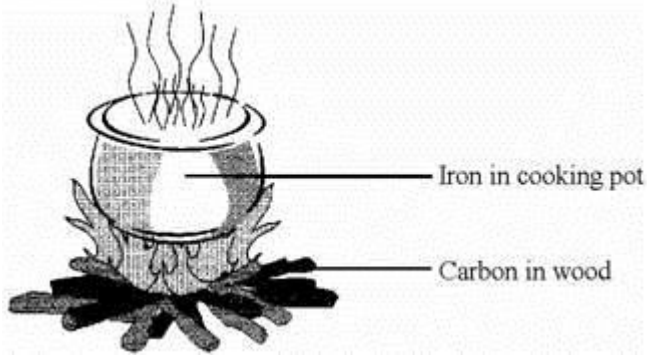


(1)

(Total 3 marks)

Q19.

The uses of *elements* depend on their properties.



(a) Carbon and iron are both *elements.* What is an *element?*

_____

_____

(1)

(b) Complete the sentences by crossing out the words that are wrong. The first one has been done for you.

~~Non-Metals~~	Metals	can be hammered into shape.
Non-Metals	Metals	often have low melting point.
Non-Metals	Metals	are good conductors of heat.

(2)

(c) In the box are the names of three metals.

copper	iron	sodium

Which **one** of these is **not** a good metal for making the cooking pot? Give a reason for your answer.

Metal _____

Reason _____

_____

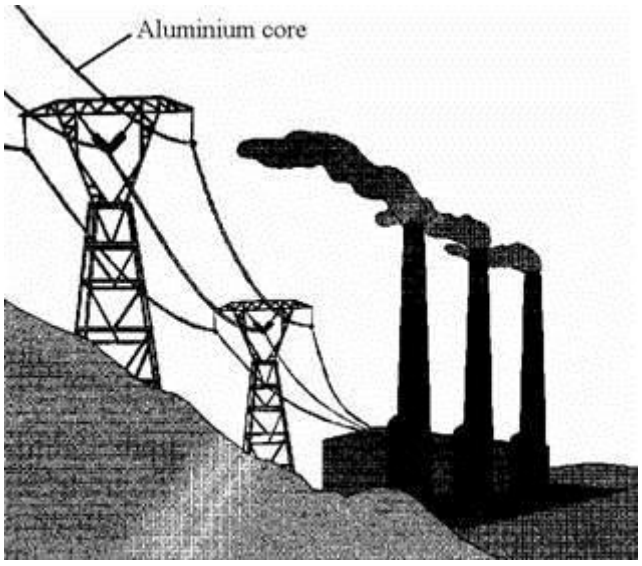
_____

(2)

(Total 5 marks)

Q20.

(a) Aluminium is more expensive than iron. Why is aluminium and not iron used for the central core in power cables?



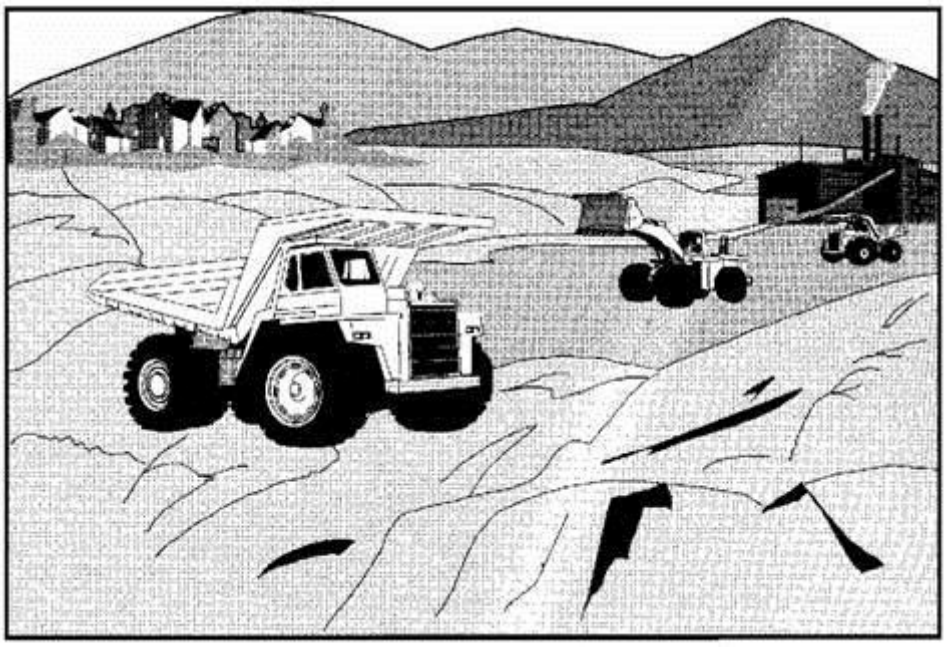
_____

_____

_____

(2)

(b) Many industrial processes involve the removal of minerals by quarrying.



All quarrying has some effect on the environment and on people's lives. Make comments about the social, economic, health, safety and environmental effects of quarrying.

(5)

(Total 7 marks)

Q21.

Sodium reacts with chlorine to form the compound sodium chloride.

$2Na + Cl_2 \rightarrow 2NaCl$

Describe, in terms of electron arrangement, the type of bonding in:

(i) a molecule of chlorine;

_____

_____

_____

(3)

(ii) the compound sodium chloride.

_____

_____

_____

_____

_____

_____

(4)

(Total 7 marks)

Q22.

Early atmospheres on Earth contained ammonia (NH_3).

(a) (i) Complete the sentence.

Our atmosphere today is made up of about _____ % nitrogen.

(1)

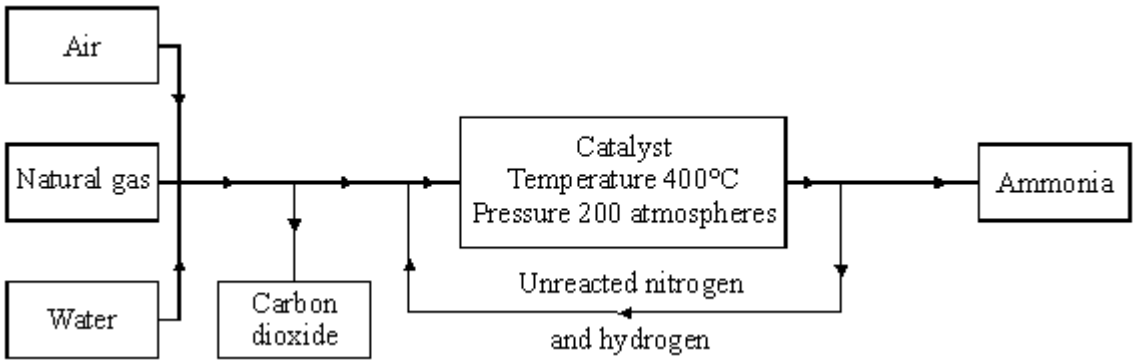
(ii) Today we convert nitrogen back to ammonia mainly for the production of fertilisers. What do plants convert the nitrogen in these fertilisers into?

_____

_____

(1)

(b) The conversion of nitrogen to ammonia is shown.



(i) When making ammonia, what is **one** source of hydrogen?

_____

(1)

(ii) Apart from ammonia, name **one** other product formed during this conversion.

_____

(1)

(c) The main reaction is the formation of ammonia from nitrogen and hydrogen.

(i) Complete and balance the equation for this reaction.

_____(g) + _____(g) → _____NH_3(g)

(2)

(ii) Name the metal catalyst used in this reaction.

_____

(1)

(iii) This reaction does not work successfully at room temperature (20 °C) and needs a much higher temperature of 400 °C. Explain why.

_____

_____

_____

(2)

(d) Draw a diagram to show the arrangement of the electrons in a molecule of ammonia. The electron arrangement of each atom is hydrogen 1 and nitrogen 2.5.

(2)

(Total 11 marks)

Q23.

Many everyday substances can be classified as acids, bases or salts. For example, car batteries contain sulphuric acid, oven cleaners contain sodium hydroxide and table salt contains sodium chloride.

(a) A solution of each of these substances was tested with universal indicator.

Solution	Colour of universal indicator
Sulphuric acid (H_2SO_4)	red
Sodium hydroxide (NaOH)	purple
Sodium chloride (NaCl)	green

(i) Explain how these universal indicator colours and the corresponding pH values could be used to identify each of these solutions.

_____

_____

_____

_____

_____

(3)

(ii) Name and give the formula of the ion which causes the solution to be acidic.

Name of ion _____

Formula of ion _____

(2)

(b) Sodium chloride can be made by reacting sodium hydroxide with hydrochloric acid in the presence of an indicator.

(i) What is the name of this type of reaction?

_____

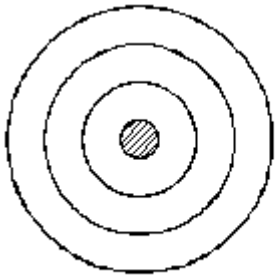
(1)

(ii) Write a balanced chemical equation for this reaction.

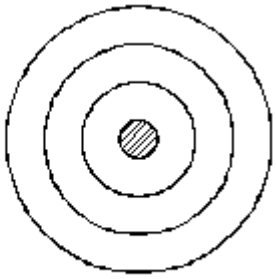
_____(aq) + _____(aq) → _____(aq) + _____(l)

(2)

(c) The atomic number for sodium is 11 and for chlorine is 17.



Sodium atom



Chlorine atom

(i) Complete the diagrams to show the electron arrangements for a sodium atom and a chlorine atom.

(2)

(ii) These atoms form different particles by one electron transferring from the sodium atom to the chlorine atom. What is the name given to the particles formed?

_____

(1)

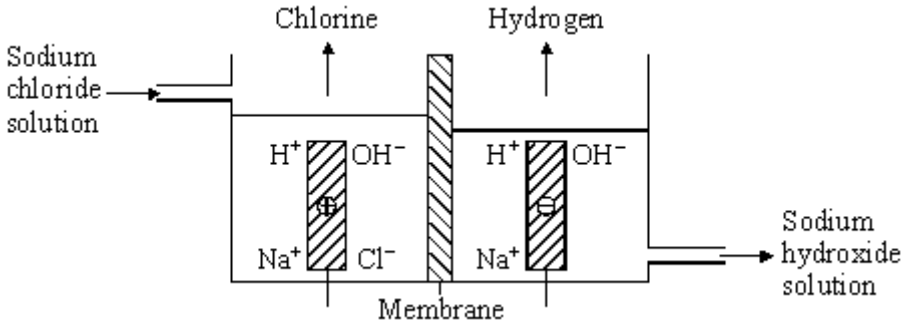
(iii) Why do these sodium and chloride particles bond?

_____

_____

(1)

(d) Sodium chloride solution is electrolysed to form three products, hydrogen, chlorine and sodium hydroxide.



Describe how each of these products are formed.

_____

_____

_____

_____

_____

_____

(3)

(Total 15 marks)

Q24.

Calcium tablets are taken to build and maintain strong bones and teeth.

(a) These tablets react with hydrochloric acid in the stomach.

$CaCO_3(\quad) + 2HCl(aq) \rightarrow CaCl_2(\quad) + H_2O(\quad) + CO_2(\quad)$

(i) Add all these missing state symbols [aq g l s] to the balanced chemical equation.

(2)

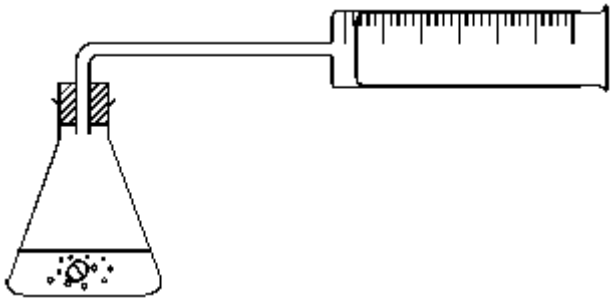
(ii) The calcium salt that is formed is absorbed during digestion. What is the name of the calcium salt?

_____

_____

(1)

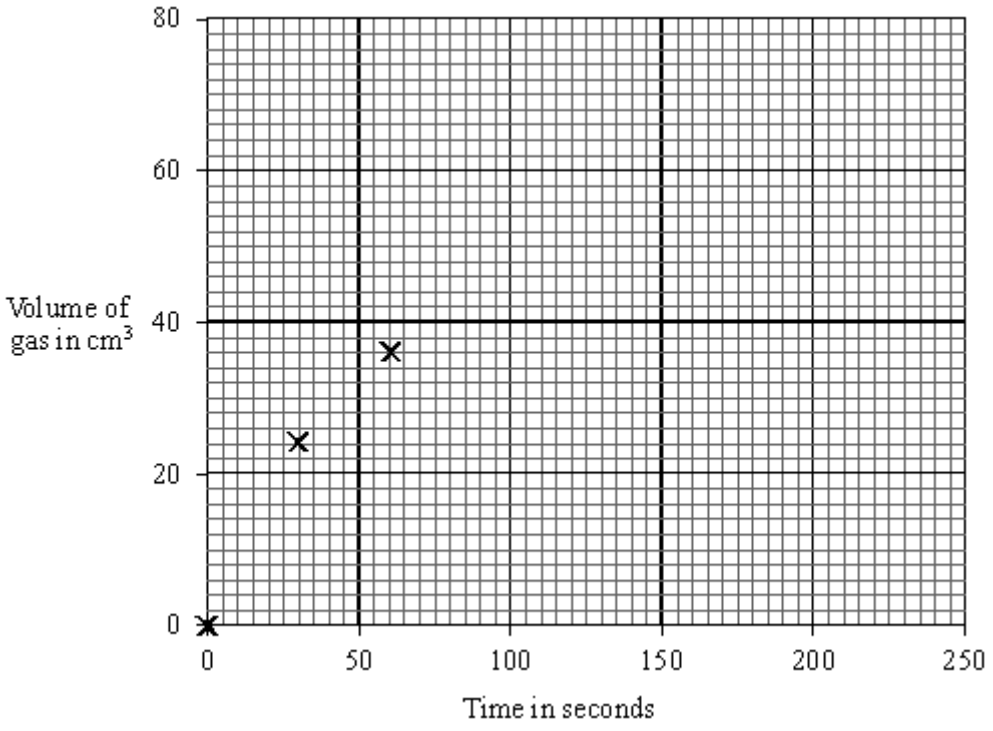
(b) The volume of carbon dioxide produced by one calcium tablet in the stomach can be found as shown.



The volume of carbon dioxide was recorded every 30 seconds until the reaction stopped.

Time in seconds	0	30	60	90	120	150	180	210	240
Volume of gas in cm^3	0	24	36	46	52	56	59	60	60

(i) Complete the graph of these results.



(3)

(ii) Describe **one** way in which this reaction can be made to go faster.

_____

_____

(1)

(iii) A calculation, using the mass of this tablet, showed that 80 cm^3 of carbon dioxide would be produced if the tablet was pure calcium carbonate. What do the results show about the purity of the tablet? Explain your answer by calculating the purity of this tablet.

_____

_____

_____

_____

_____

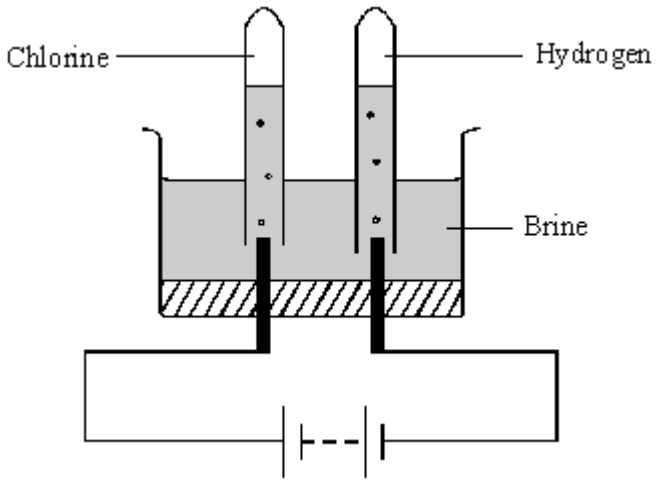
_____

(3)

(Total 10 marks)

Q25.

Brine, a solution containing sodium chloride in water, can be used to manufacture chlorine, hydrogen and sodium hydroxide. A student sets up a simplified model of the industrial cell.



(a) The electron arrangements of some atoms are shown here.

H	1
O	2.6
Na	2.8.1
C1	2.8.7

(i) Use the relevant electron arrangements to describe the bonding in water.

_____

(2)

(ii) Use the relevant electron arrangements to describe the bonding in sodium chloride.

(3)

(b) Use the atomic structures of $^{35}_{17}Cl$ and $^{37}_{17}Cl$ to explain the meaning of the term *isotopes.*

(3)

(Total 8 marks)

Q26.

This question is about sodium chloride (common salt) which is an important chemical.

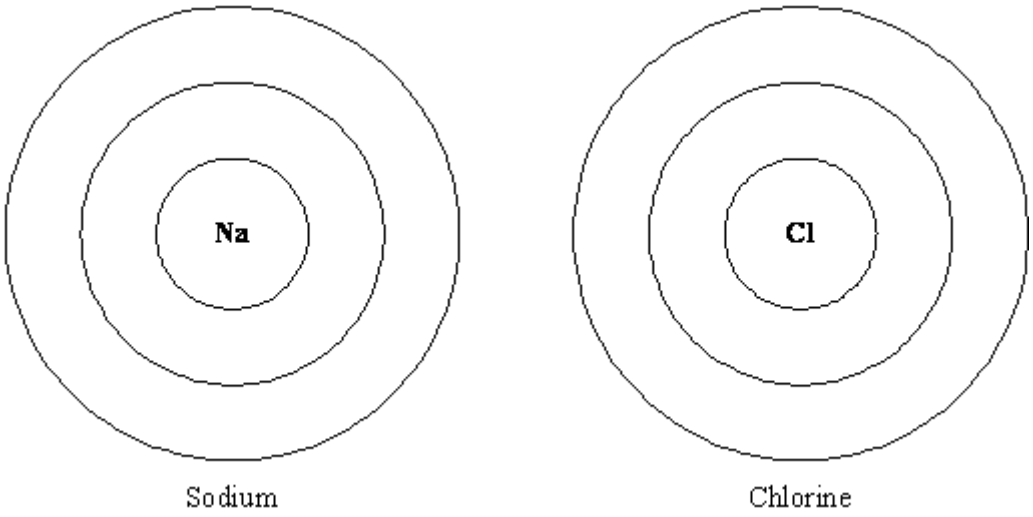
Sodium chloride can be made by burning sodium in chlorine gas.

(a) Balance the symbol equation for the reaction of sodium with chlorine.

$$Na_{(s)} + Cl_{2(g)} \rightarrow NaCl_{(s)}$$

(1)

(b) (i) Complete the diagrams below to show the electronic structures of a sodium and a chlorine atom. (Atomic number of sodium = 11 and chlorine = 17.)



(3)

(ii) When sodium reacts with chlorine the sodium atoms are changed into sodium ions (Na^+) and the chlorine atoms are changed into chlorine ions (Cl^-).

Explain how:

1. a sodium atom changes into a sodium ion;

_____

_____

(2)

2. a chlorine atom changes into a chloride ion.

_____

_____

(2)

(c) The element potassium is in the same group of the Periodic Table as sodium.

Potassium reacts with chlorine to make potassium chloride which is sometimes used instead of common salt in cooking.

(i) Predict the formula of potassium chloride.

_____

(1)

By reference to the electronic structures of potassium and sodium explain:

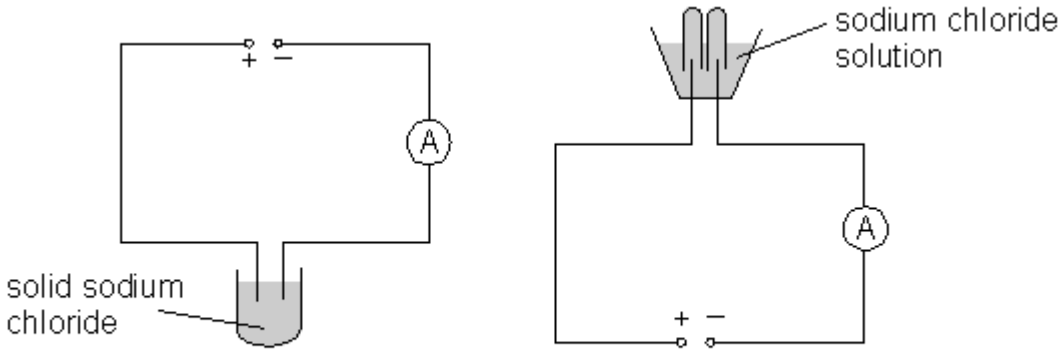
(ii) Why the reaction of potassium with chlorine is similar to the reaction of sodium with chlorine.

_____

_____

(1)

(d) The electrolysis of sodium chloride solution is an important industrial process. The diagrams below show two experiments set up during an investigation of the electrolysis of sodium chloride.



Experiment 1 Experiment 2

(i) What would be the reading on the ammeter in experiment 1?

_____ A

(ii) Explain your answer.

_____

_____

_____

(3)

(e) The equations below show the reactions which take place in experiment 2.

$$H_2O_{(1)} \rightarrow H^+_{(aq)} + OH^-_{(aq)}$$

$$2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$$

$$2Cl^-_{(aq)} - 2e^- \rightarrow Cl_{2(g)}$$

(i) Which substance provides hydrogen ions?

_____

(1)

(ii) Name the product formed at:

(A) the positive electrode;

_____

(B) the negative electrode.

_____

(1)

(Total 15 marks)

Q27.

Fluorine is a very useful element. It is placed in group 7 of the Periodic Table.

Use your knowledge of the elements in group 7 to help you answer these questions. You may find that information in the Data Sheet may help you with this question.

(a) Name another element in group 7 of the Periodic Table.

_____

(1)

(b) Cylinders filled with fluorine molecules are commercially available. What would you expect the formula of a fluorine molecule to be?

_____

(1)

(c) Fluoride ions are added to drinking water to help prevent tooth decay. What is the charge on fluoride ions in the water?

_____

(1)

(d) Fluorine reacts with the non-metal sulphur to make sulphur hexafluoride (SF_6).

(i) What type of bonding would you expect in sulphur hexafluoride?

_____

(1)

(ii) Explain the reason for your answer to part (i).

_____

_____

_____

(1)

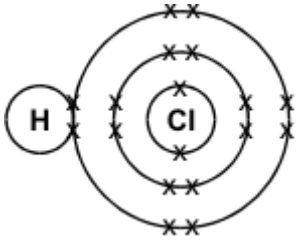
(Total 5 marks)

Q28.

The hydrogen halides (hydrogen fluoride, hydrogen chloride, hydrogen bromide and

hydrogen iodide) are important chemicals.

The diagram below represents a molecule of hydrogen chloride.



(i) What type of particles are represented by the crosses (X)?

_____

(1)

(ii) What type of chemical bond holds the atoms in this molecule together?

_____

(1)

(iii) Would you expect hydrogen chloride to be a gas, a liquid or a solid, at room temperature and pressure? Explain your answer.

_____

_____

_____

(3)

(Total 5 marks)

Q29.

The extract below was taken from a leaflet on the uses of platinum. One of the uses described was in making electrodes for spark plugs in car engines. The spark plug produces the spark which ignites the fuel in the engine.

Spark Plugs

The electrodes in a spark plug have to conduct electricity very well. Since they project into the combustion chamber of the engine, they must also be able to withstand extremely high temperatures in a very corrosive atmosphere.

Nickel-based plugs have been produced for many years. They only last a fairly short time. As the electrodes wear, combustion becomes less efficient and the petrol is not burnt completely.

Platinum and other precious metals can now be used in spark plugs. These last much longer and are more efficient. This can help to reduce air pollution.

The table below gives some information about platinum and nickel.

	MELTING POINT (° C)	BOILING POINT (° C)	POSITION IN REACTIVITY SERIES	COST (£/kg)

nickel	1455	2920	Higher than gold	2.5
platinum	1769	4107	below gold	6110

(a) Compare nickel and platinum for use in making the electrodes in spark plugs.

A good answer should give advantages and disadvantages of each metal linking these to the properties of the metals. Marks will be given for the way in which you organise your answer.

You will need a sheet of lined paper.

(8)

(b) (i) Describe the structure and bonding in metals.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) Explain why metals such as nickel and platinum are good conductors of electricity.

_____

_____

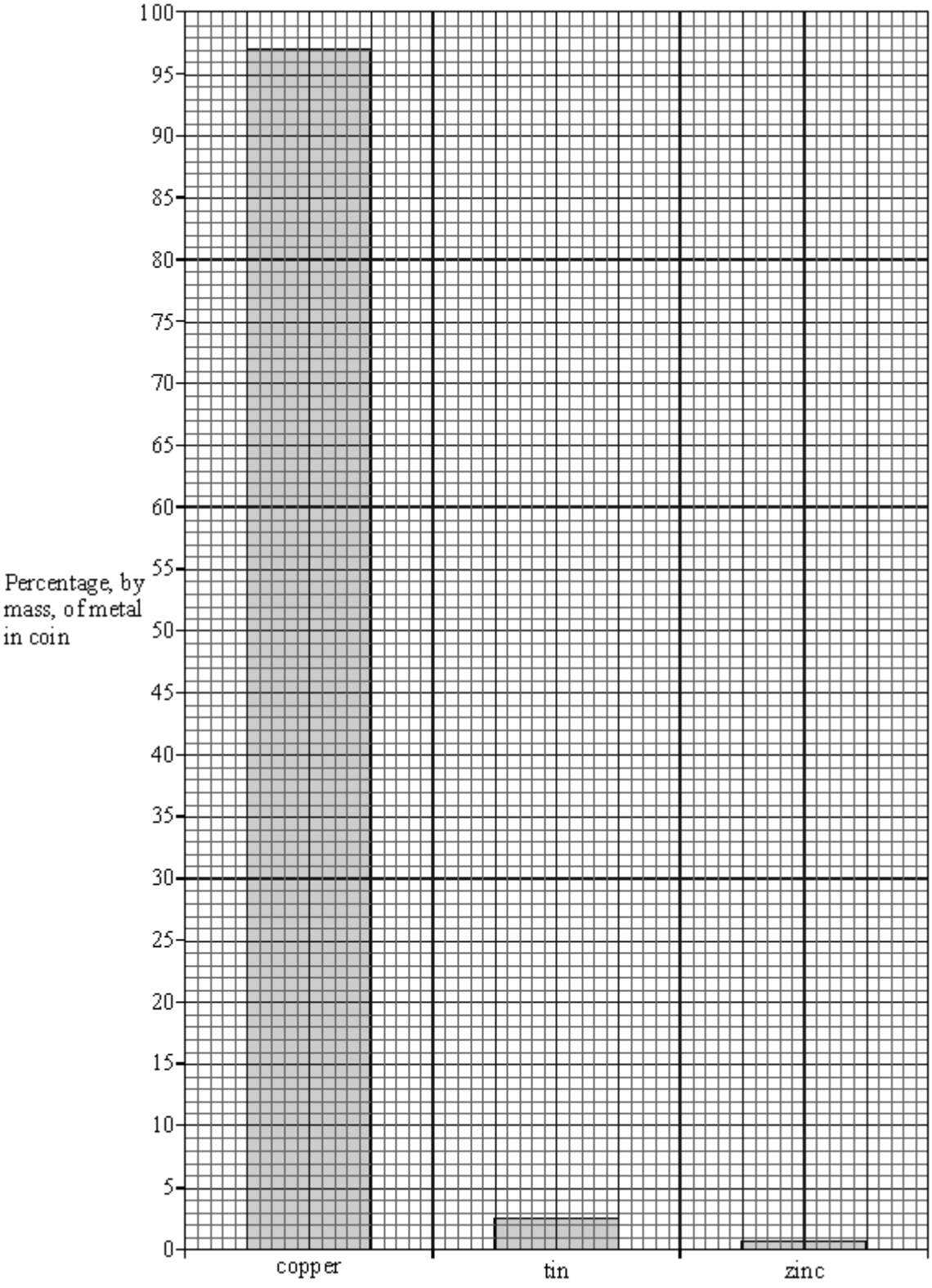
_____

(2)

(Total 13 marks)

Q30.

The chart below shows the metals which are present in a coin.



(a) Identify the alloy used to make this coin.

_____

(1)

(b) The mass of the coin is 2.5 g.
Calculate the mass of copper in this coin.

_____

_____

(2)

(c) Suggest what properties would make an alloy suitable for making a coin.

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q31.

Read the following information about an element X.

The element X melts above 600°C. It conducts electricity at room temperature. It burns in oxygen to form an oxide. When the oxide is mixed with water it turns Universal Indicator blue.

The oxide of X is a white solid at room temperature. It has the formula XO and contains the ion X^{2+}.

The element X reacts with chlorine to form a chloride with a high melting point. The chloride conducts electricity when molten and it is soluble in water.

(a) From the information give **three** pieces of evidence which suggest that X is a metal.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(b) In which Group of the Periodic Table should X be placed? Give a reason for your answer.

Group _____

Reason _____

_____

(2)

(c) Predict the formula for the chloride of X. _____

(1)

(Total 6 marks)

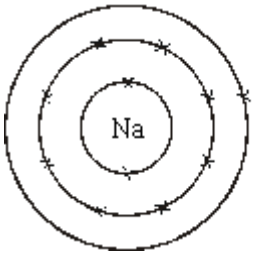
Q32.

(a) The electronic structure of a sodium atom can be written 2,8,1.
Write the electronic structure of a potassium atom in the same way.

_____

(1)

(b) The electronic structure of a sodium atom can also be represented as in the diagram below.



(i) Draw a similar diagram for a fluorine atom.

(ii) Draw similar diagrams to show the electronic structure of the particles in sodium fluoride.

(4)
(Total 5 marks)

Q33.

The following passage was taken from a chemistry textbook.

Germanium is a white, shiny, brittle element. It is used in the electronics industry because it is able to conduct a small amount of electricity.

It is made from germanium oxide obtained from flue dusts of zinc and lead smelters. The impure germanium oxide from the flue dusts is changed into germanium by the process outlined below.

STEP 1 The germanium oxide is reacted with hydrochloric acid to make germanium tetrachloride. This is a volatile liquid in which the germanium and chlorine atoms are joined by covalent bonds.

STEP 2 The germanium tetrachloride is distilled off from the mixture.

STEP 3 The germanium tetrachloride is added to an excess of water to produce germanium oxide and hydrochloric acid.

STEPS 1 to 3 are repeated several times.

STEP 4 The pure germanium oxide is reduced by hydrogen to form germanium.

(a) Balance the equation below which represents the reaction in step 1.

GeO_2 + _____ HCl → $GeCl_4$ + _____ H_2O

(1)

(b) Write a word equation for the reaction in step 3.

_____

(1)

(c) Suggest why steps 1 to 3 are repeated several times.

_____

_____

(1)

(d) The equation which represents the reaction in step 4 is shown below.

GeO_2 + $2H_2$ → Ge + $2H_2O$

(i) Explain what is meant by the term 'reduced'.

_____

_____

(1)

(ii) Calculate the mass of germanium which could be made from 525 g of germanium oxide. (Relative atomic masses: Ge = 73; O = 16).

_____

_____

_____

_____

Mass _____ g

(3)

(e) Germanium is difficult to classify as either a metal or a non-metal.

(i) Give as much evidence as you can from the information in this question to support the view that germanium is a metal. Explain your answer as fully as you can.

_____

_____

_____

_____

_____

(3)

(ii) Give as much evidence as you can from the information in this question to support the view that germanium is a non-metal. Explain your answer as fully as you can.

_____

_____

_____

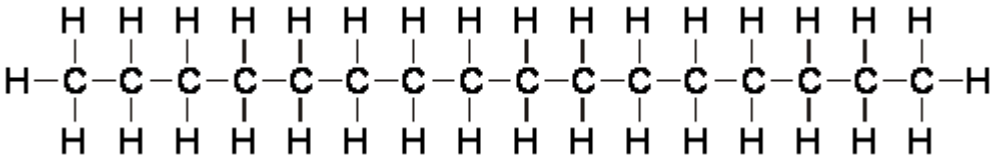
_____

(3)

(Total 13 marks)

Q34.

Diesel oil is obtained from crude oil. It can be used as a fuel for car engines. The diagram below represents a compound found in diesel oil.



(a) What is the formula of this compound?

_____

(1)

(b) Each of the lines on the diagram above represents a covalent bond.

What is a covalent bond?

_____

_____

(2)

(Total 3 marks)

Q35.

(a) The list below gives six substances.

- aluminium
- beer
- copper
- milk

- pure water
- sodium chloride

Put each substance in the correct column of the table.

ELEMENTS	COMPOUNDS	MIXTURES

(3)

(b) Elements can be divided into two groups, metals and non-metals.

The list below gives some properties of elements.

- brittle
- can be hammered into shape
- dull
- good conductors of electricity
- poor conductors of electricity
- shiny

Put each property into the correct column.

PROPERTIES OF METALS	PROPERTIES OF NON-METALS

(3)

(Total 6 marks)

Q36.

Sando-K is a medicine. It is given to people whose bodies contain too little of a particular element.

Sando-K is a mixture of two compounds. The formulae of the two compounds are given below.

$KHCO_3$ KC1

(a) Which metal do people given Sando-K need?

_____

(1)

(b) Sando-K contains the ion, CO_3^{2-}. Which gas would be produced if a dilute acid was

added to Sando-K? (The Data Sheet may help you to answer this question.)

_____

(1)

(c) The compounds in Sando-K contain ions.

Complete the two sentences below.

Atoms change into positive ions by _____ one or more

_____ .

Atoms change into negative ions by _____ one or

more _____ .

(4)

(d) Electricity can be used to show that an aqueous solution of Sando-K contains ions.

(i) Draw a diagram of an apparatus that you could use to prove that Sando-K contains ions.

(4)

(ii) Explain, as fully as you can, what would happen when the electricity is switched on.

_____

_____

_____

_____

(3)

(Total 13 marks)

Q37.

Calcium and magnesium are elements. They are found in the Earth's crust as compounds, often carbonates and sulphates. Magnesium is also found as its chloride.

(a) Calcium and magnesium are in the same Group in the Periodic Table.
State which Group this is.

_____

(1)

(b) Use the Data Sheet to help you to answer this question.

(i) Write the chemical formula of magnesium chloride.

_____

(1)

(ii) Name the type of bonding in magnesium chloride.

_____

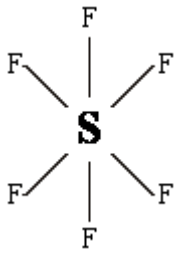
(1)

(Total 3 marks)

Q38.

Sulphur hexafluoride is a colourless, odourless, non-flammable gas, which is insoluble in water and extremely unreactive. It is used as an insulator in high voltage transformers and switchgear.

The diagram below represents a molecule of sulphur hexafluoride.



(a) What type of chemical bond holds the sulphur and fluorine atoms together in sulphur hexafluoride molecules?

_____

(1)

(b) Explain why sulphur hexafluoride has a low boiling point.

_____

_____

(2)

(c) Explain how **three** of the properties of sulphur hexafluoride make it suitable for use as an insulator inside electrical transformers.

Property 1: _____

Explanation: _____

_____

Property 2: _____

Explanation: _____

_____

Property 3: _____

Explanation: _____

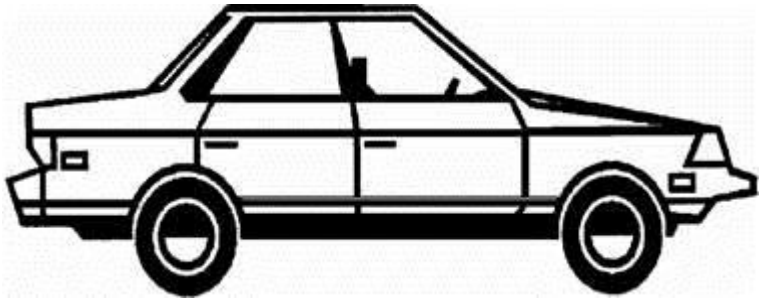
_____

(3)

(Total 6 marks)

Q39.

Iron is used (as steel) to make the body panels for cars.



The iron panels have to be bendable so that they can be pressed into the shape required, but must also be strong. The panels must also be able to conduct electricity because they form part of the electrical circuits of the car.

(a) Iron is a typical metal. Describe the structure and bonding in a metal such as iron. You may use a diagram if you wish.

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Explain how the structure and bonding of iron:

(i) allows the body panels to conduct electricity;

_____

(2)

(ii) allows the body panels to be bent into shape;

_____

(1)

(iii) gives the body panels strength.

_____

(1)

(Total 8 marks)

Q40.

X is an element with the following properties:

- melts at –220°C and boils at –188°C;
- does not conduct electricity at room temperature;
- forms molecular compounds with non-metals;
- forms ionic salts with metals in which its ion has a 1–charge.

(a) Would you expect X to be a solid, a liquid or a gas at 20°C?

_____

(1)

(b) Predict the formula of the product formed when X reacts with aluminium.
(The aluminium ion is Al^{3+} and the X ion is X^{-}.)
Select your answer from the list below.

AlX **AlX_2** **AlX_3** **Al_3X** **Al_2X_3**

Predicted formula _____

(1)

(c) To which Group of the Periodic Table does the element X belong?

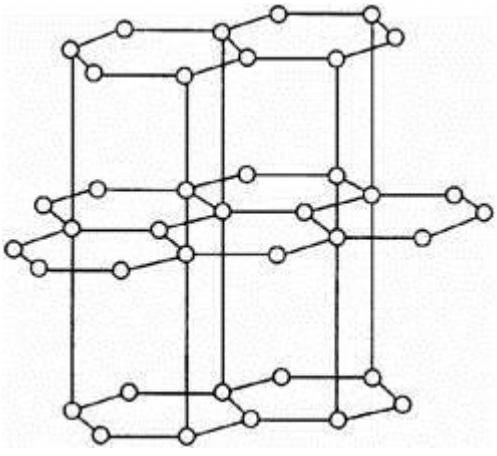
_____

(1)

(Total 3 marks)

Q41.

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;

_____

_____

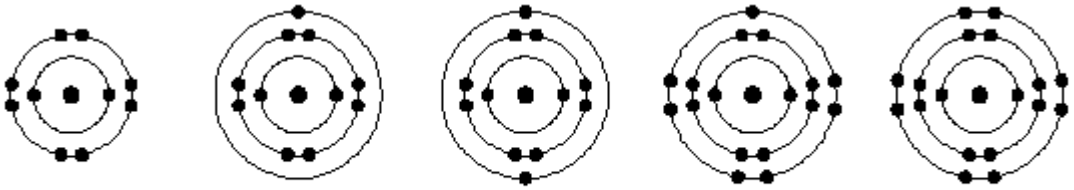
(b) as an electrical conductor.

(Total 5 marks)

Q42.

Use the Data Sheet to help you answer this question.

When sodium reacts with water it forms sodium ions.
The diagrams below represent the electron arrangements of some atoms and ions.



Which of the diagrams, **A** to **E**, represents the electron arrangement of each of the following?

(i) A sodium atom, Na _____

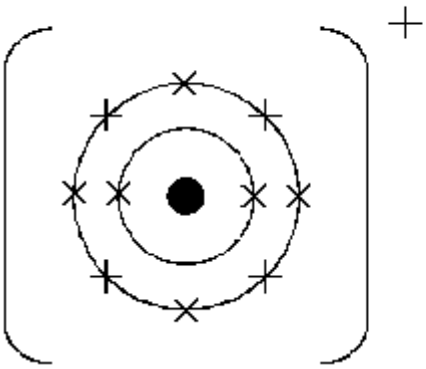
(ii) A sodium ion, Na^+ _____

(Total 2 marks)

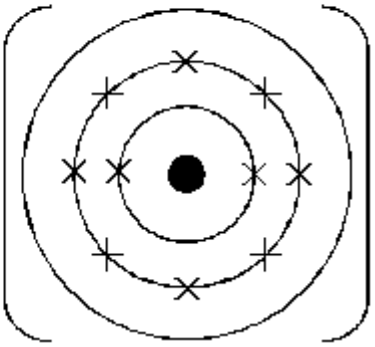
Q43.

Sodium chloride is an ionic compound.

This is a diagram of a sodium ion.



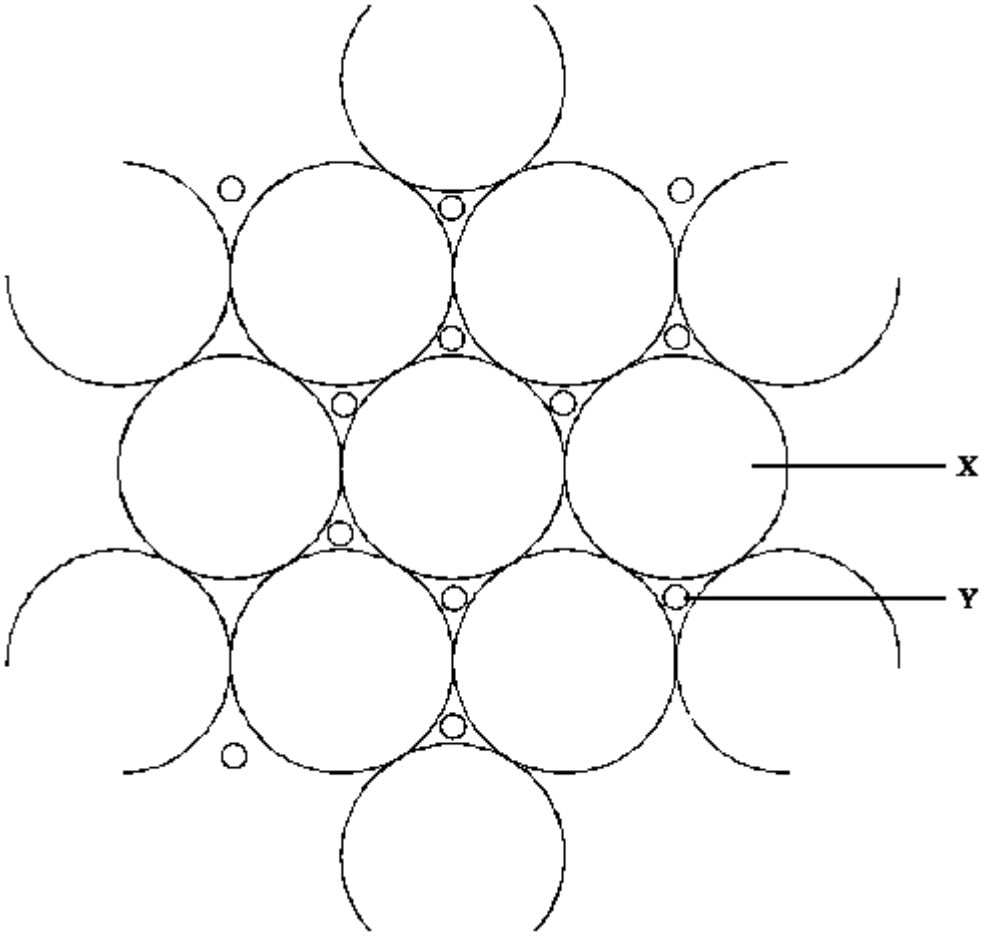
Complete this diagram of a chloride ion.



(Total 2 marks)

Q44.

The diagram shows a model of part of the giant lattice of a metal.



(a) Name particles **X** and **Y**.

X _____

Y _____

(2)

(b) Explain, in terms of the giant structure above, why is it possible to bend a piece of metal.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q45.

(a) Magnesium burns in oxygen, forming magnesium oxide.

This equation represents the reaction.

$Mg\ (s) + O_2\ (g) \rightarrow MgO\ (s)$

(i) Balance the equation.

(1)

(ii) Give the meaning of the state symbols (s) and (g).

(s) _____

(g) _____

(2)

(b) Use the Formulae of Some Common Ions table on the Data Sheet to help you to answer this question.

Magnesium also reacts with chlorine to form magnesium chloride.

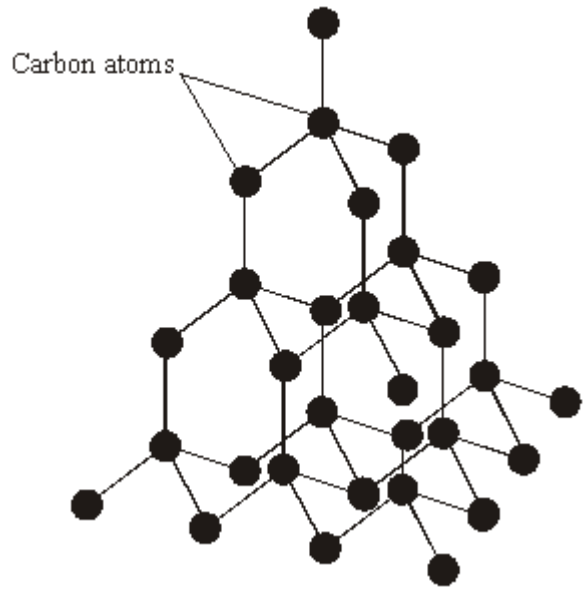
Give the formula of magnesium chloride _____

(1)

(Total 4 marks)

Q46.

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.

_____

_____

_____

_____

_____

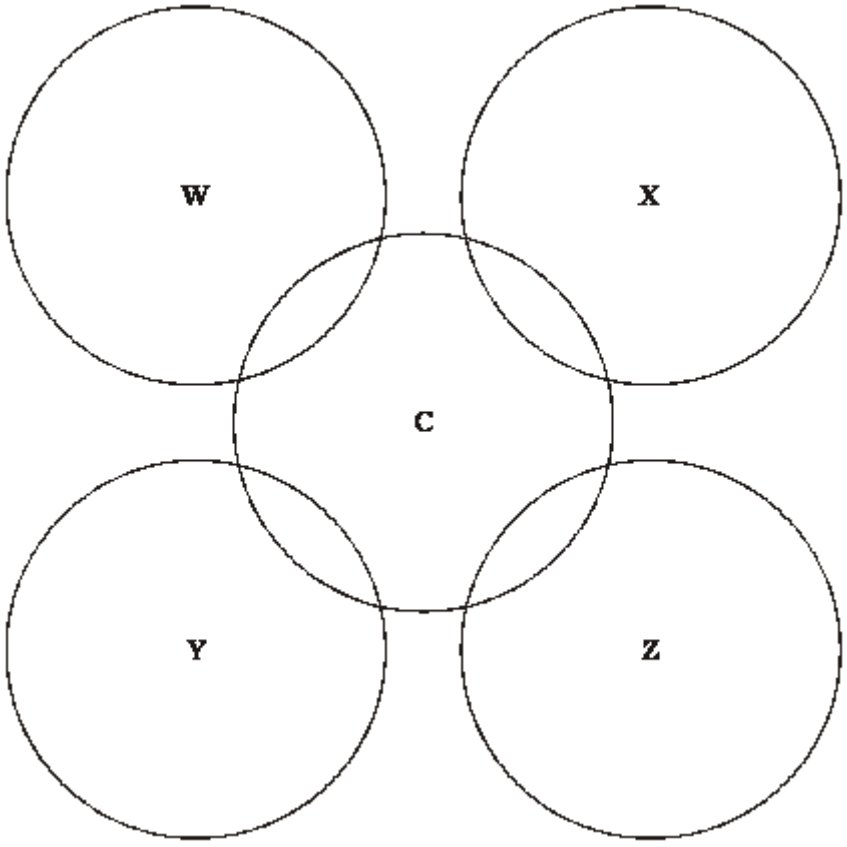
_____

(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)

Q47.

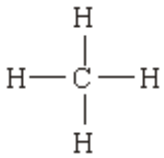
(a) A piece of lithium is placed on the surface of some water in a beaker.
Hydrogen is given off.
Lithium hydroxide is also formed.

Write a word equation for this reaction.

_____

(2)

(b) The diagram shows the structure of a molecule of methane.



Write down everything that this diagram tells you about a methane molecule.

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

_____

_____

_____

_____

_____

_____

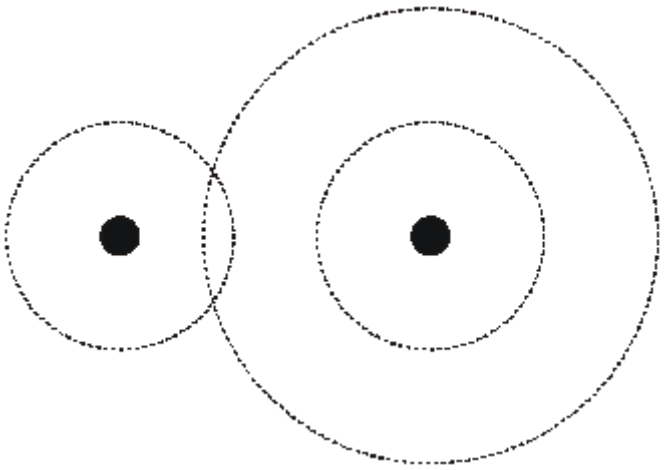
_____

(4)

(Total 6 marks)

Q48.

(i) Complete the drawing to show the electron structure of a hydrogen fluoride molecule. Draw electrons as dots or crosses.



(1)

(ii) Explain why hydrogen fluoride is a gas at room temperature.

_____

_____

_____

_____

(2)

(Total 3 marks)

Q49.

(a) In industry ammonia is produced from nitrogen and hydrogen. The equation for the reaction is:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(i) What does the symbol (g) represent?

_____

(1)

(ii) What does the symbol $\rightleftharpoons$ represent?

_____

(1)

(iii) Nitrogen is used for the industrial production of ammonia. From what raw material does this nitrogen come?

_____

(1)

(iv) Hydrogen is used for the industrial production of ammonia. It is obtained from the reaction between methane and steam. The equation for this reaction is:

$CH_4 + H_2O \rightarrow 3H_2 + CO$

Explain how you can tell that this equation is balanced.

_____

_____

_____

_____

(2)

(b) Ammonia is used to make ammonium salts which can be used as fertilisers.

(i) Complete the names in the following sentence.

One example is ammonium _____ which is made by reacting

ammonia with _____ acid.

(2)

(ii) All ammonium salts are soluble in water. Why is this a useful property of a fertiliser?

_____

_____

(1)

(c) Ammonia is a covalent, chemical compound.

(i) Complete the following sentence to describe a chemical compound.

In a chemical compound, two or more _____

_____

_____

(1)

(ii) What is a covalent bond?

_____

_____

(1)

(Total 10 marks)

Q50.

Electrons, neutrons and protons are sub-atomic particles.

(a) Complete the **six** spaces in the following table.

Name of sub-atomic particle	Relative mass	Relative charge
_____	1	_____
_____	_____	0
_____	$\frac{1}{1840}$	_____

(3)

(b) An aluminium atom has 13 electrons. How are these arranged in shells around the nucleus?

_____

(1)

(c) Chromium atoms have 24 protons and 28 neutrons.

(i) How many electrons does each neutral chromium atom have?

_____

(1)

(ii) What is the mass number of chromium?

_____

(1)

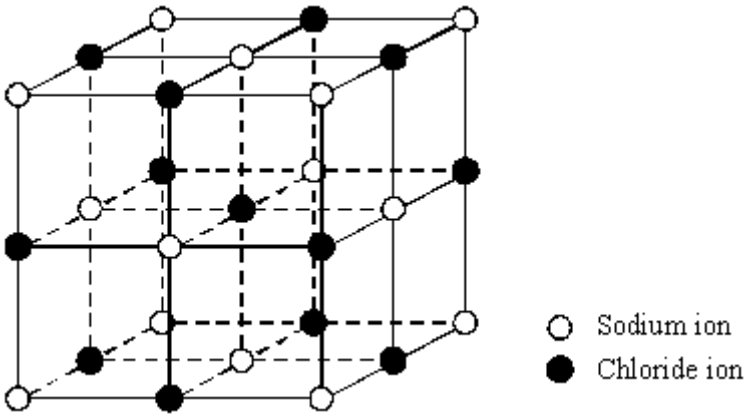
(d) What change occurs to an atom which undergoes the process of *reduction* in a chemical reaction?

_____

_____

(1)

(e) The diagram shows part of the ionic lattice of a sodium chloride crystal.



Explain why the ions in this lattice stay in place.

_____

_____

_____

_____

_____

_____

(3)

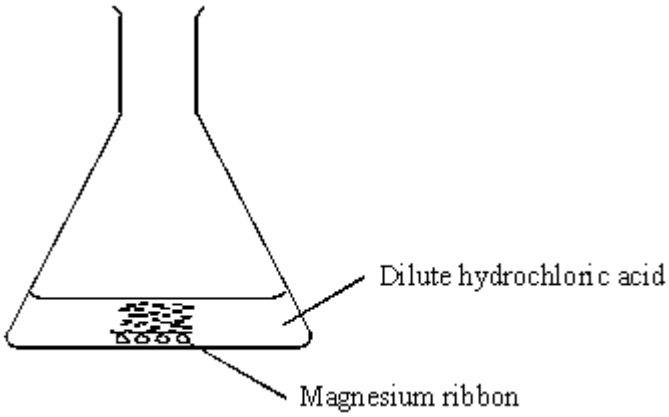
(Total 10 marks)

Q51.

In this question you will need to use the following information:

Relative atomic masses: H 1; O 16; Mg 24. The volume of one mole of any gas is 24 $dm^{>3}$ at room temperature and atmospheric pressure.

The diagram shows a chemical reaction taking place in a conical flask.



The balanced equation for this reaction is:

$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

(a) Write a balanced ionic equation for this reaction.

_____

(2)

(b) Calculate the mass of magnesium required to produce 0.50 g of hydrogen. Show clearly how you work out your final answer and give the unit.

_____

_____

Mass = _____

(2)

(c) (i) Draw a diagram to show how the electrons are arranged in a hydrogen molecule.

(1)

(ii) What is the name of the type of chemical bond between the hydrogen atoms in a hydrogen molecule?

_____

(1)

(d) The chemical formula for hydrogen peroxide is H_2O_2.

Calculate, to the nearest whole number, the percentage, by mass, of hydrogen in hydrogen peroxide. Show clearly how you work out your answer.

_____

Percentage = _____ %

(2)

(Total 8 marks)

Q52.

(a) Atoms are made of sub-atomic particles. Complete the **six** spaces in the table.

Name of sub-atomic particle	Relative mass	Relative charge
_____	$\frac{1}{1840}$	_____
Neutron	_____	_____
_____	1	_____

(3)

(b) Complete the spaces in the sentences.

(i) The atomic number of an atom is the number of _____ in its nucleus and is equal to the number of _____ if the atom is not charged.

(1)

(ii) The mass number of an atom is the total number of _____ and _____ in its nucleus.

(1)

(c) The table gives information about the atoms of three elements.

Name of element	Chemical symbol	Number of electrons in:		
		1st shell	**2nd shell**	**3rd shell**
Fluorine	F	2	7	0
Neon	Ne	2	8	0
Sodium	Na	2	8	1

Two of these elements can react together to form a chemical compound.

(i) What is the name and the formula of this compound?

Name _____ Formula _____

(2)

(ii) What type of bonding holds this compound together?

_____

(1)

(iii) Explain, in terms of electron transfer, how the bonding occurs in this compound.

_____

_____

_____

_____

_____

_____

(2)

(Total 10 marks)