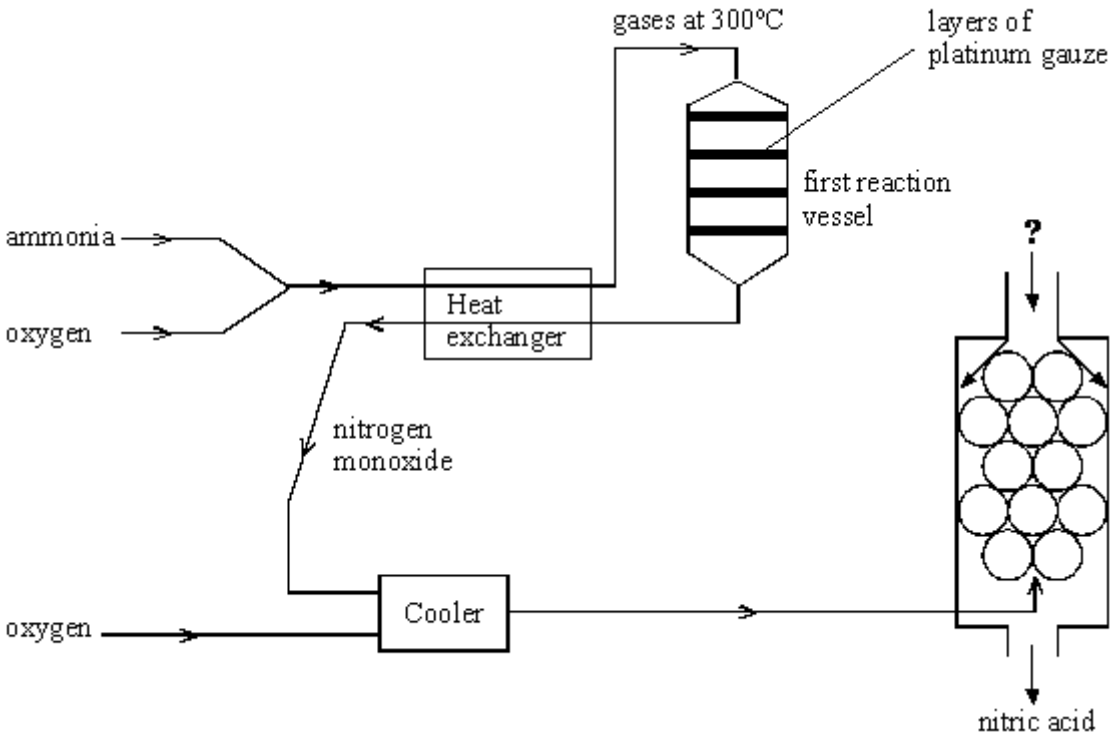
Q1. The chart shows the processes involved in the manufacture of nitric acid from ammonia.



(a) Complete the word equation for the reaction that takes place in the first reaction vessel.

ammonia + ... ⟶ nitrogen monoxide + water

(1)

(b) (i) What is the use of the platinum gauze in the reaction vessel?

.....

(1)

(ii) At first, the platinum gauze is electrically heated. However, as the reaction continues, no further heating is necessary.
Explain why.

.....

(1)

(c) Explain why the heat exchanger is used.

.....

.....

.....

.....

(2)

(d) To convert nitrogen monoxide into nitric acid, **two** further reactants are needed. What are they?

..... and .....

(1)

(e) In an old method, nitrogen monoxide was produced from nitrogen instead of ammonia.

$N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$

184 kJ of energy is taken in from the surroundings for each formula mass (mole) of reactants.

The reaction was carried out at a high temperature (3000°C). Suggest **two** reasons for this.

1 .....

2 .....

(2)

(f) Complete the word equation below, to show how to make the fertiliser, ammonium nitrate.

..... + ... ⟶ ammonium nitrate + water

(2)

(Total 10 marks)

Q2. (a) Copper is a metal.
Explain how it conducts electricity.

.....

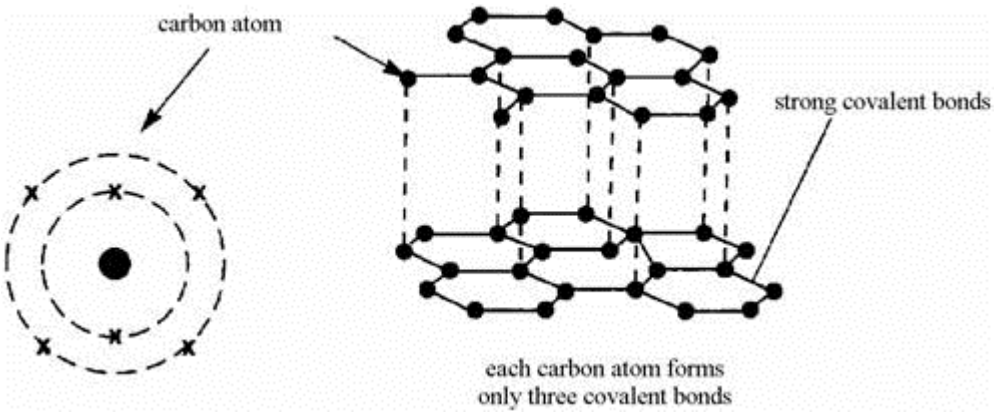
.....

.....

.....

(2)

(b) Graphite is a non-metal.



Use the information to explain why graphite conducts electricity.

.....

.....

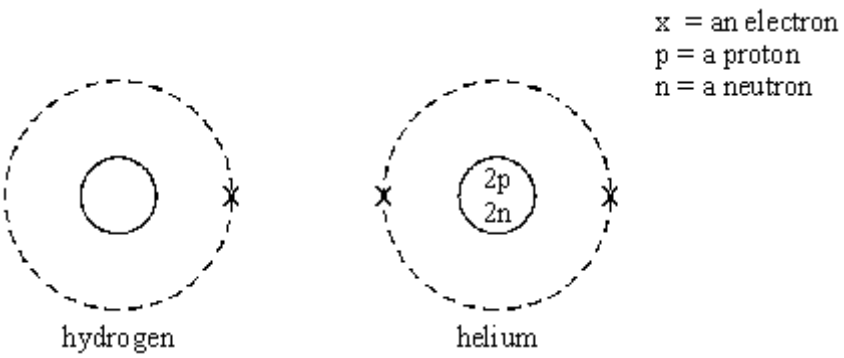
.....

.....

.....

(3)
(Total 5 marks)

Q3. (a) The diagrams represent the atomic structures of two gases, hydrogen and helium.



Hydrogen gas is made up of diatomic molecules (molecules with two atoms).
Helium gas exists as single atoms.

(i) How is a molecule of hydrogen formed from two hydrogen atoms?
(You may use a diagram as part of your answer)

.....

.....

.....

(2)

(ii) Why does helium exist only as single atoms?

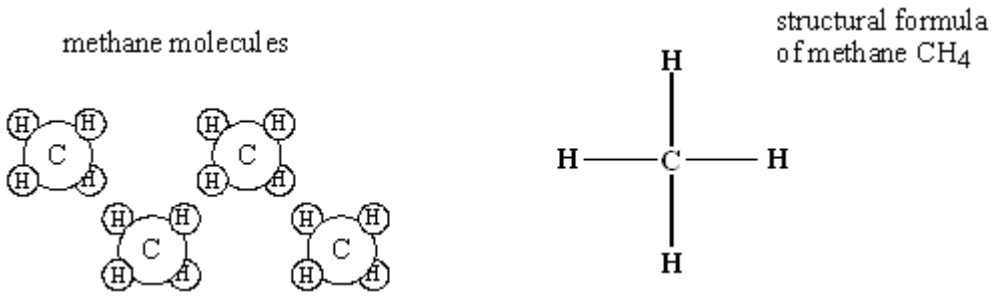
.....

.....

.....

(2)

(b) Hydrogen combines with carbon to form methane.
Each molecule contains four hydrogen atoms strongly bonded to a carbon atom.



Explain why methane has a low boiling point.

.....

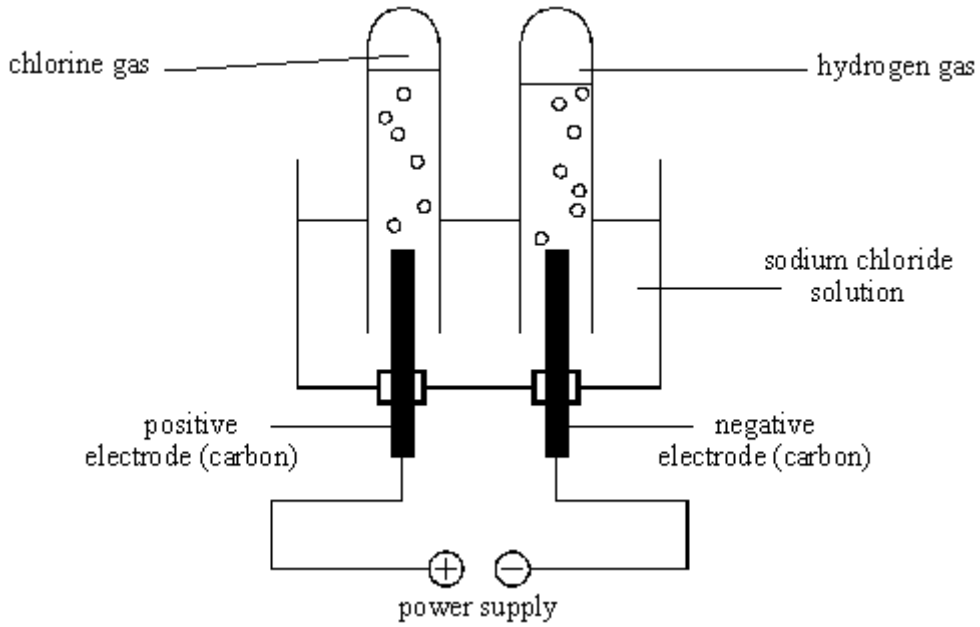
.....

.....

.....

(2)
(Total 6 marks)

Q4. The diagram shows electrolysis of sodium chloride solution.



(a) Complete and balance these equations to show the reactions during electrolysis.

At the positive electrode

$$Cl^- \quad - \quad e^- \rightarrow \quad Cl_2$$

At the negative electrode

$$Na \quad \rightarrow \quad Na$$

(2)

(b) Silver halides such as silver chloride and silver bromide are used in photography. The equation shows a reaction to prepare a silver halide.

reactants product 1 product 2

$$NaBr_{(aq)} + AgNO_{3(aq)} \longrightarrow AgBr_{(s)} + NaNO_{3(aq)}$$

Name and describe the products of this reaction, in words, as fully as you can.

product 1

.....

.....

product 2

.....

.....

(4)
(Total 6 marks)

Q5. (a) The formula for the chemical compound magnesium sulphate is $MgSO_4$.

Calculate the relative formula mass (M_r)of this compound. (Show your working.)

.....

.....

.....

.....

(2)

(b) Magnesium sulphate can be made from magnesium and dilute sulphuric acid.

This is the equation for the reaction.

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

Calculate the mass of magnesium sulphate that would be obtained from 4g of magnesium.
(Show your working.)

.....

.....

.....

.....

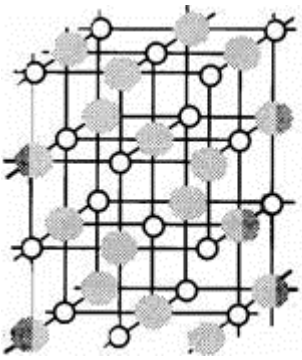
.....

.....

Answer..... g

(2)
(Total 4 marks)

Q6. The diagrams show the giant structures of sodium chloride and diamond.



sodium chloride (melting point 801°C)

diamond (melting point 4800°C)

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

Balance the equation.

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

(1)

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

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

.....

.....

.....

.....

(1)

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

.....

.....

(2)

(iii) molten sodium chloride will conduct electricity.

.....

.....

(1)

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

.....

.....

.....

.....

.....

(2)
(Total 7 marks)

Q7. The diagram shows the elements in Group 4 of the periodic table.

12	C
6	
28	Si
14	
73	Ge
32	
119	Sn
50	
207	Pb
82	

Carbon is a non- metal and silicon is usually considered to be a non- metal.

Tin and lead have all the usual properties of metals.

Germanium has these properties:

- grey-white shiny solid
- melting point 937°C
- semi-conductor
- reacts with chlorine to form the chloride ($GeCl_4$) which is a liquid molecular compound
- germanium oxide reacts with acids to form a salt solution and water. It also reacts with alkalis.

(a) With reference to their structure, explain why tin and lead are good conductors of electricity.

.....

.....

.....

.....

.....

.....

(3)

(b) Would you classify germanium as a metal or as a non-metal? Give your reasons.

.....

.....

.....

.....

.....

.....

.....

.....

(3)
(Total 6 marks)

Q8. (a) Balance these chemical equations.

(i) H_2 + O_2 → H_2O

(1)

(ii) Al + O_2 → Al_2O_3

(1)

(b) Briefly explain why an unbalanced chemical equation cannot fully describe a reaction.

.....

.....

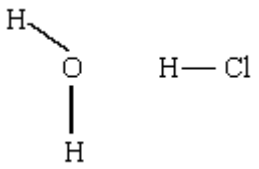
.....

.....

(2)

(c) Explain, as fully as you can, why a water molecule contains two hydrogen atoms but

a hydrogen chloride molecule contains only one.



(You may use a diagram in your answer if you wish).

.....

.....

.....

.....

(3)
(Total 7 marks)

Q9. (a) The formula for ammonia is NH_3. What does the formula tell you about each molecule of ammonia?

.....

.....

.....

.....

(3)

(b) Ammonia is used to make nitric acid (HNO_3). Calculate the formula mass (Mr) for nitric acid. (Show your working).

.....

.....

.....

.....

.....

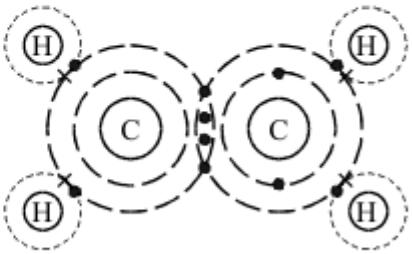
(3)
(Total 6 marks)

Q10. The questions which follow refer to the element hydrogen.

(a) Draw a diagram to show the bonding in one molecule of hydrogen.

(2)

(b) The table gives information about two compounds which contain hydrogen.

NAME	FORMULA	STRUCTURE
dilute sulphuric acid	H_2SO_4	$[H]^+[SO_4]^{2-}[H]^+$
ethene	C_2H_4	

Use the information in the table to explain why it is difficult to classify hydrogen as a metal or a non metal.

.....

.....

.....

.....

.....

.....

(4)
(Total 6 marks)

Q11. Sodium carbonate reacts with acids.

(i) Complete the word equation.

sodium carbonate + hydrochloric acid → sodium chloride + ... + water

(1)

(ii) Name the salt produced if sodium carbonate reacts with dilute nitric acid.

.....

(1)
(Total 2 marks)

Q12. (a) By reference to their structure, explain how the particles in a piece of metal are held together and how the shape of the metal can be changed without it breaking.

(You may use a diagram in your answer.)

.....

.....

.....

.....

.....

.....

.....

(5)

(b) Explain why metals are good conductors of electricity and suggest why this conductivity increases across the periodic table from sodium to magnesium to aluminium.

.....

.....

.....

.....

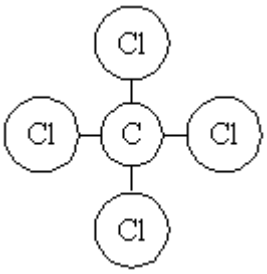
.....

.....

.....

(4)
(Total 9 marks)

Q13. Chlorine will combine with the non-metal element, carbon, to form this molecular compound.



(a) What is the type of bond in this molecule?

.....

(1)

(b) Explain how these bonds are formed. (You may use a diagram).

.....

.....

.....

.....

(2)
(Total 3 marks)

Q14. (a) Iron powder is used in the manufacture of ammonia. Why is it used?

.....

.....

(1)

(b) Ammonia is manufactured from nitrogen and hydrogen. The equation for the reaction between them is:

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

(i) Which **two** raw materials are used to make the hydrogen?

..... and .....

(1)

(ii) Why does increasing the pressure increase the chance of molecules of nitrogen reacting with molecules of hydrogen?

.....

.....

(1)

(iii) Calculate the mass, in tonnes, of ammonia which could be produced from 560 tonnes of nitrogen.

The relative atomic masses are: H 1; N 14.

Show clearly how you get to your answer.

.....

.....

.....

Mass of ammonia = ... tonnes

(3)
(Total 6 marks)

Q15. Read the passage carefully and then answer the questions.

The electrolysis of acidified water

After a few drops of dilute sulphuric acid have been added to some distilled water, there will be three types of ion in solution:

from the water, $H_2O(l) \rightarrow H^+(aq) + OH^-(aq)$

from the acid, $H_2SO_4(aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$

When the electrodes (anode and cathode) in a circuit are put into the acidified water, the hydroxide ions and the sulphate ions are both attracted to the electrode called the anode. However, it is harder for the sulphate ions to give up their electrons than for the hydroxide ions to do this. So the hydroxide ions are the ones which react and bubbles of oxygen are formed at the anode.

There are only hydrogen ions to be attracted towards the cathode and, when they get there, they take up electrons to form hydrogen molecules.

From Chemistry Matters by Richard Hart, reproduced by permission of Oxford University Press

Even in a small volume of water acidified with dilute sulphuric acid there will be billions of ions. Some will be anions and some will be cations.

(i) Name the ions in water acidified with dilute sulphuric acid.

.....

(1)

(ii) Explain why only some of the ions are attracted to the anode.

.....

.....

.....

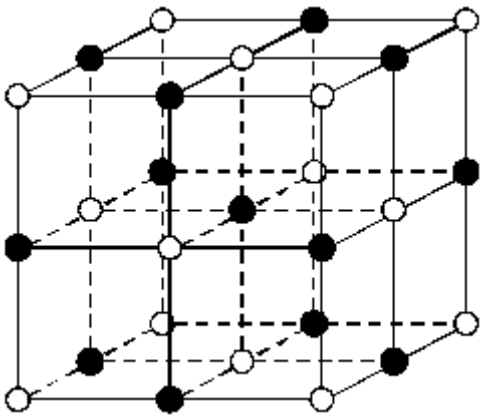
(2)

(iii) Balance the equation for the reaction of hydroxide ions at the anode.

$4OH^- \rightarrow H_2O + O_2 + e^-$

(1)
(Total 4 marks)

Q16. (a) The diagram shows part of the ionic lattice of a sodium chloride crystal.



(i) Complete the spaces in the table to give information about **both** of the ions in this lattice.

Name of ion	**Charge**
.....	.....
.....	.....

(2)

(ii) When it is solid, sodium chloride will not conduct electricity. However, molten sodium chloride will conduct electricity. Explain this difference.

.....

.....

.....

.....

(2)

(iii) Complete the sentence.

Sodium chloride conducts electricity when it is molten and when it is

.....

(1)

(b) The symbol for a calcium atom can be shown like this:

$^{40}_{20}Ca$

(i) What is the mass number of this atom?

.....

(1)

(ii) What information is given by the mass number?

.....

.....

(1)

(c) Calcium burns in oxygen with a brick-red flame. The product is a white solid. It is calcium oxide and its formula is CaO.

(i) Balance the chemical equation for the reaction.

$$Ca(s) + O_2(g) \rightarrow CaO(s)$$

(1)

(ii) Describe, in terms of electrons, what happens to a calcium atom when it becomes a calcium ion.

.....

.....

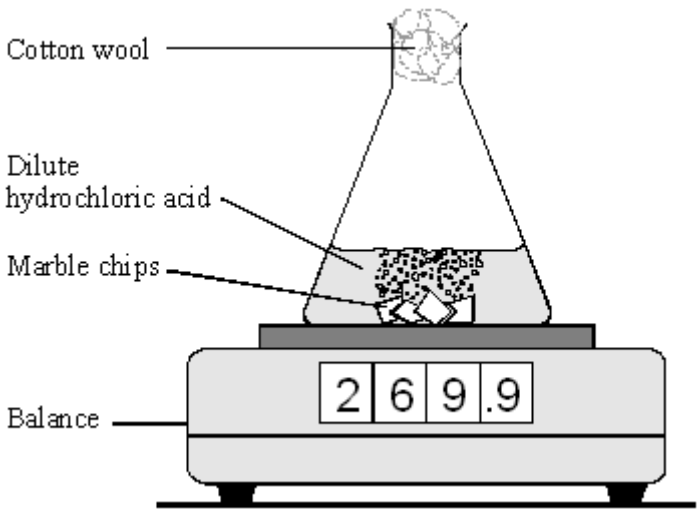
.....

.....

(2)

(Total 10 marks)

Q17. The apparatus shown in the diagram was used to investigate the rate of reaction of excess marble chips with dilute hydrochloric acid, HCl. Marble is calcium carbonate, formula $CaCO_3$. The salt formed is calcium chloride, $CaCl_2$.



(a) Write a balanced equation for the reaction.

.....

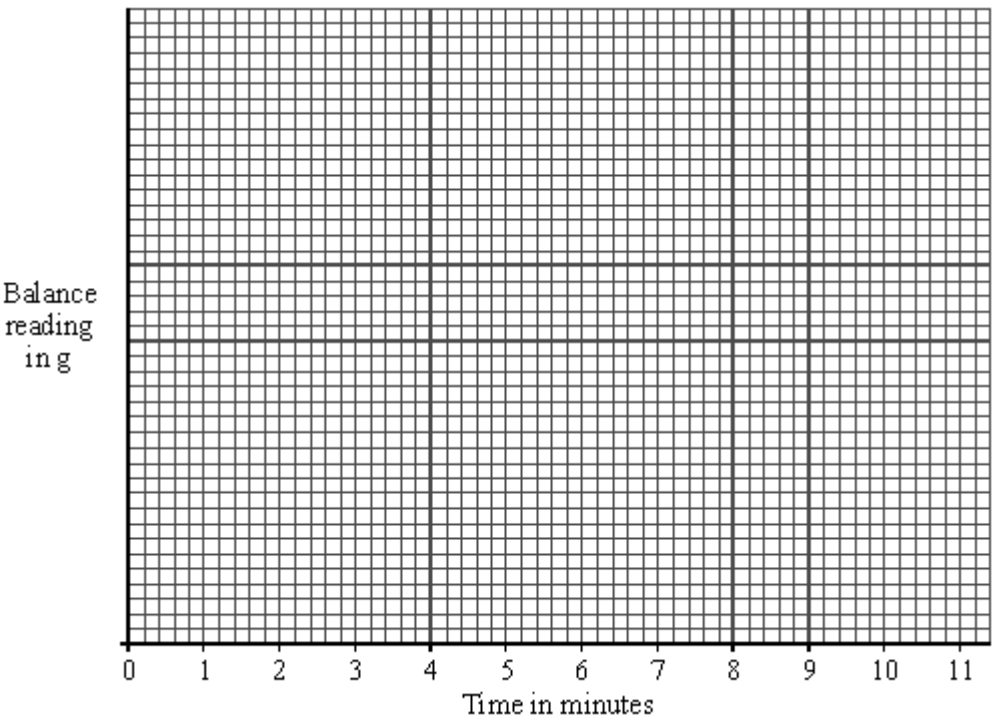
.....

(2)

The following results were obtained from the experiment.

Time in minutes	**Reading on balance in g**
0.5	269.6
1.0	269.3
2.0	269.0
3.0	268.8
5.0	268.7
9.0	268.6

(b) (i) Plot the results and draw a graph on the axes below.



(3)

(ii) Continue the graph you have drawn to show the expected reading after11 minutes.

(1)

(iii) On the axes above, sketch a graph of the result which would be obtained if in a similar experiment the same mass of powdered marble was used instead of marble chips.

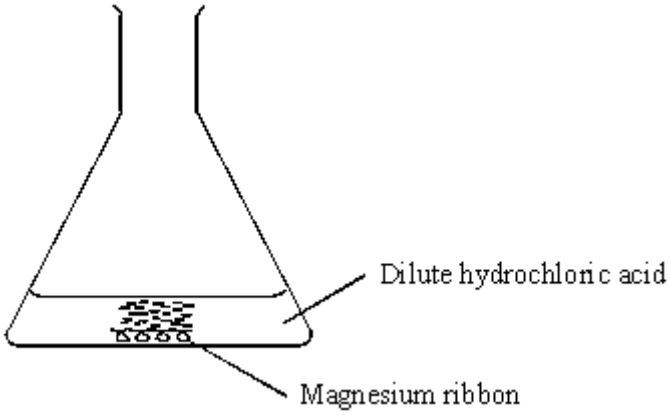
(2)
(Total 8 marks)

##

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)

Q19. The balanced symbol equation for the reaction is

$$H_2(g) + Cl_2(g) \rightarrow 2HCl\ (g)$$

Starting with 2 g of hydrogen, what mass of hydrogen chloride would be produced?
(Relative atomic masses: H = 1; Cl = 35.5)

.....

.....

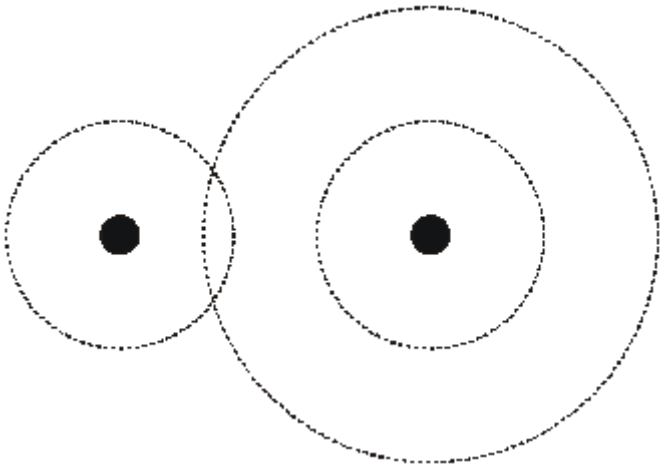
.....

.....

Mass of hydrogen chloride = ... g

(Total 3 marks)

Q20. (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.

.....

.....

.....

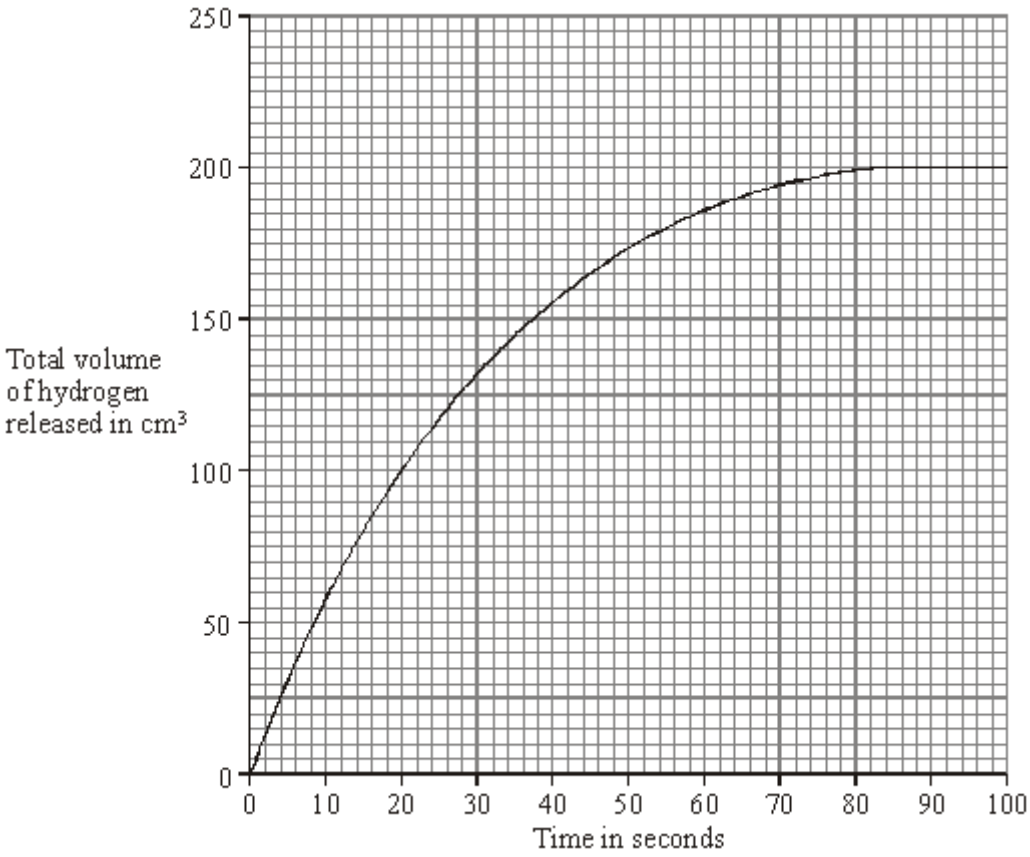
.....

(2)
(Total 3 marks)

Q21. Magnesium reacts with dilute sulphuric acid.

magnesium + sulphuric acid → magnesium sulphate + hydrogen

A student measured the volume of hydrogen given off every 10 seconds. The results are shown on the graph.



(a) The average rate of hydrogen production in the first 10 seconds is (60 cm^3 ÷ 10 s) = 6 cm^3/s.

(i) Calculate the average rate of production of hydrogen between 30 seconds and 50 seconds. Show clearly how you work out your answer.

.....

.....

.....

Rate ..... cm^3/s

(3)

(ii) Explain, as fully as you can, why the average rate between 30 and 50 seconds is different from the rate between 0 and 10 seconds.

.....

.....

.....

.....

(2)

(b) In industry, enzymes are used in both batch processes and continuous processes.

Give **one** reason why continuous processes are usually more profitable than batch processes.

.....

.....

(1)
(Total 6 marks)

Q22. 'Iron tablets' usually contain iron sulphate ($FeSO_4$).

(a) This salt can be made by reacting iron with sulphuric acid.

$$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$$

Calculate the mass of iron sulphate that could be obtained from 4 g of iron.

(Relative atomic masses: Fe = 56, H = 1, O = 16, S = 32)

.....

.....

.....

.....

.....

.....

Mass of iron sulphate = ... g

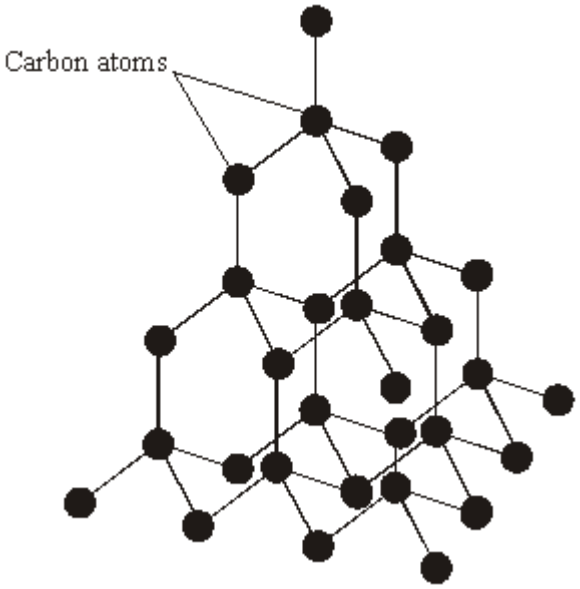
(3)

(b) Under different conditions, another type of iron sulphate may form.
Balance the symbol equation for this reaction.

$$Fe + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + H_2$$

(1)
(Total 4 marks)

Q23. 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.

.....

.....

.....

.....

.....

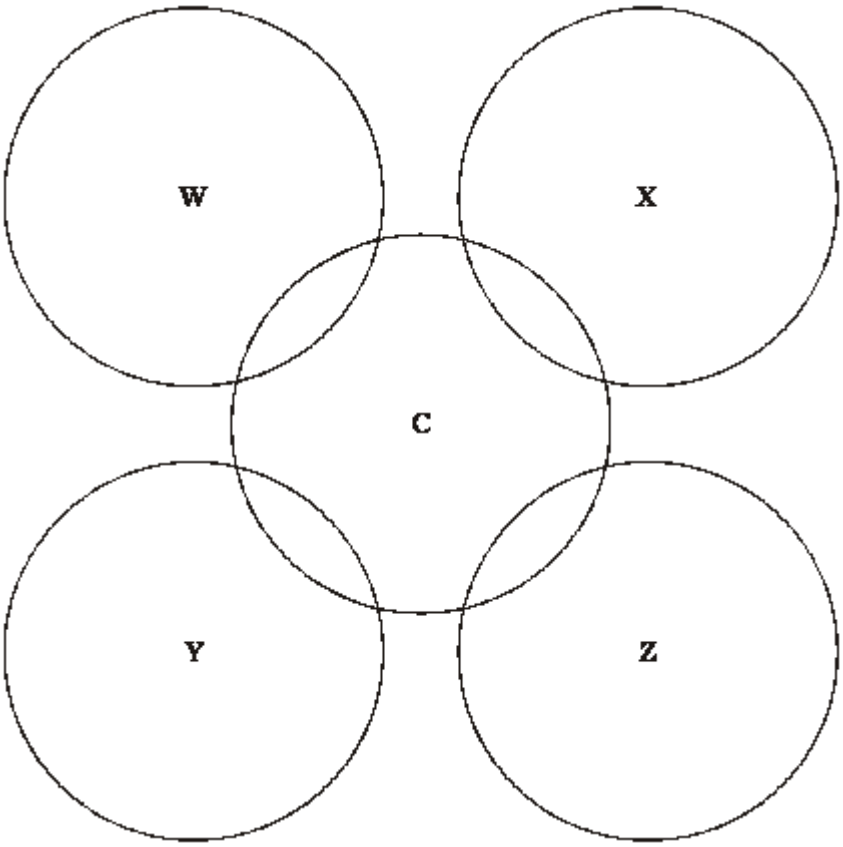
.....

(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)

Q24. Iron is the most commonly used metal. Iron is extracted in a blast furnace from iron oxide using carbon monoxide.

$$Fe_2O_3 + 3CO \rightarrow Fe + 3CO_2$$

(a) A sample of the ore haematite contains 70% iron oxide.

Calculate the amount of iron oxide in 2000 tonnes of haematite.

.....
.....

.....
.....

Amount of iron oxide = ... tonnes

(1)

(b) Calculate the amount of iron that can be extracted from 2000 tonnes of haematite.
(Relative atomic masses: O = 16; Fe = 56)

.....

.....

.....

.....

.....

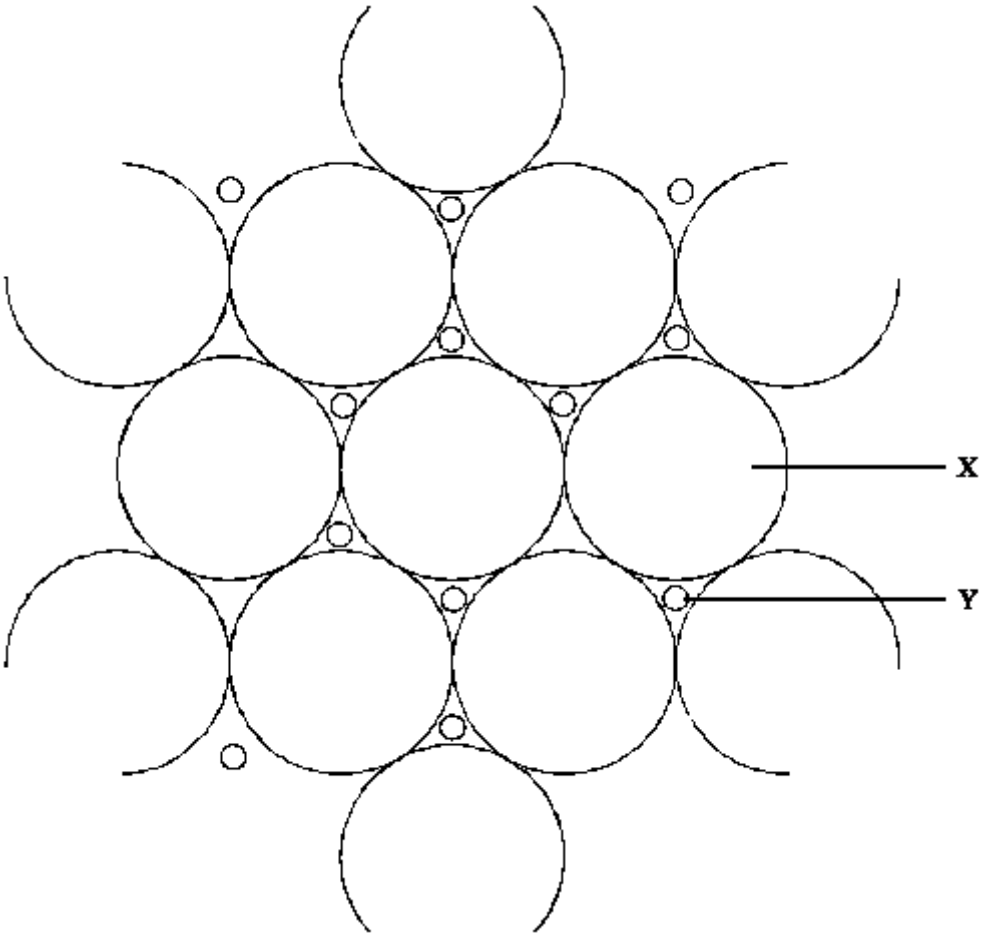
.....

.....

Amount of iron = ... tonnes

(4)
(Total 5 marks)

Q25. 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)

Q26. Bromine can be made from sea water. In 1000 g of sea water there is 0.065 g of bromine.
What mass of sea water would be needed to make 1000 g of bromine?

.....

.....

(Total 2 marks)

Q27. The electrolysis of sodium chloride solution is an important industrial process. Three useful substances are produced:

- chlorine gas is formed at the positive electrode;
- hydrogen gas is formed at the negative electrode;
- an alkali is left in the solution.

The reactions which take place at the electrodes are represented by the equations shown below:

$$2Cl^- - 2e^- \rightarrow Cl_2$$

$$2H^+ + 2e^- \rightarrow H_2$$

(a) Name the important alkali which is left in the solution.

.....

(1)

(b) State why chloride ions move towards the positive electrode.

.....

(1)

(c) Why is the formation of chlorine at this electrode said to be an oxidation reaction?

.....

(1)

(Total 3 marks)

Q28. Quicklime can be converted to slaked lime. The equation which represents this reaction is shown below.

$$CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2(s)}$$

quickline slaked line

(i) Why do farmers sometimes add slaked lime to acidic soil?

.....

.....

(1)

(ii) Use these relative atomic masses: H = 1; O = 16; Ca = 40
to calculate the relative formula mass (M_r) of

quicklime CaO .....

slaked lime $Ca(OH)_2$ .....

(2)

(iii) Calculate the mass of slaked lime that could be made from 1000 kg of quicklime.

.....

.....

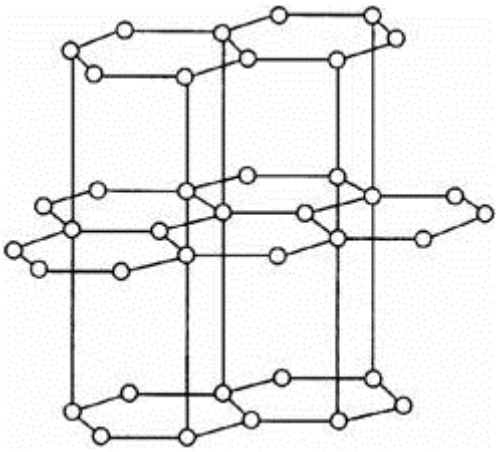
.....

Mass of slaked lime ..... kg

(2)

(Total 5 marks)

Q29. 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)

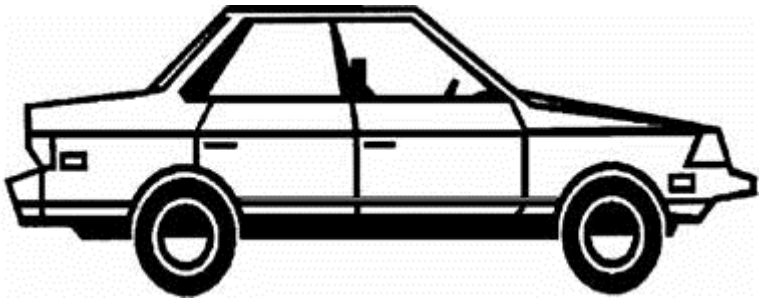
Q30. Use these relative atomic masses: H = 1; O = 16; Ca = 40
to calculate the relative formula mass *(M_r)* of

quicklime CaO .....

slaked lime $Ca(OH)_2$ .....

(Total 2 marks)

Q31. 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)

Q32. Some drain cleaners contain a mixture of sodium hydroxide and powdered aluminium. When the mixture is poured into a drain it mixes with water and a chemical reaction takes place. The heat from the reaction helps to melt grease in the drain. Hydrogen gas is produced which stirs up the particles and helps to unclog the drain.

(a) Balance the equation for the reaction.

$$2Al_{(s)} + \ldots\ldots\ NaOH_{(aq)} + \ldots\ldots\ H_2O \rightarrow \ldots\ldots NaAl(OH)_{4(aq)} + 3H_2$$

(2)

(b) Why do the solid sodium hydroxide and aluminium powder **not** react when stored in a sealed container?

.....

(1)

(c) Sodium hydroxide is a strong alkali and would react with any acids in the drain.

(i) Name the ion produced when any alkali is dissolved in water.

.....

(1)

(ii) Name the ion produced when any acid is dissolved in water.

.....

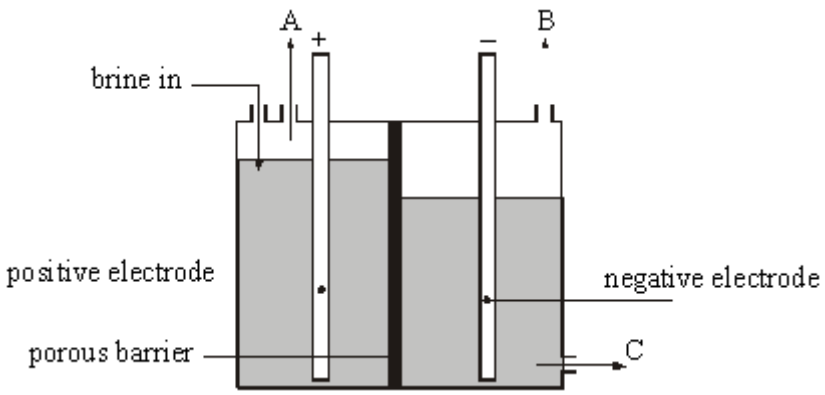
(1)

(iii) Name the compound formed when these ions react with each other.

.....

(1)
(Total 6 marks)

Q33. Sodium hydroxide, hydrogen and chlorine can all be made in one industrial process. Electricity is passed through aqueous sodium chloride solution (brine). The diagram below shows a cell that can be used for this process.



(a) Name A, B and C.

Gas A .....

Gas B .....

Solution C .....

(2)

(b) Balance the equations for the reactions at the electrodes.

(i) ..... Cl^- – ..... e^- → Cl_2

(ii) ..... H^+ + ... e^- → H_2

(2)

(c) Name the compound in this cell which produces the hydrogen ions.

.....

(1)

(d) Which type of particles must be able to pass through the barrier to allow the electrolysis to take place?

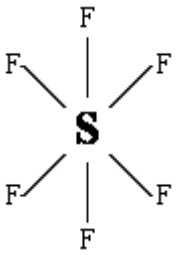
.....

(1)

(Total 6 marks)

Q34. 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: .....

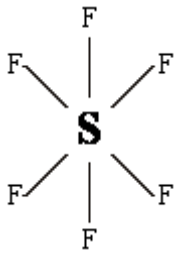
Explanation: .....

.....

(3)
(Total 6 marks)

Q35. 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)