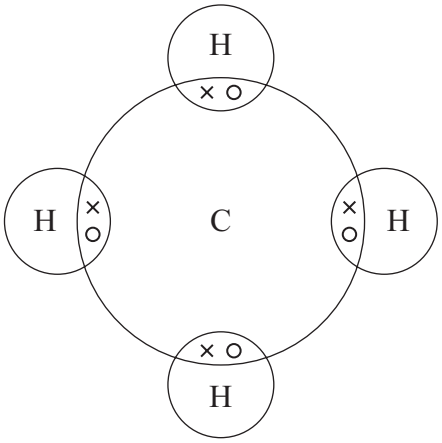
NOTICE TO CUSTOMER:

The sale of this product is intended for use of the original purchaser only and for use only on a single computer system. Duplicating, selling, or otherwise distributing this product is a violation of the law ; your license of the product will be terminated at any moment if you are selling or distributing the products.

Answer **all** questions in the spaces provided.

1 The diagram represents a particle of methane.



(a) What is the formula of methane? .....

(1 mark)

(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 mark)

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

covalent	**ionic**	**metallic**

What is the type of bonding shown in the diagram?

.....

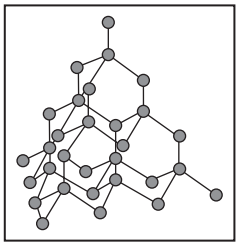
(1 mark)

3

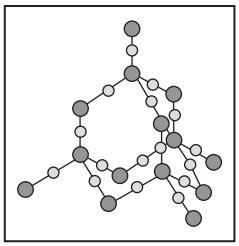
2 This question is about giant structures. Diamond, graphite and silicon dioxide all have giant structures.

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

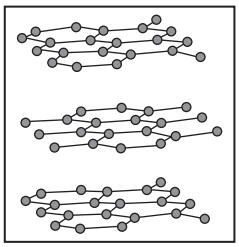
Draw a line from each structure to its name.



Silicon dioxide



Graphite



Diamond

(2 marks)

(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 mark)

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

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

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

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

(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 mark)

8

Turn over for the next question

3 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*.

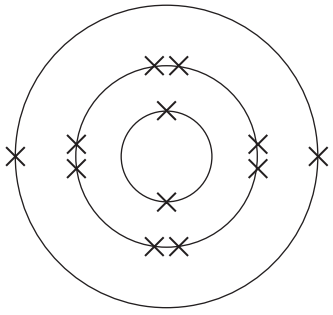
Complete the following sentence using the correct words from the box.

gives out heat	**stores heat**	**takes in heat**

An *exothermic* reaction is one which ..... .

(1 mark)

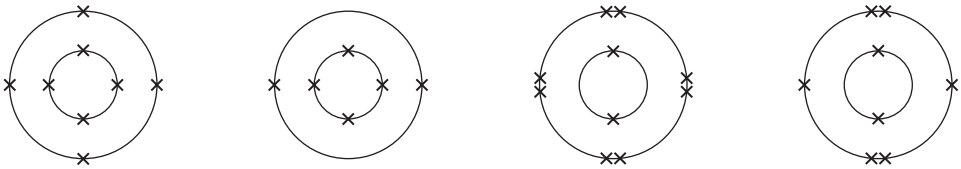
(b) The diagram shows the electronic structure of a magnesium atom.
The atomic (proton) number of magnesium is 12.



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?

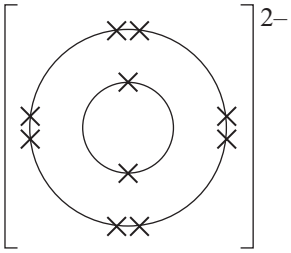


A **B** **C** **D**

Diagram .....

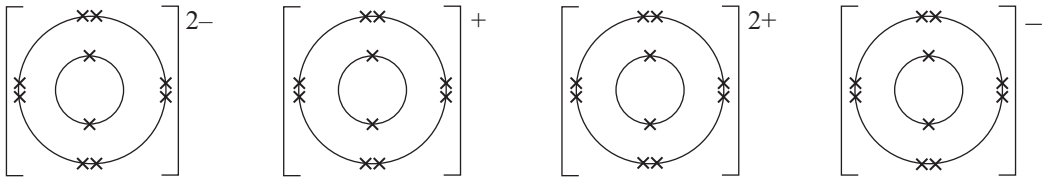
(1 mark)

(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

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



J **K** **L** **M**

Diagram .....

(1 mark)

(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 mark)

4

4 The electrolysis of sodium chloride solution produces useful substances.

(a) (i) Choose a word from the box to complete the sentence.

covalent	**ionic**	**non-metallic**

Electrolysis takes place when electricity passes through ..... compounds when they are molten or in solution.

(1 mark)

(ii) Choose a word from the box to complete the sentence.

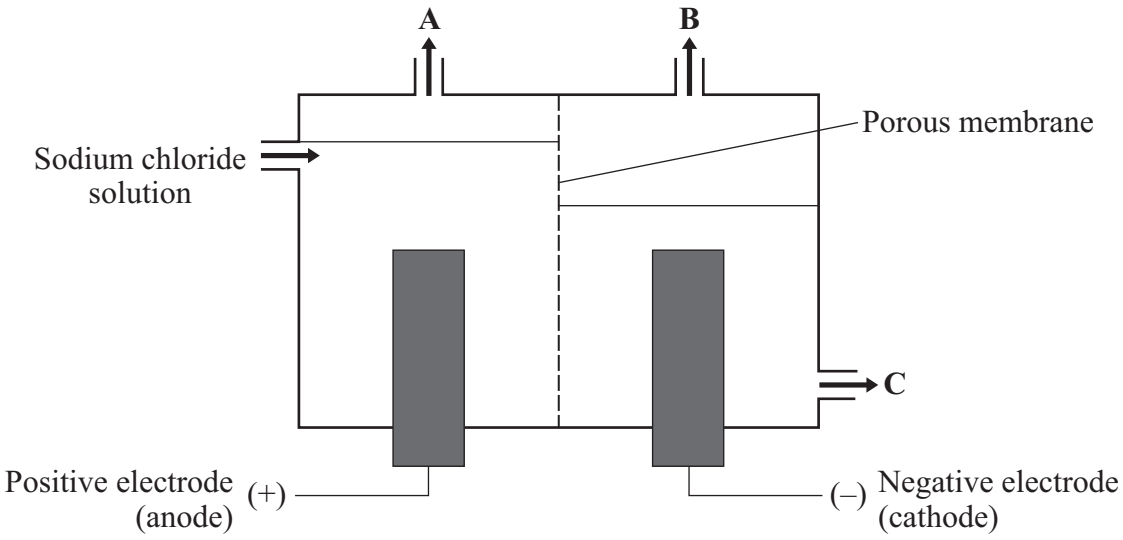
alkenes	**elements**	**salts**

During electrolysis the compound is broken down to form ..... .

(1 mark)

(b) The table of ions on the Data Sheet may help you to answer this question.

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



Identify the products **A**, **B** and **C** on the diagram using substances from the box.

chlorine gas	**hydrogen gas**	**oxygen gas**
sodium hydroxide solution		**sodium metal**

(i) **A** is ..... .
(1 mark)

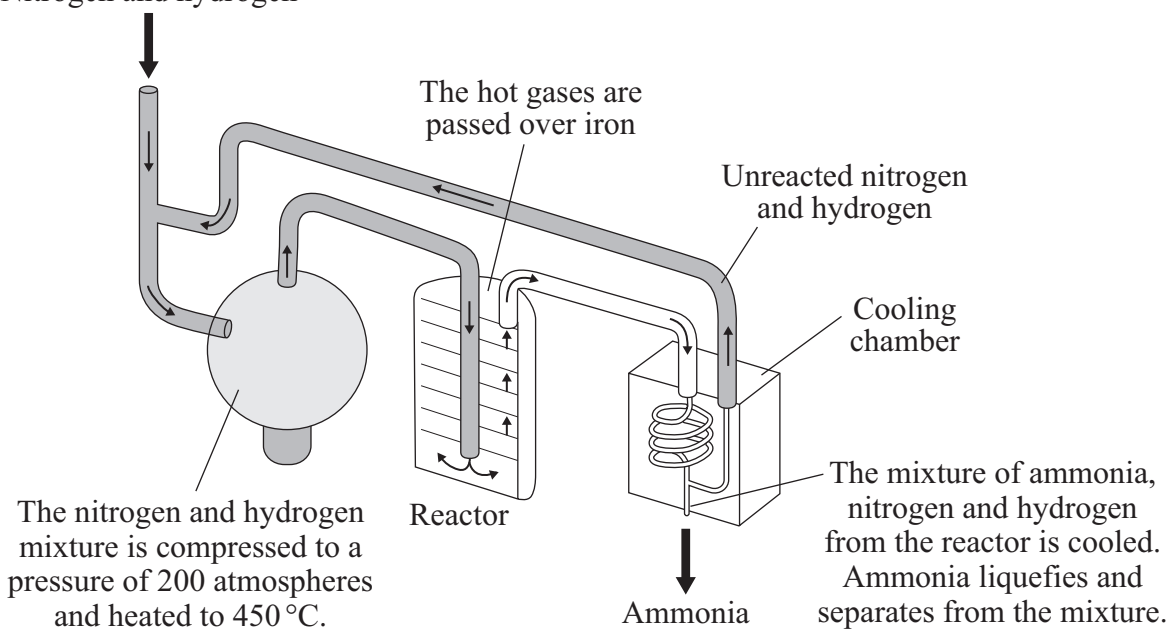
(ii) **B** is ..... .
(1 mark)

(iii) **C** is ..... .
(1 mark)

5

Turn over for the next question

5 The Haber process is named after the German chemist, Fritz Haber.
The diagram shows the main stages in the Haber process.



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

(i) Complete the word equation for the reaction that takes place in the reactor.

nitrogen + ... ⇌ .....

(1 mark)

(ii) What does the symbol ⇌ mean?

.....

(1 mark)

(iii) What is the purpose of the iron in the reactor?

.....

(1 mark)

(iv) Ammonia is separated from unreacted nitrogen and hydrogen.
Draw a ring around the physical property that allows this separation to take place.

boiling point **density** **melting point**

(1 mark)

(v) What is done with the unreacted nitrogen and hydrogen?

.....

(1 mark)

(b) Some of the products that can be made from ammonia are:

- fertilisers
- dyes
- explosives
- medicines
- plastics

(i) The Haber process was invented a few years before the start of the First World War. It is thought that the First World War would have finished earlier if the Germans had **not** invented the Haber process.

Suggest why.

.....

.....

(1 mark)

(ii) The Haber process has helped to increase food production.

Explain why.

.....

.....

(1 mark)

(c) Factories that make ammonia are very large and operate night and day.

(i) Ammonia factories are often near towns.

Suggest why.

.....

(1 mark)

(ii) Suggest and explain **one** reason why local people might not want an ammonia factory near their town.

.....

.....

.....

.....

(2 marks)

10

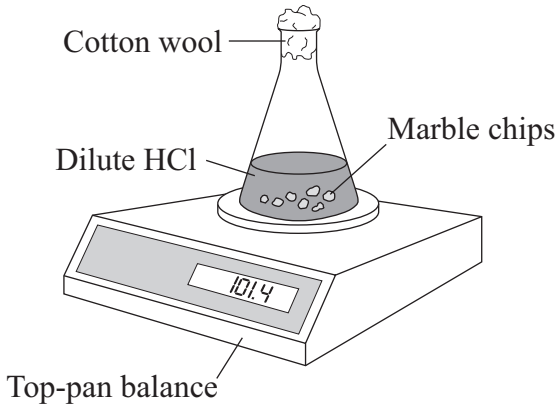
6 A student investigated the rate of reaction between marble and hydrochloric acid.

The student used an excess of marble.

The reaction can be represented by this equation.

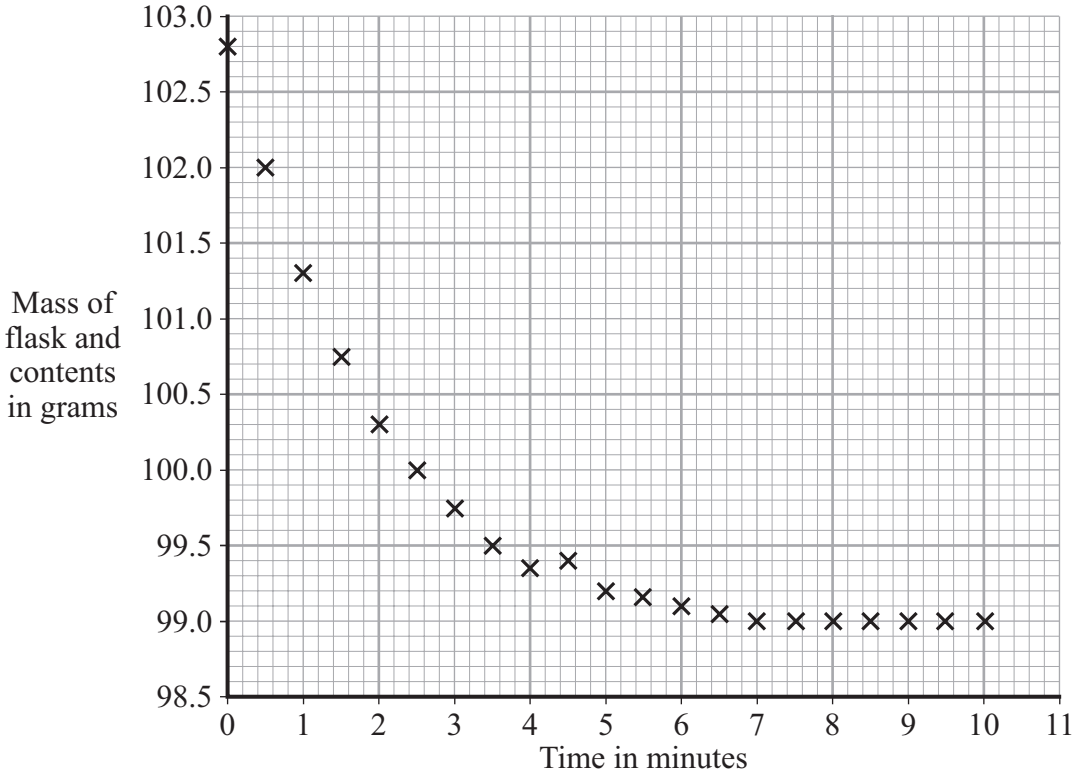
$CaCO_3$ (s) + 2HCl (aq) → $CaCl_2$ (aq) + H_2O (l) + CO_2 (g)

The student used the apparatus shown in the diagram.



The student measured the mass of the flask and contents every half minute for ten minutes.

The results are shown on the graph. Use the graph to answer the questions.



(a) **Complete the graph** opposite by drawing a line of best fit.

(1 mark)

(b) Why did the mass of the flask and contents decrease with time?

.....

.....

(1 mark)

(c) After how many minutes had all the acid been used up?

..... minutes

(1 mark)

(d) The student repeated the experiment at a higher temperature. All other variables were kept the same as in the first experiment. The rate of reaction was much faster.

(i) Draw a line **on the graph** opposite to show what the results for this second experiment might look like.

(2 marks)

(ii) Why does an increase in temperature increase the rate of reaction?

.....

.....

.....

.....

.....

.....

(3 marks)

8

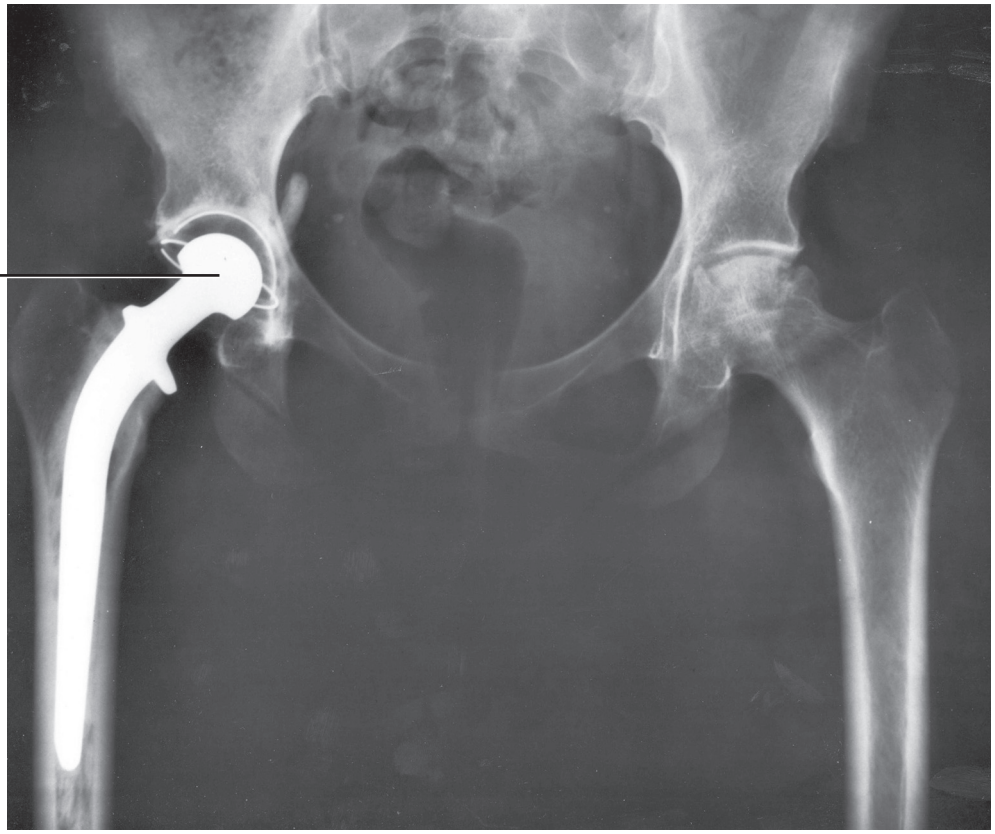
Turn over for the next question

7 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.



The use of nanocrystalline metals should give people better hip replacements which last longer.

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

.....

.....

(1 mark)

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

.....

.....

(1 mark)

(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 marks)

4

Turn over for the next question

8 (a) A chemist was asked to identify a nitrogen compound. The chemist carried out an experiment to find the relative formula mass (M_r) of the compound.

The M_r of the compound was **44**.

Relative atomic masses: N = 14, O = 16

Draw a ring around the formula of the compound.

NO **NO_2** **N_2O_4** **N_2O**

(1 mark)

(b) Potassium nitrate is another nitrogen compound. It is used in fertilisers.
It has the formula **KNO_3**.

The M_r of potassium nitrate is **101**.

Calculate the percentage of **nitrogen** by mass in potassium nitrate.

Relative atomic mass: N = 14.

.....

.....

Percentage of nitrogen = ... %

(2 marks)

3

END OF QUESTIONS

Answer **all** questions in the spaces provided.

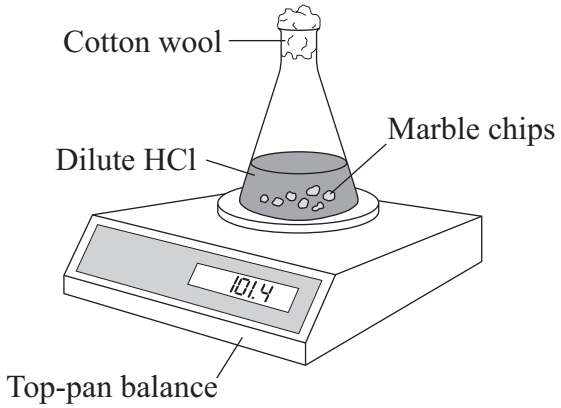
1 A student investigated the rate of reaction between marble and hydrochloric acid.

The student used an excess of marble.

The reaction can be represented by this equation.

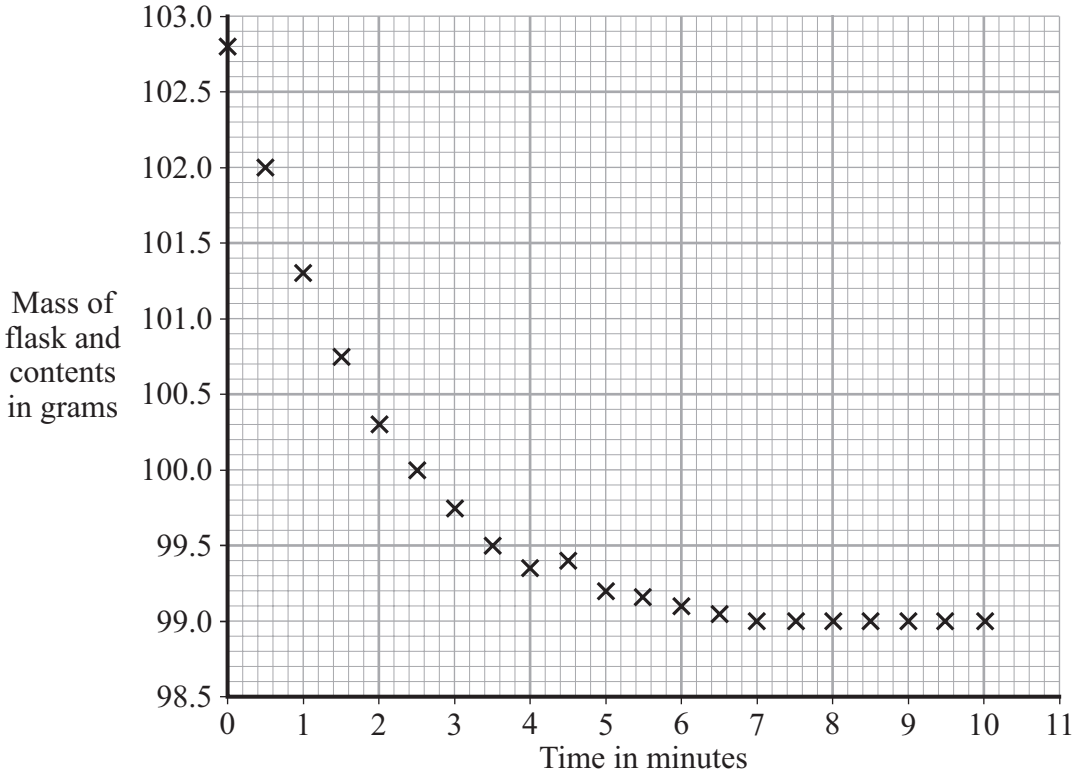
$CaCO_3$ (s) + 2HCl (aq) → $CaCl_2$ (aq) + H_2O (l) + CO_2 (g)

The student used the apparatus shown in the diagram.



The student measured the mass of the flask and contents every half minute for ten minutes.

The results are shown on the graph. Use the graph to answer the questions.



(a) **Complete the graph** opposite by drawing a line of best fit.

(1 mark)

(b) Why did the mass of the flask and contents decrease with time?

.....

.....

(1 mark)

(c) After how many minutes had all the acid been used up?

..... minutes

(1 mark)

(d) The student repeated the experiment at a higher temperature. All other variables were kept the same as in the first experiment. The rate of reaction was much faster.

(i) Draw a line **on the graph** opposite to show what the results for this second experiment might look like.

(2 marks)

(ii) Why does an increase in temperature increase the rate of reaction?

.....

.....

.....

.....

.....

.....

(3 marks)

8

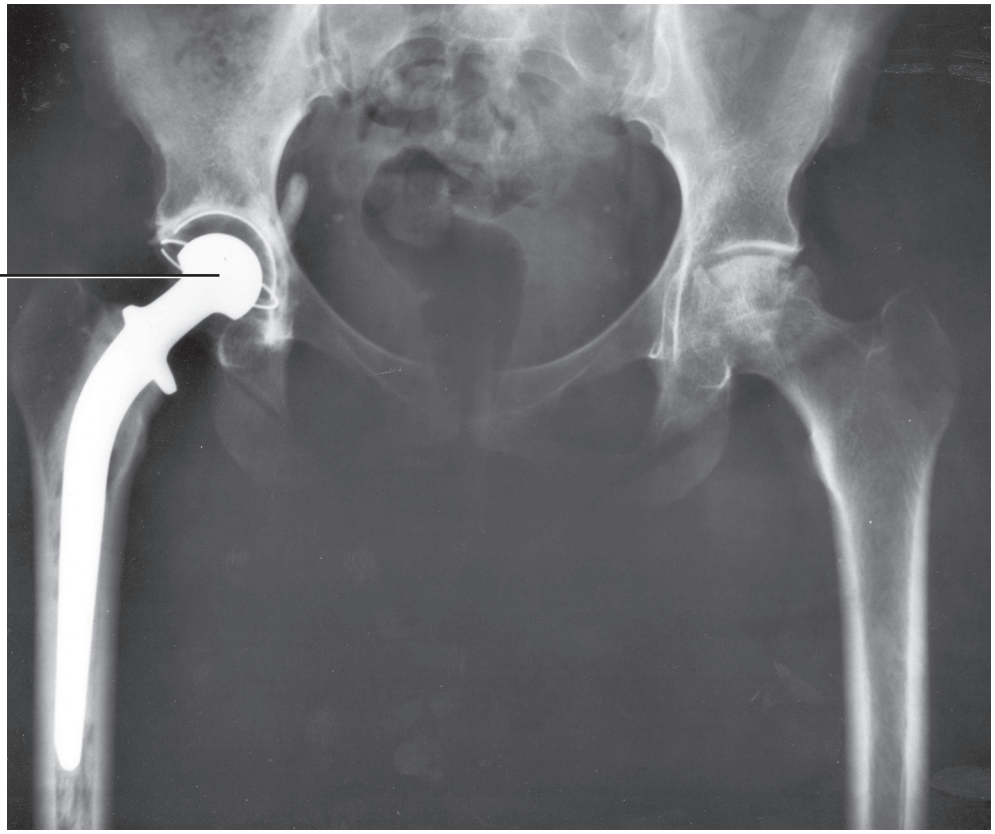
Turn over for the next question

2 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.



The use of nanocrystalline metals should give people better hip replacements which last longer.

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

.....

.....

(1 mark)

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

.....

.....

(1 mark)

(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 marks)

4

Turn over for the next question

3 (a) A chemist was asked to identify a nitrogen compound. The chemist carried out an experiment to find the relative formula mass (M_r) of the compound.

The M_r of the compound was **44**.

Relative atomic masses: N = 14, O = 16

Draw a ring around the formula of the compound.

NO **NO_2** **N_2O_4** **N_2O**

(1 mark)

(b) Potassium nitrate is another nitrogen compound. It is used in fertilisers.
It has the formula **KNO_3**.

The M_r of potassium nitrate is **101**.

Calculate the percentage of **nitrogen** by mass in potassium nitrate.

Relative atomic mass: N = 14.

.....

.....

Percentage of nitrogen = ... %

(2 marks)

3

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

(a) Explain the meaning of *electrolysis*.

.....

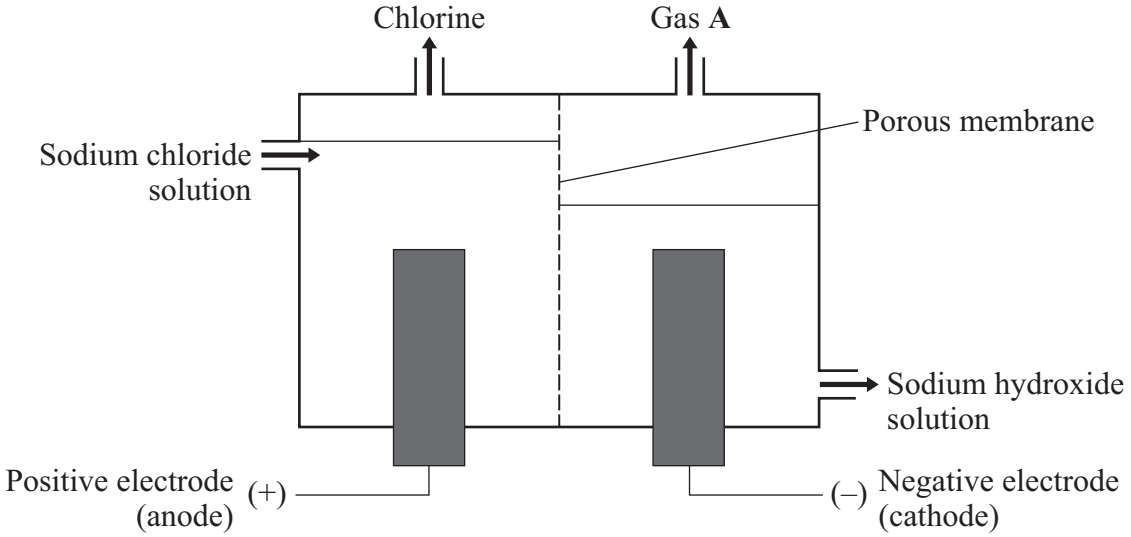
.....

.....

.....

(2 marks)

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



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

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

(1 mark)

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

.....

.....

.....

.....

(2 marks)

5

5 Distress flares are used to attract attention in an emergency.

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

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

State the meaning of *exothermic*.

.....

.....

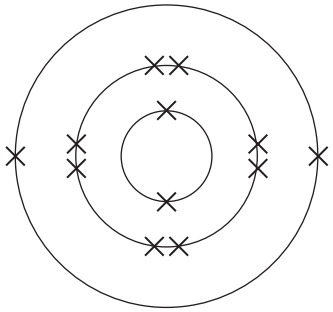
(1 mark)

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

.....

(1 mark)

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



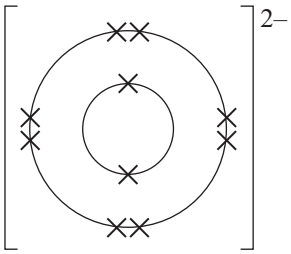
Magnesium atom

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

(1 mark)

(d) 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 mark)

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

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

.....

.....

.....

.....

(2 marks)

(f) 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 mark)

7

6 Photographic film often contains silver bromide. Silver bromide is changed by light to form silver which appears as a black solid. This darkens the photographic film.

A photographic film can be made by coating thin transparent plastic with a gel containing silver bromide.

The main steps in making this photographic film are as follows:

Step 1 Gelatine is dissolved in warm water to make a solution.

Step 2 Compound **A**, a soluble compound which contains bromide ions, is dissolved into this solution.

Step 3 The lights are turned out in the darkroom.

Step 4 Compound **B**, a soluble compound which contains silver ions, is dissolved in water.

Step 5 The solution of compound **B** is added to the solution containing compound **A** and gelatine. Solid silver bromide is formed.

Step 6 The warm mixture is poured onto thin, transparent plastic film.

Step 7 The mixture sets to form a gel containing solid silver bromide.

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

SOLUBLE	INSOLUBLE
All sodium and potassium salts	
All nitrates	
Most chlorides, bromides and iodides	Silver and lead chlorides, bromides and iodides
Most sulfates	Lead sulfate and barium sulfate
Sodium, potassium and ammonium carbonates	Most other carbonates

Use the table to help you to name suitable compounds for **A** and **B**.

Compound **A** .....

Compound **B** .....

(2 marks)

(b) Suggest why the lights are turned out at **step 3** in this method of making a photographic film.

.....

.....

(1 mark)

(c) What type of chemical reaction takes place when the compounds are mixed in **step 5**?

.....

(1 mark)

(d) The photographic film is placed in a camera and a picture is taken. Where light hits the photographic film the silver ions (Ag^+) are changed into silver metal (Ag).

Explain why this reaction is a reduction.

.....

.....

.....

.....

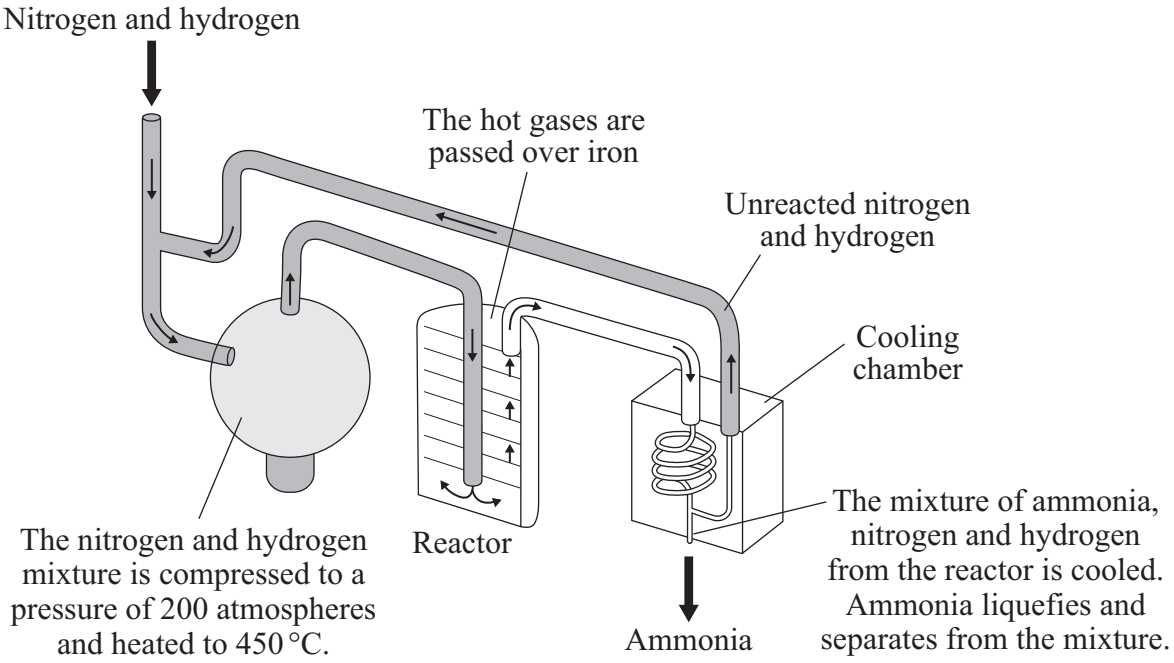
(2 marks)

6

Turn over for the next question

7 The Haber process is named after the German chemist, Fritz Haber.

The diagram shows the main stages in the Haber process.



An exothermic reaction takes place when nitrogen reacts with hydrogen to make ammonia. The reaction can be represented by this equation.

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

(a) Calculate the maximum mass of ammonia that could be made from 1000 g of nitrogen.

Relative atomic masses: H = 1; N = 14

.....

.....

.....

.....

Mass .....g

(3 marks)

(b) At a temperature of 450 ºC and 200 atmospheres the actual mass of ammonia produced when 1000 g of nitrogen is passed through the reactor is 304 g.

Calculate the percentage yield of ammonia produced in the reactor.

(If you did not answer part (a), then assume that the maximum mass of ammonia that can be made from 1000 g of nitrogen is 1100 g. This is **not** the correct answer to part (a).)

.....

.....

.....

.....

.....

Percentage yield of ammonia = ... %

(2 marks)

(c) State **and** explain:

(i) how a **decrease** in temperature would affect the yield of ammonia

.....

.....

.....

.....

(2 marks)

(ii) how an **increase** in pressure would affect the yield of ammonia.

.....

.....

.....

.....

(2 marks)

Question 7 continues on the next page

(d) Factories that make ammonia are often near to large towns.

Discuss the economic, safety and environmental factors to be considered when there is an ammonia factory near a town.

.....

.....

.....

.....

.....

.....

.....

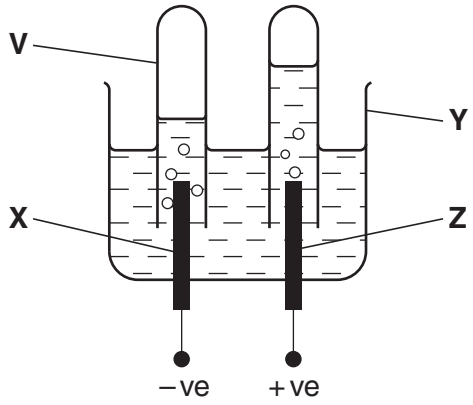
(3 marks)

12

END OF QUESTIONS

1 Hannah investigates the electrolysis of aqueous potassium sulfate.

Look at the apparatus she uses.



(a) Look at the table. It shows some of the names of the apparatus used.

Finish the table.

name of apparatus	letter
anode	
cathode	
test tube	

[3]

(b) There are bubbles of gas made at both electrodes.

What are the names of the **two** gases made during this electrolysis?

Choose from the list.

carbon dioxide

hydrogen

nitrogen

oxygen

sulfur dioxide

answer ..... and ..... [2]

[Total: 5]

[Turn over

2 Monty investigates the properties of two acids

- dilute ethanoic acid, CH_3COOH
- dilute hydrochloric acid, HCl.

(a) How many different **elements** are chemically bonded in ethanoic acid?

..... [1]

(b) Describe how Monty can measure the pH value of dilute ethanoic acid.

.....

..... [2]

(c) Monty adds a small piece of magnesium ribbon to a sample of dilute ethanoic acid.

Look at the word equation for this reaction.

magnesium + ethanoic acid $\longrightarrow$ magnesium ethanoate + hydrogen

A gas is made when magnesium reacts with ethanoic acid.

What is the name of this gas?

..... [1]

(d) Ethanoic acid and hydrochloric acid both react with calcium carbonate.

A gas is made when these acids react with calcium carbonate.

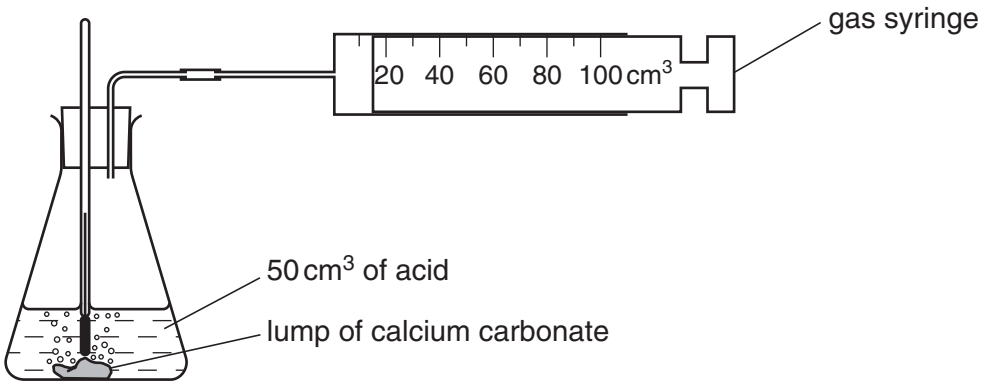
What is the name of this gas?

..... [1]

(e) Monty investigates the reaction of both acids with a lump of calcium carbonate.

He wants to find out the volume of gas made every 10 seconds.

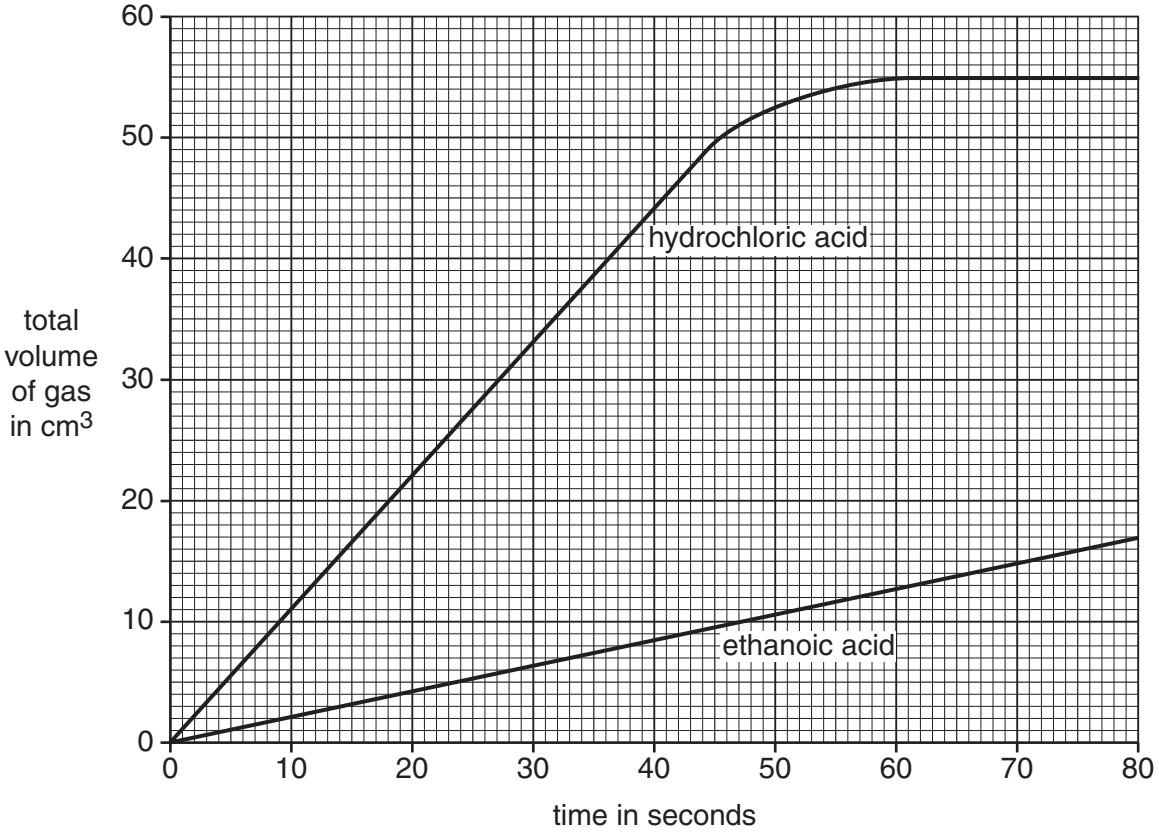
Look at the apparatus he uses.



He does two experiments, one with dilute ethanoic acid and one with dilute hydrochloric acid.

He makes sure he does a fair test.

Look at the graph of his results.



(i) Which acid reacts faster?

.....

Use the graph to explain your answer.

.....

..... [1]

(ii) How long does it take for the reaction with hydrochloric acid to stop?

..... seconds [1]

(iii) The reaction between calcium carbonate and ethanoic acid is still happening after 80 seconds.

What will be the total volume of gas collected at the **end** of this reaction?

..... cm^3 [1]

[Total: 8]

[Turn over

3 Zoe tests an unknown solution.

(a) She uses barium ions in solution to test for sulfate ions.

Look at the ionic equation.

It shows the reaction between barium ions and sulfate ions.

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$$

(i) What is the meaning of (s) in $BaSO_4(s)$?

..... [1]

(ii) What is the meaning of (aq) in $Ba^{2+}(aq)$?

..... [1]

(b) Zoe tests the unknown solution again.

This time she adds silver nitrate solution.

She sees a pale yellow precipitate.

Which ion is in the solution?

Choose from the list.

chloride, Cl^-

bromide, Br^-

iodide, I^-

answer ..... [1]

[Total: 3]

4 This question is about equilibrium and reversible reactions.

Ethene reacts with steam in a reversible reaction to make ethanol.

$$\text{ethene} + \text{water} \rightleftharpoons \text{ethanol}$$

This reversible reaction can reach equilibrium if it is in a sealed container.

(a) At equilibrium there is a connection between the rate of the forward reaction and the rate of the backward reaction.

What is this connection?

..... [1]

(b) What happens to the concentration of ethene and of water at equilibrium?

..... [1]

(c) Look at the table.

It shows how the percentage of ethene at equilibrium changes as the **temperature** changes and as the **pressure** changes.

	temperature		
pressure	200 °C	260 °C	320 °C
30 atmospheres	37%	26%	21%
40 atmospheres	40%	30%	25%
50 atmospheres	44%	35%	30%
60 atmospheres	48%	40%	34%

(i) Look at the row at 30 atmospheres.

What happens to the percentage of ethene as the temperature increases?

..... [1]

(ii) What happens to the percentage of ethene as the pressure increases but the temperature stays the same?

..... [1]

[Total: 4]

5 People living in hard water areas find they use more soap when washing.

The hardness of water can be measured by adding soap to the water until it makes permanent bubbles.

Look at the table.

It shows the results for some samples of water.

The volume of water in each sample was the same.

	sample of water			
	distilled water	**A**	**B**	**C**
volume of soap added to cold water in cm^3	3	3	15	14
volume of soap added to boiled water in cm^3	3	3	15	3

(a) (i) Which sample of water shows **permanent** hardness?

Choose from **A**, **B** or **C**.

answer ..... [1]

(ii) Which sample of water shows **temporary** hardness?

Choose from **A**, **B** or **C**.

answer ..... [1]

(b) Look at the list.

calcium hydrogencarbonate

calcium sulfate

ethanoic acid

sodium chloride

sodium hydroxide

(i) Write down the name of a substance that causes **permanent** hardness.

Choose from the list.

answer ..... [1]

(ii) Write down the name of a substance that causes **temporary** hardness.

Choose from the list.

answer ..... [1]

(iii) Hard water causes limescale to form on the heating element of a kettle.

Write down the name of a substance that could be used as a limescale remover.

Choose from the list.

answer ..... [1]

[Total: 5]

6 Chlorofluorocarbons, CFCs, are substances that damage the ozone layer.

$CFCl_3$ is the formula for a chlorofluorocarbon.

(a) Write down the **names** of the three elements found in $CFCl_3$.

element 1 .....

element 2 .....

element 3 .....

[2]

(b) What is the main use of CFCs?

Choose from the list.

cooking oil

disinfectants

refrigerants

rocket fuel

answer ..... [1]

(c) Damage to the ozone layer causes increased levels of ultraviolet light.

This can lead to medical problems.

Write about **two** of these medical problems.

.....

.....

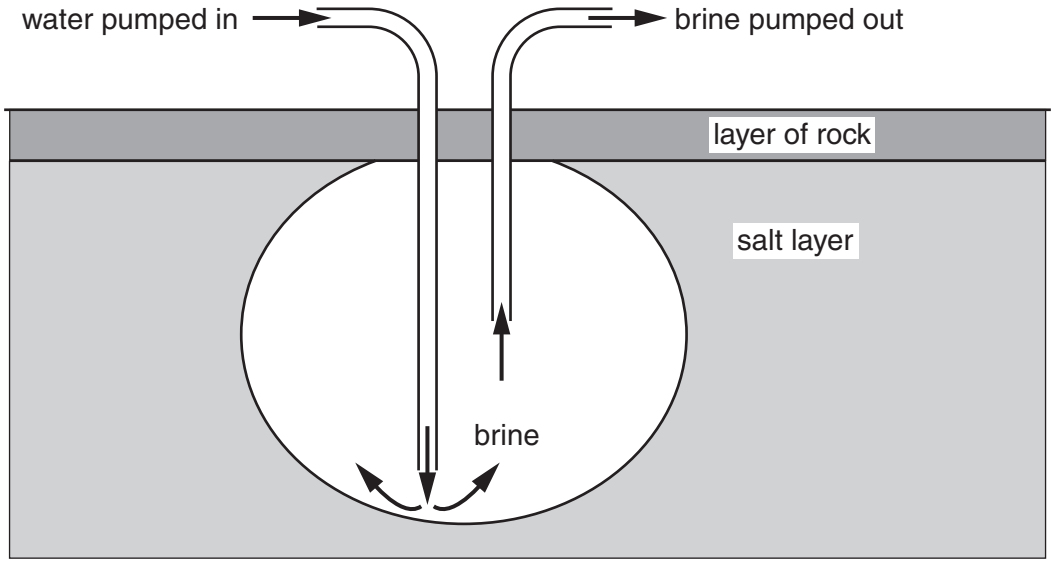
..... [2]

[Total: 5]

7 Brine is a solution of sodium chloride.

Solution mining is used to get brine out of the ground.

Look at the diagram of solution mining.



(a) Write about one major environmental problem caused by solution mining.

..... [1]

(b) Hydrogen and chlorine can be obtained by the electrolysis of brine.

(i) Describe a chemical test for hydrogen gas.

test .....

result .....

..... [2]

(ii) Describe a chemical test for chlorine gas.

test .....

result .....

..... [2]

[Total: 5]

[Turn over

8 Ethanol is made by the fermentation of glucose.

Carbon dioxide is also made in the process.

(a) Complete the **word** equation for fermentation.

glucose → ..... + ... [1]

(b) What is the best temperature for fermentation to happen?

Choose from the list.

0 °C

40 °C

100 °C

400 °C

answer ..... [1]

(c) Fermentation makes a dilute solution of ethanol.

What method of separation could be used to get almost pure ethanol?

Choose from the list.

crystallisation

electrolysis

evaporation

filtration

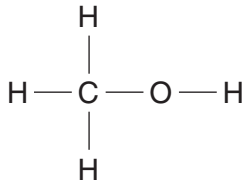
fractional distillation

answer ..... [1]

(d) Write down **one** of the uses of ethanol.

..... [1]

(e) Look at the displayed formula for methanol, CH_3OH.



Draw the displayed formula of ethanol, C_2H_5OH.

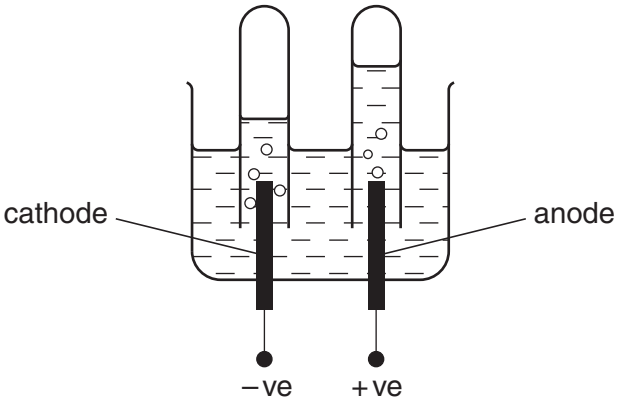
[1]

[Total: 5]

END OF QUESTION PAPER

1 Hannah investigates the electrolysis of aqueous potassium sulfate.

Look at the apparatus she uses.



(a) There are bubbles of gas made at both electrodes.

What are the names of the **two** gases made during this electrolysis?

Choose from the list.

carbon dioxide

hydrogen

nitrogen

oxygen

sulfur dioxide

answer ..... and ..... [2]

(b) Write down **two** factors that affect the amount of gas made when aqueous potassium sulfate is electrolysed.

1 .....

2 ..... [2]

[Total: 4]

2 Monty investigates the properties of two acids

- dilute ethanoic acid, CH_3COOH
- dilute hydrochloric acid, HCl.

(a) Monty adds a small piece of magnesium ribbon to dilute ethanoic acid.

Monty sees bubbles of a gas. At the end of the reaction a colourless solution is left.

The colourless solution contains magnesium ethanoate, $Mg(CH_3COO)_2$.

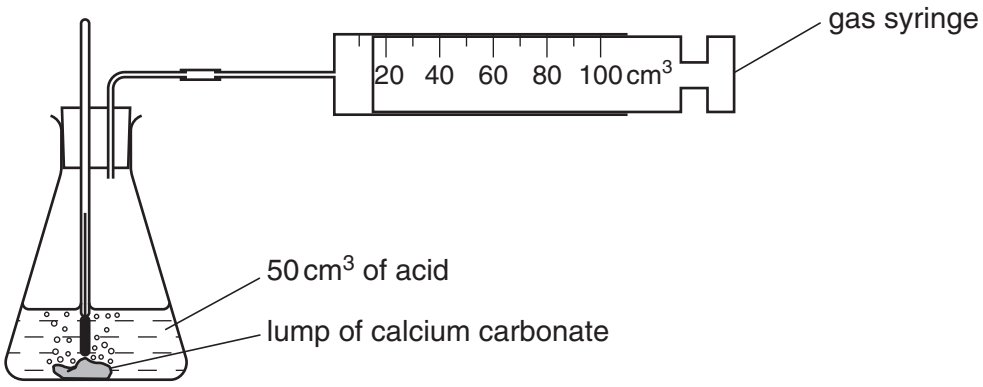
Write down the balanced **symbol** equation for the reaction between magnesium and ethanoic acid.

..... [2]

(b) Monty investigates the reaction of both acids with a lump of calcium carbonate.

He wants to find out the volume of gas made every 10 seconds.

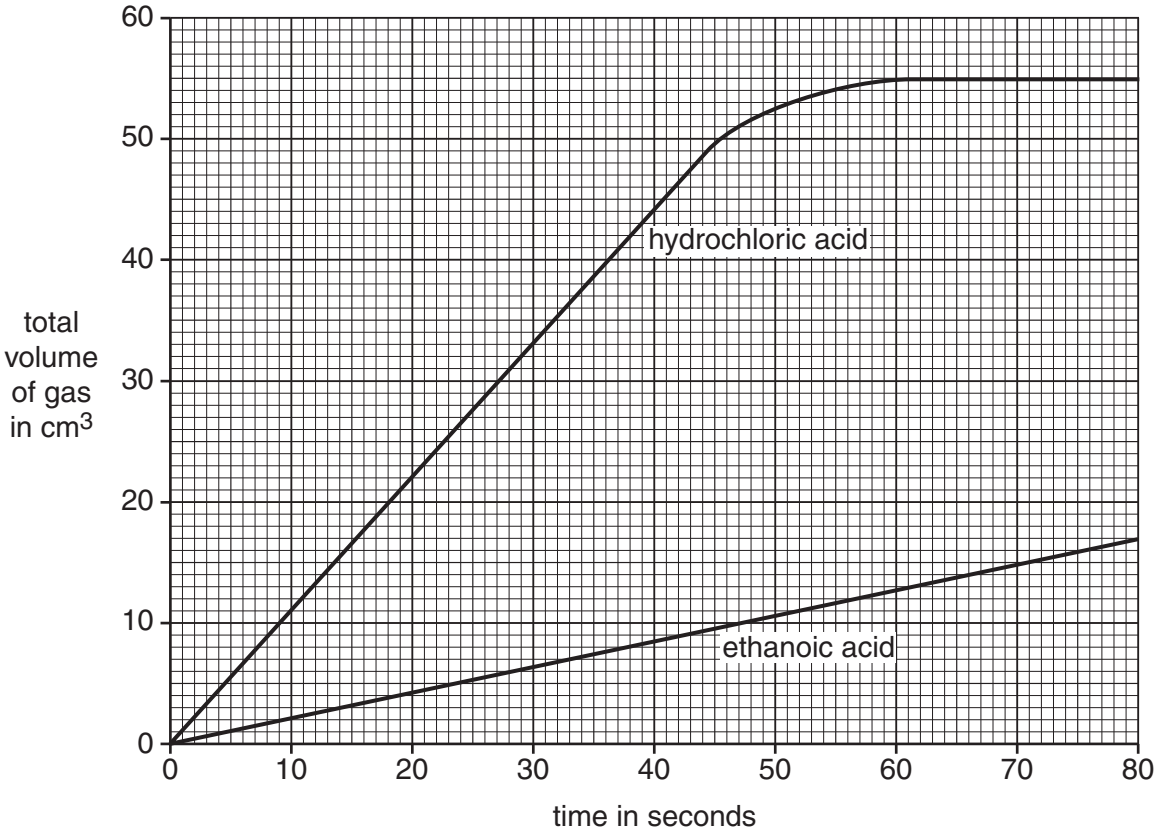
Look at the apparatus he uses.



He does two experiments, one with dilute ethanoic acid and one with dilute hydrochloric acid.

He makes sure he does a fair test.

Look at the graph of his results.



(i) The reaction between calcium carbonate and ethanoic acid is still happening after 80 seconds.

What will be the total volume of gas collected at the **end** of this reaction?

..... cm^3 [1]

(ii) Dilute hydrochloric acid reacts much faster than dilute ethanoic acid.

Explain why.

Use ideas about

- hydrogen ions
- collisions between particles.

.....

.....

.....

..... [3]

[Total: 6]

[Turn over

3 This question is about equilibrium and reversible reactions.

Ethene reacts with steam in a reversible reaction to make ethanol.

$$C_2H_4 + H_2O \rightleftharpoons C_2H_5OH$$

This reversible reaction can reach equilibrium if it is in a sealed container.

(a) At equilibrium there is a connection between the rate of the forward reaction and the rate of the backward reaction.

What is this connection?

..... [1]

(b) What happens to the concentration of ethene and of water at equilibrium?

..... [1]

(c) Look at the table.

It shows how the percentage of ethene at equilibrium changes as the **temperature** changes and as the **pressure** changes.

	temperature		
pressure	200 °C	260 °C	320 °C
30 atmospheres	37%	26%	21%
40 atmospheres	40%	30%	25%
50 atmospheres	44%	35%	30%
60 atmospheres	48%	40%	34%

What happens to the percentage of ethene as the pressure increases but the temperature stays the same?

..... [1]

(d) Calculate the maximum mass of ethanol that can be made from 5.6 tonnes of ethene.

The relative atomic mass for H is 1, for C is 12 and for O is 16.

.....

.....

.....

.....

maximum mass of ethanol = ... [3]

[Total: 6]

4 Zoe tests copper(II) sulfate solution.

(a) Zoe adds barium chloride solution to copper(II) sulfate solution.

A white precipitate appears.

Write down the **word** equation for this reaction.

..... [1]

(b) Zoe adds sodium hydroxide solution to copper(II) sulfate solution.

This time she gets a blue precipitate of copper(II) hydroxide, $Cu(OH)_2$.

Write down the **ionic** equation for the reaction between aqueous Cu^{2+} and aqueous OH^-.

Include **state** symbols.

..... [3]

[Total: 4]

5 This question is about the hardness of water.

(a) Look at the list.

calcium hydrogencarbonate

calcium sulfate

ethanoic acid

sodium chloride

sodium hydroxide

(i) Write the name of a substance that causes **permanent** hardness.

Choose from the list.

answer ..... [1]

(ii) Write the name of a substance that causes **temporary** hardness.

Choose from the list.

answer ..... [1]

(b) Calcium carbonate, $CaCO_3$, reacts with water and carbon dioxide to make calcium hydrogencarbonate, $Ca(HCO_3)_2$.

Write a balanced **symbol** equation for this reaction.

..... [1]

(c) Ion exchange resins can be used to soften water.

Explain how ion exchange resins soften water.

.....

.....

.....

..... [2]

[Total: 5]

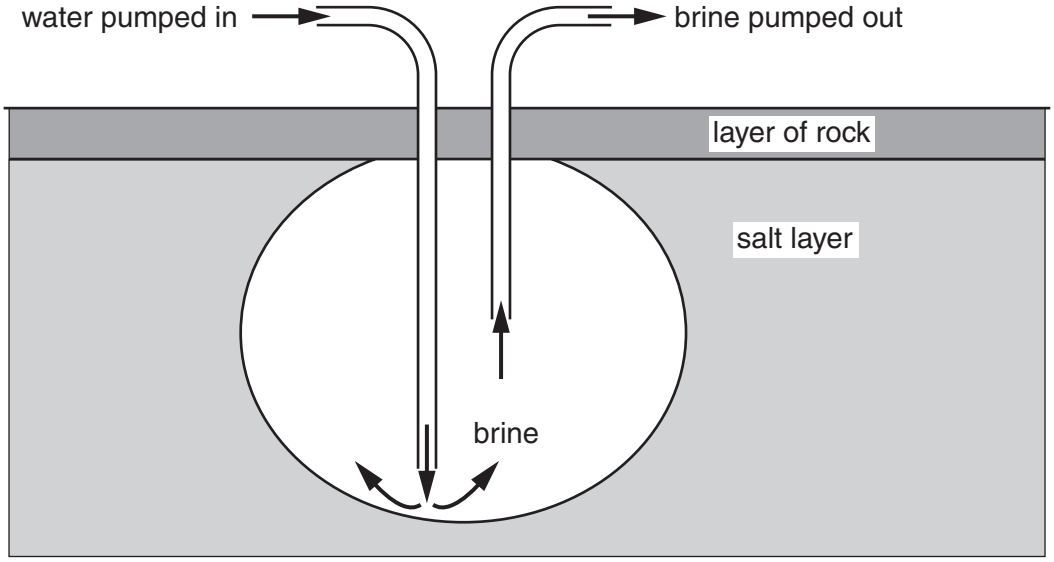
[Turn over

6 This question is about sodium chloride.

Brine is a solution of sodium chloride.

Solution mining is used to get brine out of the ground.

Look at the diagram of solution mining.



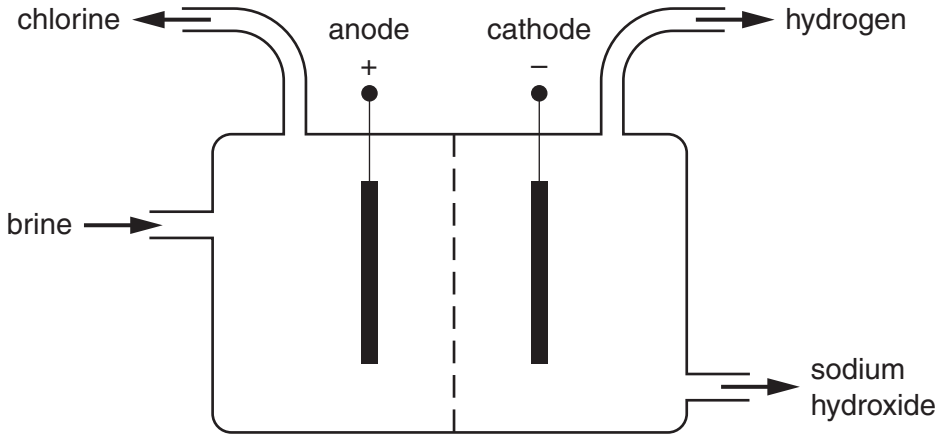
(a) Write about one major environmental problem caused by solution mining.

..... [1]

(b) Look at the diagram.

It shows the apparatus used for the electrolysis of sodium chloride solution (brine).

Chlorine, hydrogen and sodium hydroxide are made.



(i) Hydrogen ions, H^+, react to make hydrogen gas, H_2.

Write an equation for this reaction.

Use e^- to show an electron.

..... [1]

(ii) Chloride ions, Cl^-, react to form chlorine gas.

Write an equation for this reaction.

Use e^- to show an electron.

..... [1]

(iii) Sodium hydroxide is also made in this electrolysis.

Explain why.

..... [1]

[Total: 4]

[Turn over

7 Ethanol is made by the fermentation of glucose.

Carbon dioxide is also made in the process.

(a) Complete the **word** equation for fermentation.

glucose → ..... + ... [1]

(b) Fermentation makes a dilute solution of ethanol.

What method of separation could be used to get almost pure ethanol?

Choose from the list.

crystallisation

electrolysis

evaporation

filtration

fractional distillation

answer ..... [1]

(c) A fermentation reaction takes place at 40 °C.

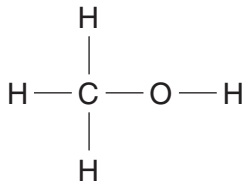
When the temperature is raised to 80 °C, fermentation stops.

Explain why.

.....

..... [1]

(d) Look at the displayed formula for methanol, CH_3OH.



Draw the displayed formula of ethanol, C_2H_5OH.

[1]

(e) Look at this table.

It shows the formulae of some alcohols.

alcohol	**formula**
methanol	CH_3OH
ethanol	C_2H_5OH
propanol	
butanol	C_4H_9OH

(i) Complete the table by writing the formula for propanol. [1]

(ii) The general formula for an **alkene** is C_nH_{2n}.

Write down the general formula for an **alcohol**.

..... [1]

[Total: 6]

8 This question is about fats and oils.

(a) In a saturated fat all the bonds between carbon atoms are single bonds.

How is an unsaturated fat different?

..... [1]

(b) Describe a chemical test for unsaturation in a fat.

test..... [1]

result ..... [1]

(c) Fats and oils can be heated with sodium hydroxide to make soap.

Look at the list.

displacement

neutralisation

oxidation

reduction

saponification

Put a (ring) around the word that best describes the process. [1]

(d) How is margarine manufactured from vegetable oils?

..... [1]

[Total: 5]

END OF QUESTION PAPER

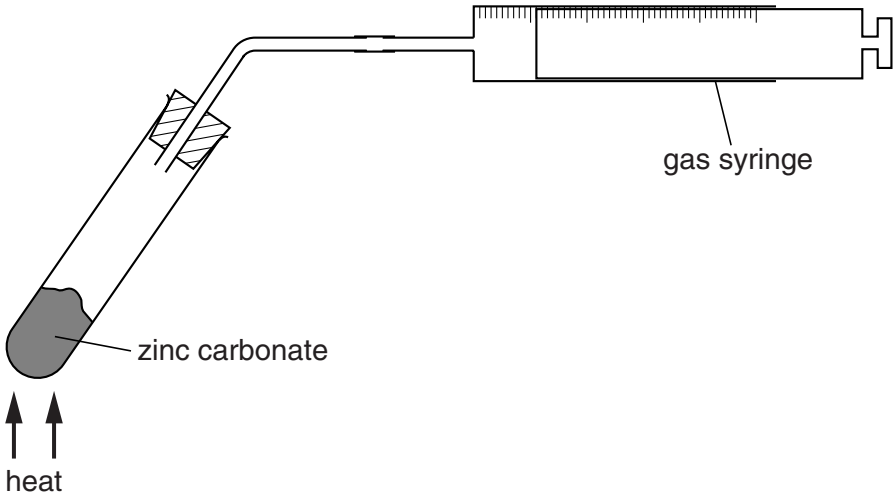
1 Viviana investigates the thermal decomposition of zinc carbonate.

She puts 0.47 g of zinc carbonate into a test-tube.

She then heats the zinc carbonate using a blue Bunsen flame.

Carbon dioxide and zinc oxide are made.

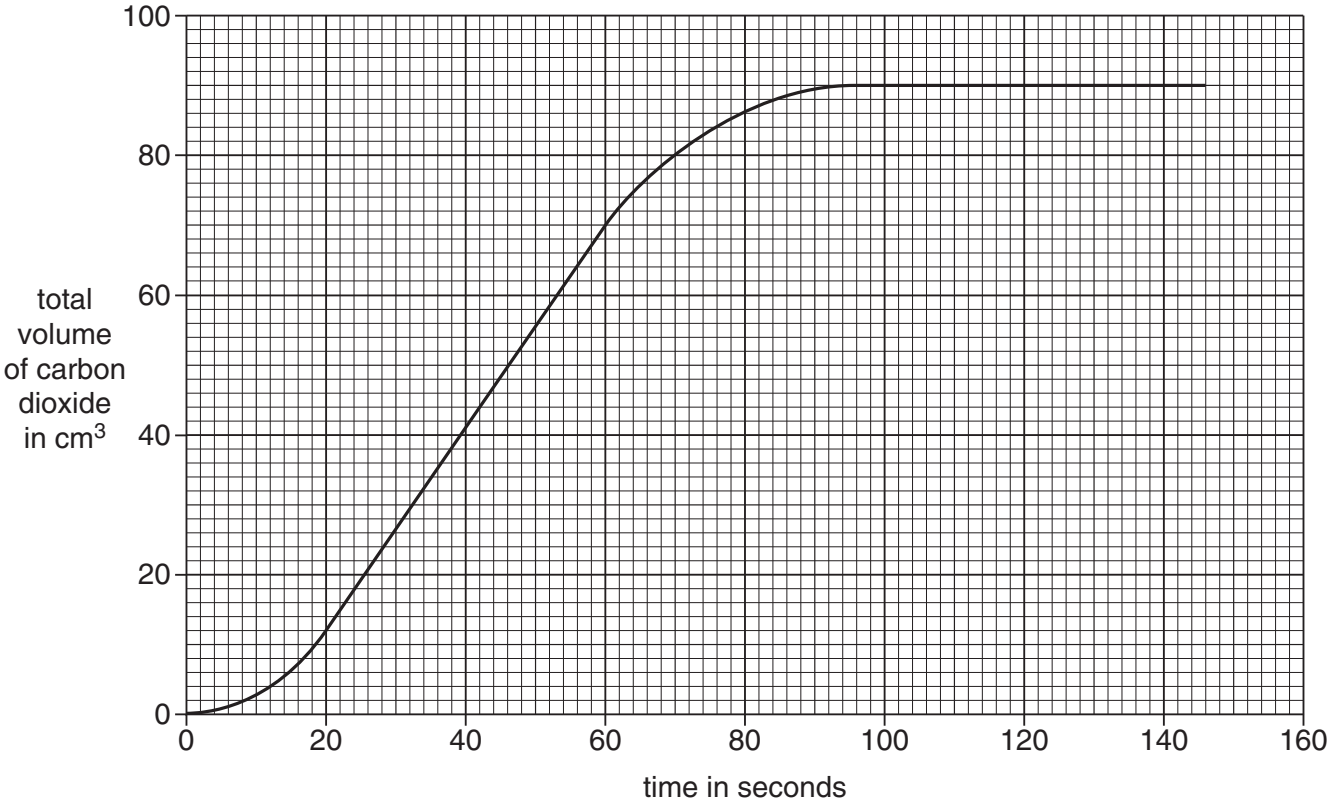
Look at the apparatus she uses.



She uses a gas syringe to collect the carbon dioxide made.

Every 30 seconds she measures the total volume of carbon dioxide in the gas syringe.

Look at the graph of Viviana's results.



(a) (i) How long does it take to make 70 cm^3 of carbon dioxide?

..... seconds **[1]**

(ii) What is the total volume of carbon dioxide made at the end of the reaction?

..... cm^3 **[1]**

(iii) At what time does the reaction stop?

..... seconds **[1]**

Turn over for the remainder of question 5

(b) At the end of the experiment Viviana finds out how much zinc oxide she has made.

Look at her table of results.

substance	mass in grams
mass of zinc carbonate before heating	0.47
mass of zinc oxide after heating	0.30
mass of carbon dioxide made	……

(i) What is the mass of carbon dioxide made?

Put your answer in the table. **[1]**

(ii) Viviana repeats the experiment.

This time she uses **0.94** g of zinc carbonate instead of 0.47 g.

Predict how much zinc oxide she should make.

.....

.....

mass of zinc oxide = ... g **[1]**

[Total: 5]

2 Sulfur, air and water are raw materials used to make sulfuric acid.

Sulfuric acid is made by the Contact Process.

(a) Complete the word equation for **stage 1** of the Contact Process.

Stage 1 ..... + ... → sulfur dioxide

Stage 2 sulfur dioxide + oxygen ⇌ sulfur trioxide

Stage 3 sulfur trioxide + water → sulfuric acid **[1]**

(b) Look at **stage 2**.

(i) What is the meaning of the symbol ⇌?

..... **[1]**

(ii) The conditions used for **stage 2** are

- 450 °C
- atmospheric pressure
- a catalyst.

What is the name or formula of the catalyst used?

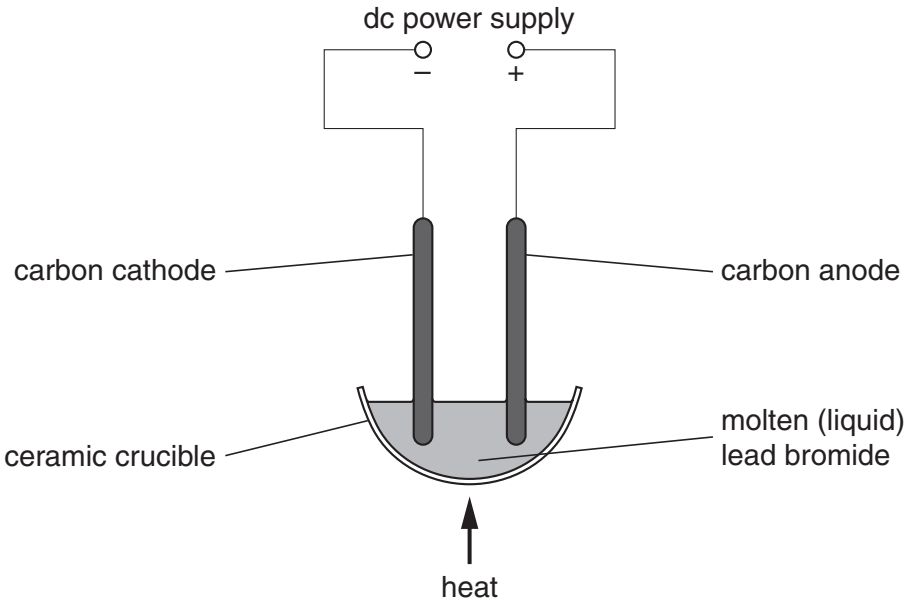
..... **[1]**

[Total: 3]

3 This question is about electrolysis.

Look at the diagram.

It shows the apparatus needed for the electrolysis of molten (liquid) lead bromide.



Look at the symbol equation. It shows how lead bromide is broken down during electrolysis.

$$PbBr_2 \rightarrow Pb + Br_2$$

(a) Molten lead bromide is electrolysed.

(i) Write down the **name** of one **product** of this electrolysis.

..... **[1]**

(ii) Two factors affect how much product is made in this electrolysis.

One factor is the current used.

Write down the **other factor** that affects how much product is made.

..... **[1]**

(b) Electrolysis involves the movement of ions.

Molten (liquid) lead bromide can be electrolysed but **solid** lead bromide cannot.

Explain why.

.....

.....

..... **[2]**

[Total: 4]

4 Imran researches acids using the internet.

He finds out that hydrobromic acid is a **strong** acid.

He also finds out that citric acid is a **weak** acid.

(a) Imran tests the pH value of both acids.

Both acids have the same concentration.

Finish the sentence.

Choose words from the list.

less than

more than

the same as

The pH value of hydrobromic acid is …… the pH value of citric acid.

[1]

(b) Write down the name of another **weak** acid.

Choose from the list.

ethanoic acid

hydrochloric acid

nitric acid

sulfuric acid

answer ..... **[1]**

(c) Ethanoic acid reacts with magnesium ribbon.

It makes a gas.

What is the name of this gas?

Choose from the list.

carbon dioxide

ethane

hydrogen

oxygen

answer ..... **[1]**

(d) The molar mass of hydrochloric acid, HC*l*, is 36.5 g / mol.

What is the molar mass of nitric acid, HNO_3?

The relative atomic mass (A_r) of H is 1, of N is 14, of O is 16 and of C*l* is 35.5.

.....

.....

.....

molar mass = ... g / mol **[1]**

[Total: 4]

5 Precipitation reactions can be used to test for ions in solution.

Silver nitrate solution can be used to test for the halide ions.

Look at the ionic equation.

$$Ag^{+}(aq) + Cl^{-}(aq) \rightarrow AgCl(s)$$

(a) What does the symbol **(s)** in the ionic equation mean?

..... **[1]**

(b) What does the symbol **(aq)** in the ionic equation mean?

..... **[1]**

(c) Rachael tests a solution to see if it contains either

- chloride ions, Cl^{-}
- or iodide ions, I^{-}.

She adds silver nitrate to the solution.

Her results tell her which ion is present in the solution.

Describe how.

Include the possible results of her test.

.....

.....

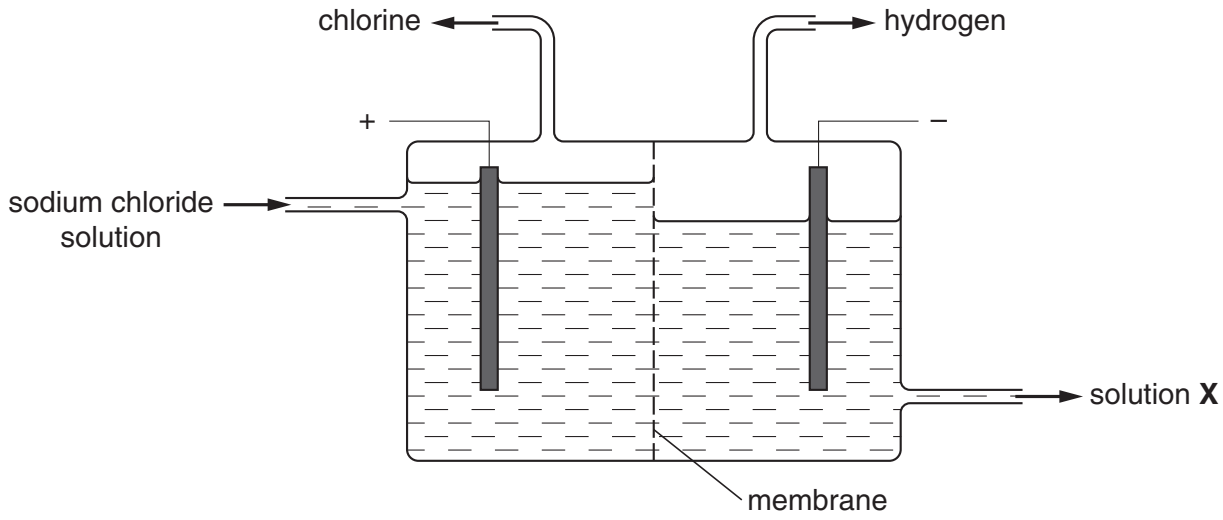
..... **[2]**

[Total: 4]

6 This question is about chemicals made from sodium chloride.

(a) A solution of concentrated sodium chloride is electrolysed.

Look at the diagram. It shows the apparatus used.



Hydrogen gas and chlorine gas are made.

(i) Write down a chemical test for hydrogen.

test .....

result ..... **[2]**

(ii) Write down a chemical test for chlorine.

test .....

result ..... **[2]**

(iii) Solution **X** is also made in the electrolysis cell.

What is the name of solution **X**?

..... **[1]**

(b) Write down a use for hydrogen gas.

..... **[1]**

[Total: 6]

7 This question is about chlorofluorocarbons, CFCs.

Most CFCs are now banned in the UK.

This is because they damage the ozone layer.

(a) Chlorofluorocarbons contain **three** different elements.

Two of these elements are chlorine and carbon.

Write down the **name** of the **other** element.

..... **[1]**

(b) Write down **two** uses of chlorofluorocarbons.

1 .....

2 ..... **[2]**

(c) The damage to the ozone layer can cause medical problems.

Write down **two** of these problems.

1 .....

2 ..... **[2]**

[Total: 5]

8 This question is about aspirin.

Aspirin is used to thin the blood.

(a) Write down **two** other reasons for taking aspirin.

1 .....

2 ..... **[2]**

(b) Aspirin can be extracted from a plant.

What is the name of this plant?

..... **[1]**

(c) Aspirins and other medicines are sold in some shops.

Look at the list.

engineers

geologists

pharmacists

Complete this sentence. Choose from the list.

Trained people allowed to sell medicines are called …… . **[1]**

[Total: 4]

9 This question is about the hardness of water.

Hardness of water is caused by chemicals dissolved in the water.

There are two types of hardness, temporary and permanent.

(a) Look at the list of chemicals.

calcium hydrogencarbonate

calcium sulfate

sodium chloride

sodium hydroxide

Complete the sentences using chemicals from the list.

(i) **Temporary** hardness is caused by ..... . **[1]**

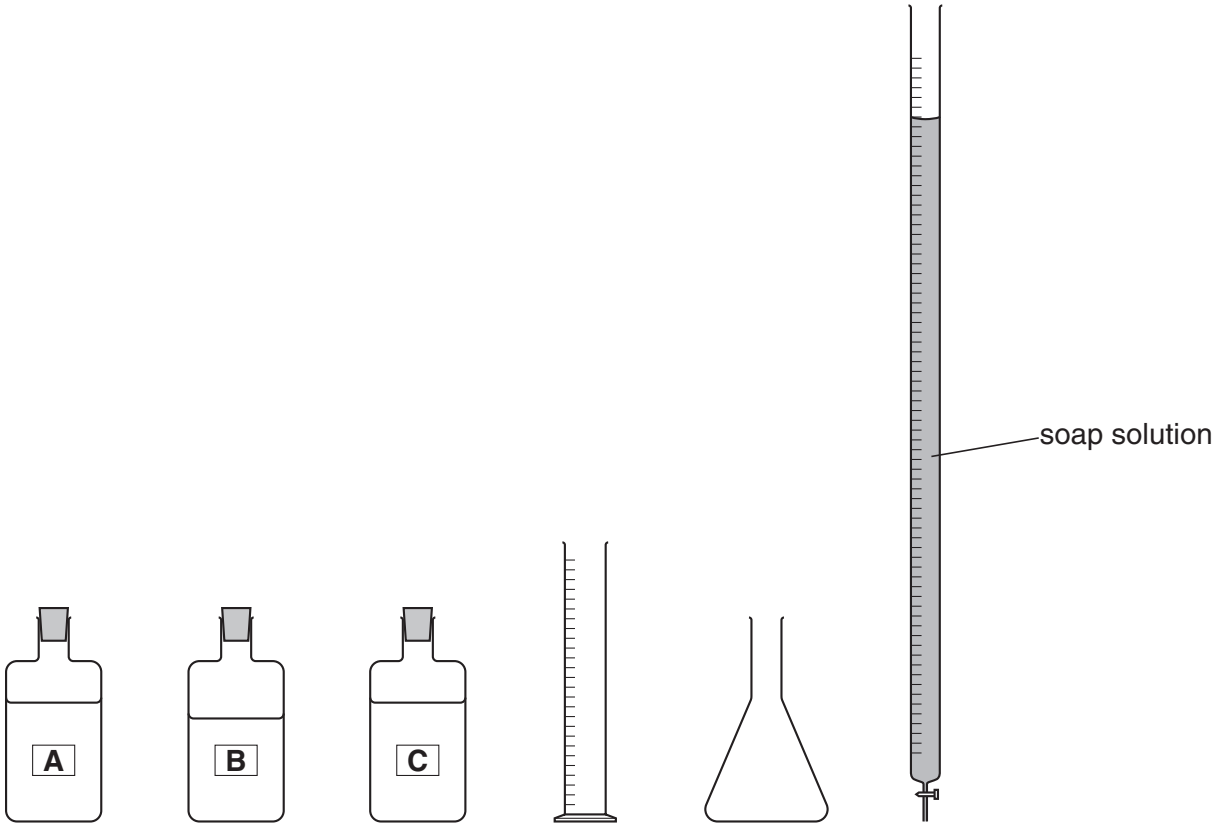
(ii) **Permanent** hardness is caused by ..... . **[1]**

(b) Claire collects water samples from three different places, **A**, **B** and **C**.

They have different amounts of hardness.

She wants to compare the hardness of these samples.

Look at the diagram. It shows the apparatus she uses.



Write about how Claire uses the apparatus to compare the hardness of the water samples.

.....

.....

.....

.....

..... **[3]**

[Total: 5]

END OF QUESTION PAPER

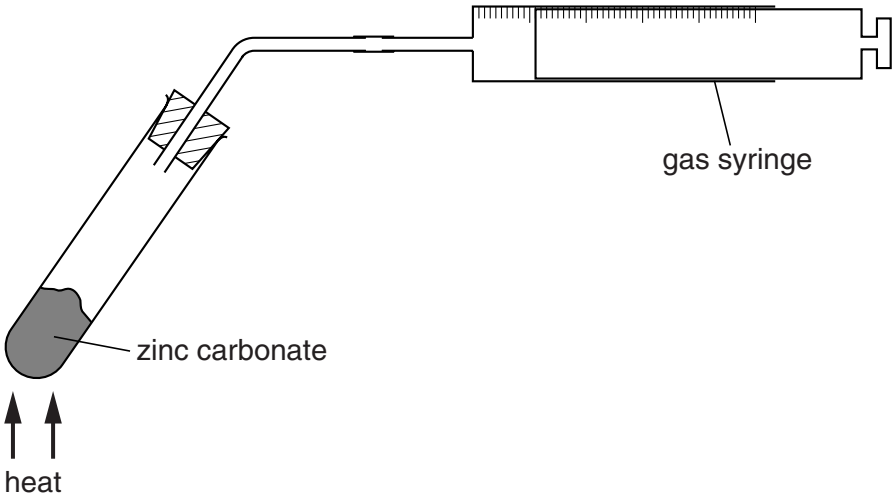
1 Viviana investigates the thermal decomposition of zinc carbonate.

She puts 0.47 g of zinc carbonate into a test-tube.

She then heats the zinc carbonate using a blue Bunsen flame.

Carbon dioxide and zinc oxide are made.

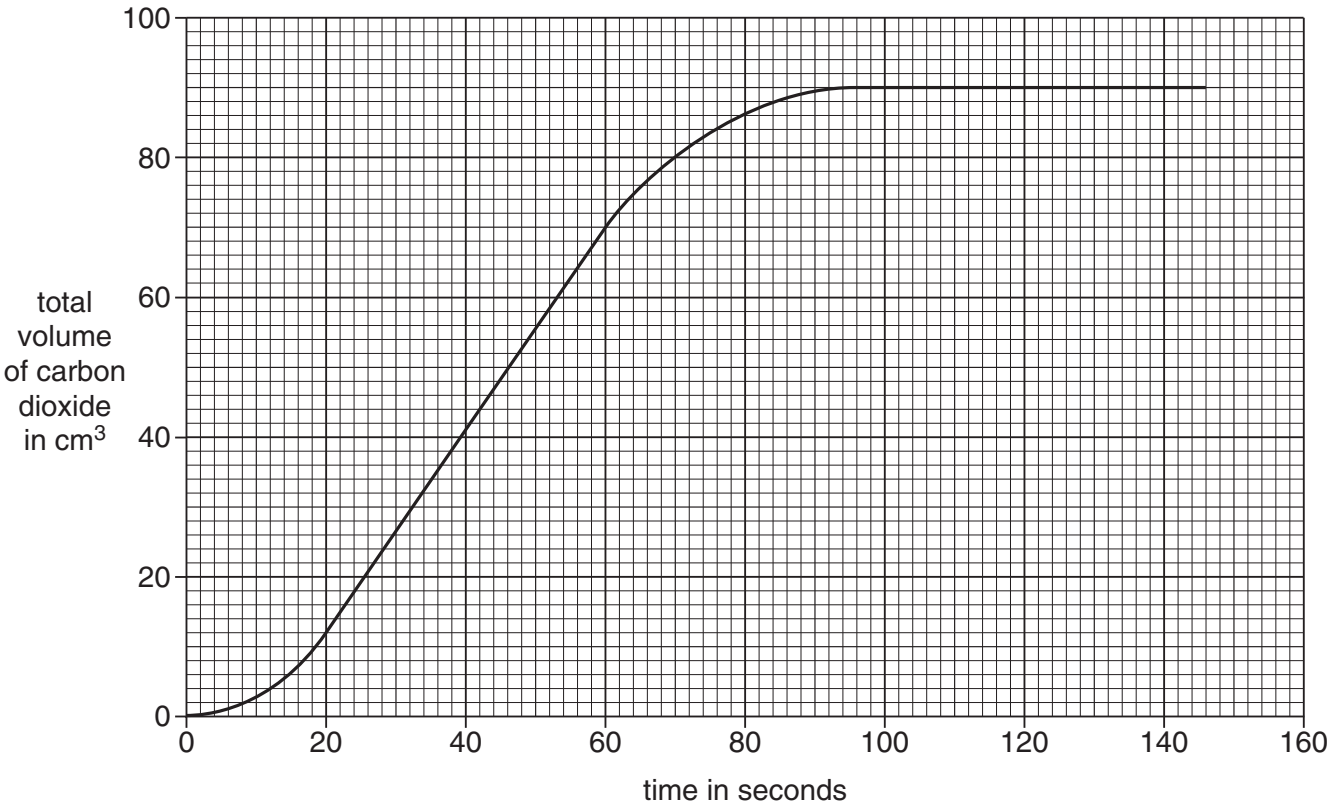
Look at the apparatus she uses.



She uses a gas syringe to collect the carbon dioxide made.

Every 30 seconds she measures the total volume of carbon dioxide in the gas syringe.

Look at the graph of Viviana's results.



(a) (i) How long does it take to make 50 cm^3 of carbon dioxide?

..... seconds **[1]**

(ii) At what time does the reaction stop?

..... seconds **[1]**

Turn over for the remainder of question 5

(b) At the end of the experiment Viviana finds out how much zinc oxide she made.

Look at her table of results.

substance	mass in grams
mass of zinc carbonate before heating	0.47
mass of zinc oxide after heating	0.30
mass of carbon dioxide made	0.17

(i) How many moles of carbon dioxide, CO_2, are made in the experiment?

The relative atomic mass (A_r) of C is 12 and of O is 16.

.....

.....

.....

number of moles = ... **[2]**

(ii) Viviana repeats the experiment.

This time she uses **0.94** g of zinc carbonate instead of 0.47 g.

Predict how much zinc oxide she should make.

.....

.....

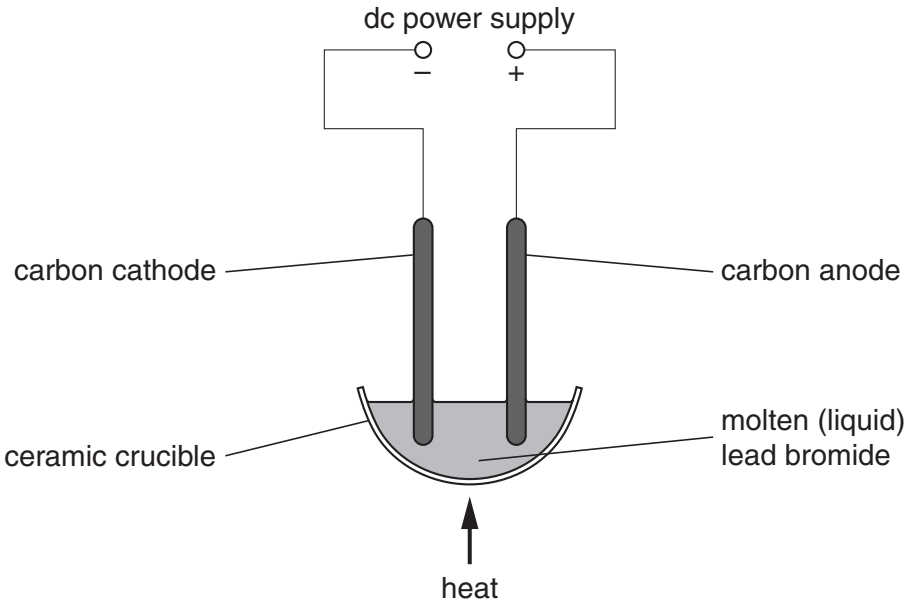
mass of zinc oxide = ... g **[1]**

[Total: 5]

2 This question is about electrolysis.

Look at the diagram.

It shows the apparatus needed for the electrolysis of molten (liquid) lead bromide.



Look at the symbol equation. It shows how lead bromide is broken down during electrolysis.

$$PbBr_2 \rightarrow Pb + Br_2$$

(a) Electrolysis involves the movement of ions.

Molten (liquid) lead bromide can be electrolysed but **solid** lead bromide cannot.

Explain why.

.....

.....

..... **[2]**

(b) Molten lead bromide contains lead ions, Pb^{2+}, and bromide ions, Br^-.

Bromide ions lose electrons at the anode to make bromine molecules, Br_2.

Construct the equation for this electrode reaction.

Use e^- to represent an electron.

..... **[2]**

(c) During an experiment 9.65 A is passed through molten lead bromide for 100 seconds.

A mass of 1.035 g of lead was made at the cathode.

In a second experiment 19.3 A is passed through molten lead bromide for 50 seconds.

The same mass of lead was made at the cathode.

Explain why.

Use ideas about current and time.

.....

.....

.....

..... **[2]**

[Total: 6]

3 Sulfur, air and water are raw materials used to make sulfuric acid.

Sulfuric acid is made by the Contact Process.

(a) Complete the word equation for **stage 1** of the Contact Process.

Stage 1 ..... + ... → sulfur dioxide

Stage 2 sulfur dioxide + oxygen ⇌ sulfur trioxide

Stage 3 sulfur trioxide + water → sulfuric acid **[1]**

(b) Look at **stage 2**.

The conditions used for **stage 2** are

- 450 °C
- atmospheric pressure
- a catalyst.

(i) What is the name or formula of the catalyst used?

..... **[1]**

(ii) Explain the conditions used in the Contact Process.

Use ideas about

- rate of reaction
- position of equilibrium.

catalyst

rate of reaction .....

.....

position of equilibrium .....

.....

450 °C

rate of reaction .....

.....

position of equilibrium .....

..... **[4]**

[Total: 6]

4 Imran researches acids using the internet.

He finds out that both strong and weak acids react with magnesium ribbon to make hydrogen.

Imran adds a 1 cm length of magnesium ribbon to 50 cm^3 of ethanoic acid.

He adds another 1 cm length of magnesium ribbon to 50 cm^3 of hydrochloric acid.

Both acids have the same concentration.

He finds the hydrochloric acid reacts much faster.

Explain why.

Use ideas about

- strong and weak acids
- hydrogen ions
- collision theory.

.....

.....

.....

.....

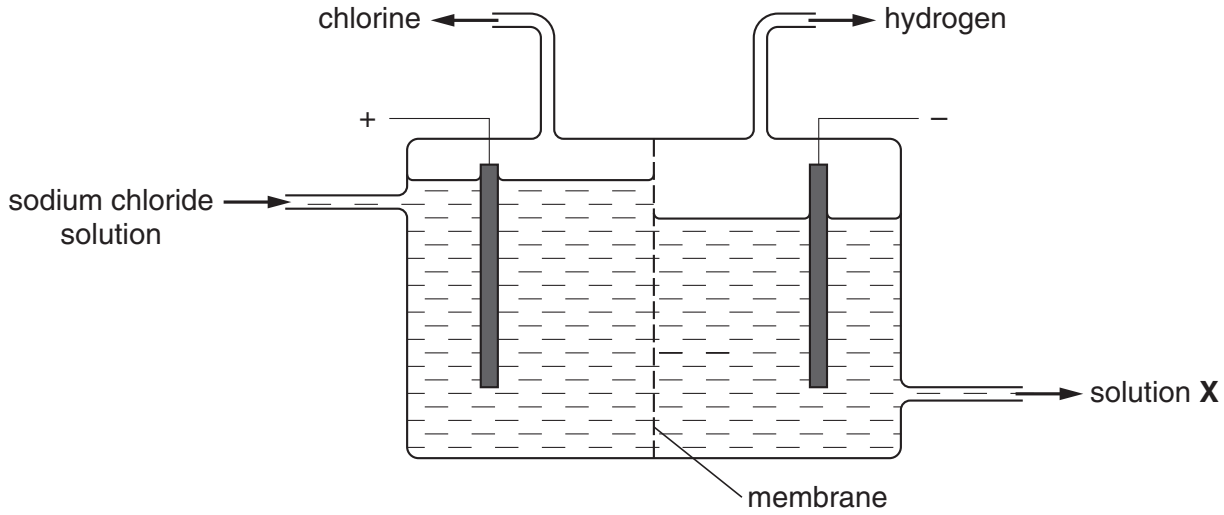
..... **[3]**

[Total: 3]

5 This question is about sodium chloride and chemicals obtained from it.

A solution of concentrated sodium chloride is electrolysed.

Look at the diagram. It shows the apparatus used.



Hydrogen gas and chlorine gas are produced.

(a) Solution **X** is also made in the electrolysis cell.

What is the name of solution **X**?

..... **[1]**

(b) During electrolysis hydrogen ions, H^+, are turned into hydrogen gas, H_2.

Write a balanced **symbol** equation for this reaction. Use e^- to represent an electron.

..... **[2]**

(c) Very dilute sodium chloride solution is electrolysed.

Chlorine gas is no longer given off at the positive electrode.

A different gas is given off.

Write down the name of this gas.

..... **[1]**

(d) Sodium chloride (salt) solution is obtained in Cheshire by **solution mining**.

Write down **one** hazard caused by solution mining.

..... **[1]**

[Total: 5]

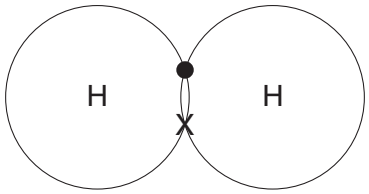
6 This question is about the ozone layer.

The ozone layer is damaged by free radicals.

Chlorofluorocarbons, CFCs, are one source of free radicals.

Most CFCs are now banned in the UK.

(a) Look at the diagram. It shows a 'dot and cross' diagram for a hydrogen molecule.



The two hydrogen atoms are joined by a covalent bond.

This covalent bond is a shared pair of electrons.

The covalent bond can be broken to make two free radicals.

Explain what happens to the electrons when free radicals are made.

.....

..... **[1]**

(b) Small numbers of free radicals can do a lot of damage to the ozone layer.

Explain why.

.....

..... **[1]**

(c) Chlorofluorocarbons will continue to damage the ozone layer for a long time after they have been banned.

Explain why.

..... **[1]**

(d) Suggest a replacement for chlorofluorocarbons.

..... **[1]**

[Total: 4]

7 This question is about the hardness of water.

Hardness of water is caused by chemicals dissolved in the water.

There are two types of hardness, temporary and permanent.

(a) Look at the list of chemicals.

calcium hydrogencarbonate

calcium sulfate

sodium chloride

sodium hydroxide

Complete the sentences using chemicals from the list.

(i) **Temporary** hardness is caused by ..... . **[1]**

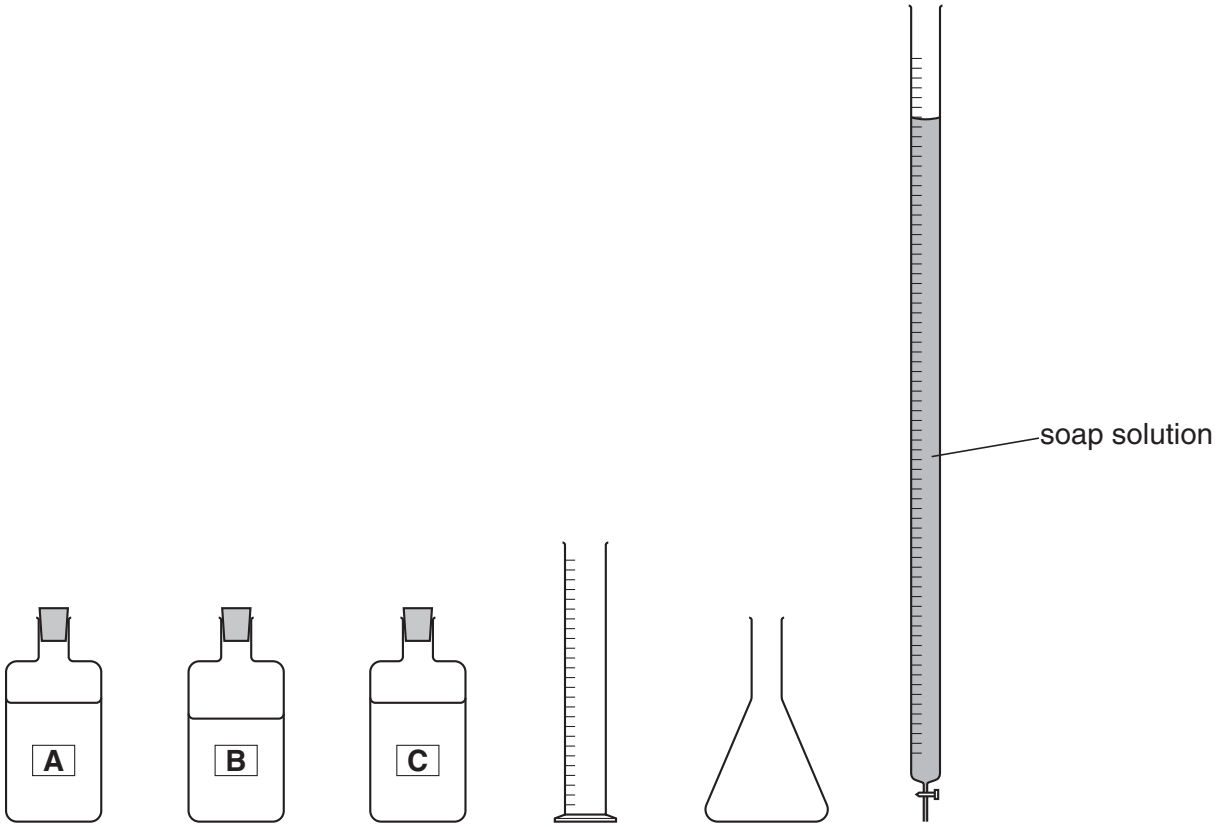
(ii) **Permanent** hardness is caused by ..... . **[1]**

(b) Claire collects water samples from three different places, **A**, **B** and **C**.

They have different amounts of hardness.

She wants to compare the hardness of these samples.

Look at the diagram. It shows the apparatus she uses.



Write about how Claire uses the apparatus to compare the hardness of the water samples.

.....

.....

.....

.....

..... **[3]**

(c) Washing soda (sodium carbonate) can soften hard water.

Explain how.

.....

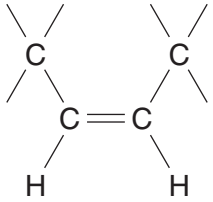
..... **[1]**

[Total: 6]

8 This question is about fats and oils.

(a) Vegetable oils are often unsaturated.

Look at the displayed formula. It is part of a molecule of vegetable oil.



An unsaturated oil has at least one carbon-carbon double bond.

Bromine water can be used to test for unsaturation in fats and oils.

Explain how.

.....

.....

..... **[2]**

(b) Vegetable oils are used to make margarine.

Vegetable oils are liquids. Margarine is solid.

Which **element** is reacted with vegetable oil to make margarine?

..... **[1]**

(c) Fats can be turned into soap by heating with sodium hydroxide solution.

What is the name of this process?

Choose from the list.

distillation

fermentation

saponification

saturation

answer ..... **[1]**

(d) Fats and oils all belong to a particular group of chemicals.

Look at the list.

alcohols

analgesics

emulsions

esters

What is the name of this group?

Choose from the list.

answer ..... **[1]**

[Total: 5]

END OF QUESTION PAPER