Rewarding Learning

71

Candidate Number

General Certificate of Secondary Education
2010

Science: Chemistry

Paper 2
Higher Tier

[G1404]

G1404

WEDNESDAY 9 JUNE, AFTERNOON

TIME

2 hours.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper .
Answer **all seven** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 160.
Quality of written communication will be assessed in question **1(c)**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Data Leaflet which includes a Periodic Table of the Elements is provided.

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
Total Marks	

Examiner Only
Marks Remark

1 Neutralisation occurs when an acid and an alkali react to form a salt and water.

(a) (i) Complete the table below to give the names and formulae of the ions present in all acids and alkalis.

	Name	**Formula**
Ion present in all acids		
Ion present in all alkalis		

[4]

(ii) Write an ionic equation for neutralisation.
Include state symbols.

_____ [2]

(b) Sulphuric acid can be neutralised using an alkali such as sodium hydroxide or by adding an insoluble base such as copper(II) oxide.

(i) Name the salt formed when sodium hydroxide reacts with sulphuric acid.

_____ [1]

(ii) Write a balanced symbol equation for the reaction between copper(II) oxide and sulphuric acid.

_____ [2]

(c) In the preparation of copper(II) sulphate crystals, an excess of copper(II) oxide was added to warm dilute sulphuric acid. The excess copper(II) oxide was removed by filtration. Describe how you would obtain pure dry crystals of copper(II) sulphate from the filtrate collected.

Examiner Only
Marks Remark

_____

_____

_____

_____

_____

_____[3]

Quality of written communication [2]

(d) (i) To prove that the **copper(II) sulphate** salt produced in **(c)** contained copper(II) ions, Cu^{2+}, two different tests were carried out on a sample of the salt.
Test 1 used a solid sample of the salt and Test 2 used a solution of the salt.
Complete the table by stating what you would observe for Test 1, Test 2(a) and Test 2(b).

Test	Observations
1 Flame test	
2 (a) Add a few drops of ammonia solution to the salt solution (b) Add excess ammonia solution to the result of Test 2(a)	

[5]

[Turn over

Examiner Only	
Marks	Remark

(ii) Name the reagent used to test for the presence of the sulphate ion in a solution of copper(II) sulphate and state the result for a positive test.

Reagent: _____

Result: _____

_____

_____ [3]

(iii) To identify the ions present in an unknown salt **A** the following tests were carried out and the observations are recorded in the table below.

Use these results to complete the table by giving the identity of the ions present and suggest the formula for salt **A**.

Test	Observations	Ion present
1. Flame test	lilac flame	
2. Dissolve half a spatula-measure of **A** in 2 cm^3 of dilute nitric acid. Add2 cm^3 of silver nitrate solution.	yellow precipitate	

Formula of salt **A** _____ [3]

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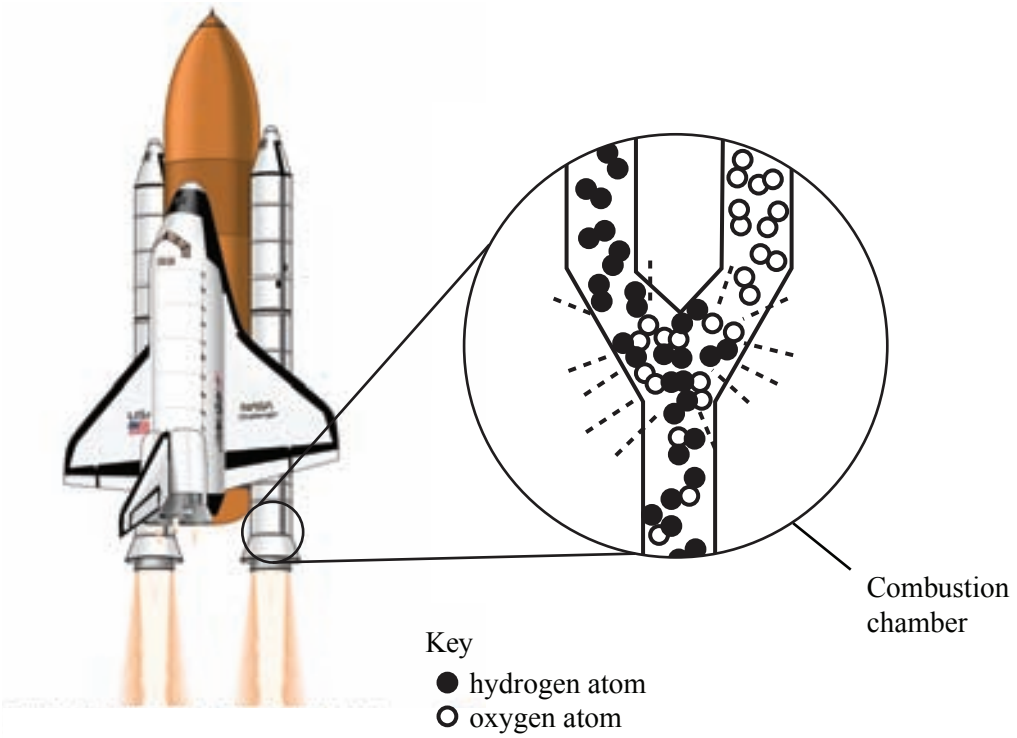
(Questions continue overleaf)

2 (a) Hydrogen is a powerful rocket fuel. The diagram shows the reaction which occurs in the combustion chamber of a rocket.



© NASA http://www1.dfrc.nasa.gov/Gallery/Graphics/STS/Large/EG-0076-04.gif

(i) Explain what you understand by the term combustion.

_____

_____

_____ [3]

(ii) Explain why hydrogen is considered to be a 'clean' fuel.

_____

_____ [1]

Examiner Only
Marks Remark

(iii) The equation for the reaction which occurs in the combustion chamber is:

$$2H_2 + O_2 \rightarrow 2H_2O$$

Explain, in terms of bonds, why the reaction in the combustion chamber is exothermic.

_____

_____

_____

_____

_____

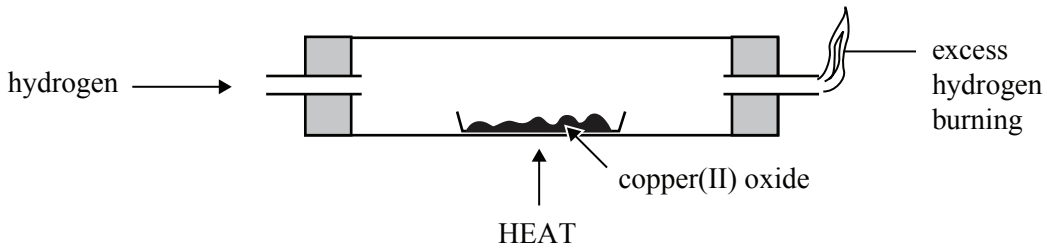
_____

_____ [5]

Examiner Only
Marks Remark

[Turn over

(b) Hydrogen is also a powerful reducing agent. The diagram shows the apparatus which could be used in the laboratory to reduce copper(II) oxide using hydrogen.



(i) State two observations made during this reaction.

1. _____

2. _____ [2]

(ii) Write a balanced symbol equation for the reduction of copper(II) oxide using hydrogen.

_____ [2]

(iii) Explain why this reaction is described as reduction.

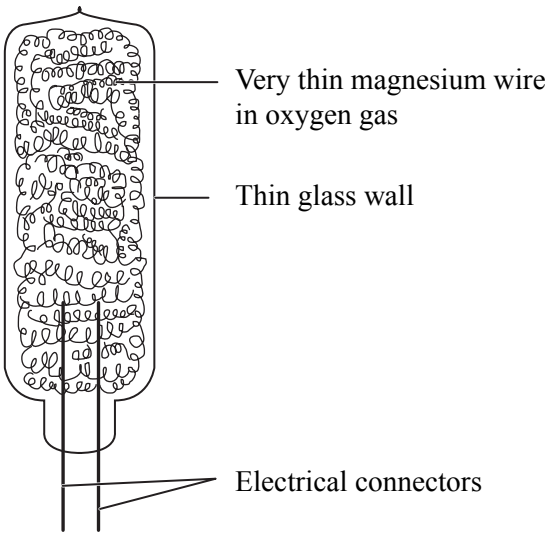
_____

_____

_____ [2]

Examiner Only
Marks Remark

(c) Before the use of electronic built-in flashes, most cameras needed flash bulbs to create a flash of artificial light. The diagram below represents a flash bulb which works by the reaction of very thin magnesium wires with oxygen.



(i) Explain why very thin magnesium wires are used instead of magnesium ribbon.

_____

_____ [2]

(ii) Write a balanced symbol equation for the reaction which occurs inside the flash bulb.

_____ [3]

(iii) State one observation made during this reaction.

_____ [1]

(iv) Complete the ionic half equation below and use it to explain, in terms of electrons, why this reaction is described as oxidation.

$$Mg \longrightarrow Mg^{2+}$$

_____

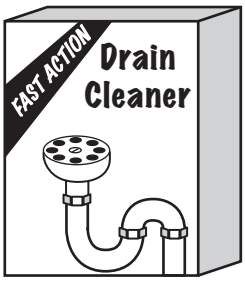
_____

_____ [3]

Examiner Only
Marks Remark

3 Barium hydroxide is a Group II metal hydroxide which is often found in drain cleaners.

Examiner Only
Marks Remark



To determine the concentration of a solution of barium hydroxide $Ba(OH)_2$ 25.0 cm^3 of the solution was placed in a conical flask with a few drops of phenolphthalein indicator and titrated with a solution of hydrochloric acid of concentration 0.2 mol/dm^3 (moles per litre).

The balanced symbol equation for the reaction is:

$$Ba(OH)_2 + 2HCl \rightarrow BaCl_2 + 2H_2O$$

(a) (i) Describe in detail, stating precautions to ensure safety and accuracy, how you would place 25.0 cm^3 of barium hydroxide solution into the conical flask.

_____

_____

_____

_____

_____

_____

_____ [4]

(ii) State the colour change of the phenolphthalein indicator at the end point.

From _____ to _____ [2]

(b) The results of the titration are shown in the table below .

	Initial burette reading (cm^3)	**Final burette reading (cm^3)**	**Volume of hydrochloric acid used (titre) (cm^3)**
Rough titration	0.0	22.8	22.8
1st accurate titration	0.0	22.4	22.4
2nd accurate titration	0.0	22.5	22.5

(i) Calculate the average titre.

Examiner Only
Marks Remark

[2]

(ii) Calculate the number of moles of hydrochloric acid used in this titration.

[2]

(iii) Use the balanced symbol equation to deduce the number of moles of barium hydroxide which reacted with the hydrochloric acid.

[2]

(iv) Calculate the concentration of the barium hydroxide solution in mol/dm^3 (moles per litre).

[2]

[Turn over

(c) Calcium is a Group II metal which reacts with nitric acid according to the balanced symbol equation:

$$Ca + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2$$

(Relative atomic masses: H = 1; N = 14; O = 16; Ca = 40)

(i) 0.2 g of calcium metal was reacted with excess nitric acid. Calculate the volume of hydrogen gas which was produced in this reaction. (1 mole of any gas occupies 24 dm^3).

_____ dm^3 [5]

(ii) If the concentration of the nitric acid was 2.0 mol/dm^3 (moles per litre) calculate the volume of nitric acid needed to completely react with the 0.2 g of calcium.

[4]

(iii) The calcium nitrate produced in this reaction is often used in fertilisers. Calculate the percentage of nitrogen, by mass, present in calcium nitrate.

[3]

Examiner Only
Marks Remark

Examiner Only
Marks Remark

4 **(a)** Calcium carbonate thermally decomposes to form calcium oxide. Calcium oxide (lime) has a high melting point and can be heated to a high temperature without melting so that it emits white light, called limelight.

© Adam Hart-Davis/Science Photo Library

(i) Explain what is meant by thermal decomposition.

_____

_____ [2]

(ii) Write a balanced symbol equation for the thermal decomposition of calcium carbonate.

_____ [2]

(iii) Explain why calcium oxide has a high melting point.

_____

_____

_____ [2]

(iv) Calcium oxide must be kept dry because when it comes into contact with even the slightest amount of moisture, it rapidly becomes hot and hisses, releasing a large amount of steam.

Write a balanced symbol equation for the reaction of calcium oxide with water.

_____ [2]

(b) Calcium carbonate reacts with acids such as hydrochloric acid and sulphuric acid. It is used in many antacid tablets, where it reacts with excess acid in the stomach, reducing acidity and relieving 'heartburn'.

Examiner Only
Marks Remark

© *drflet/istockphoto*

(i) Write a balanced symbol equation for the reaction between calcium carbonate and hydrochloric acid.

_____ [3]

(ii) State two observations for this reaction.

1. _____

2. _____ [2]

(iii) Write a balanced symbol equation for the reaction between calcium carbonate and sulphuric acid.

_____ [2]

(c) Another compound used in antacid tablets is aluminium hydroxide.

Examiner Only
Marks Remark

(i) Write a balanced symbol equation for the reaction between aluminium hydroxide and hydrochloric acid.

_____[3]

(ii) Aluminium hydroxide is amphoteric. Explain what you understand by the term amphoteric.

_____

_____[1]

5 (a) Compounds are formed when two or more different elements chemically bond together.

Examiner Only
Marks Remark

(i) Explain what you understand by the term element.

_____

_____

_____[2]

(ii) Using **full** electronic configurations, **draw diagrams** to show how atoms of magnesium combine with atoms of oxygen to form magnesium oxide.

[6]

(iii) State the type of bonding which is present in magnesium oxide.

_____[1]

(b) Substances containing covalent bonds can have very different physical properties. Graphite, which is an allotrope of the element carbon, contains covalent bonds.

Examiner Only
Marks Remark

(i) Explain what you understand by the term allotrope.

_____

_____ [2]

(ii) Draw a labelled diagram to show the structure and bonding in graphite.

[4]

(iii) Diamond is another allotrope of carbon and it is the hardest naturally occurring substance on Earth. Explain why diamond is so hard.

_____

_____

_____

_____ [2]

(c) Carbon dioxide also contains covalent bonds. The melting point of carbon dioxide is –78 °C.

Examiner Only
Marks Remark

(i) Explain what you understand by the term covalent bond.

_____

_____

_____[3]

(ii) Explain why the melting point of carbon dioxide is very low .

_____

_____

_____

_____

_____

_____[3]

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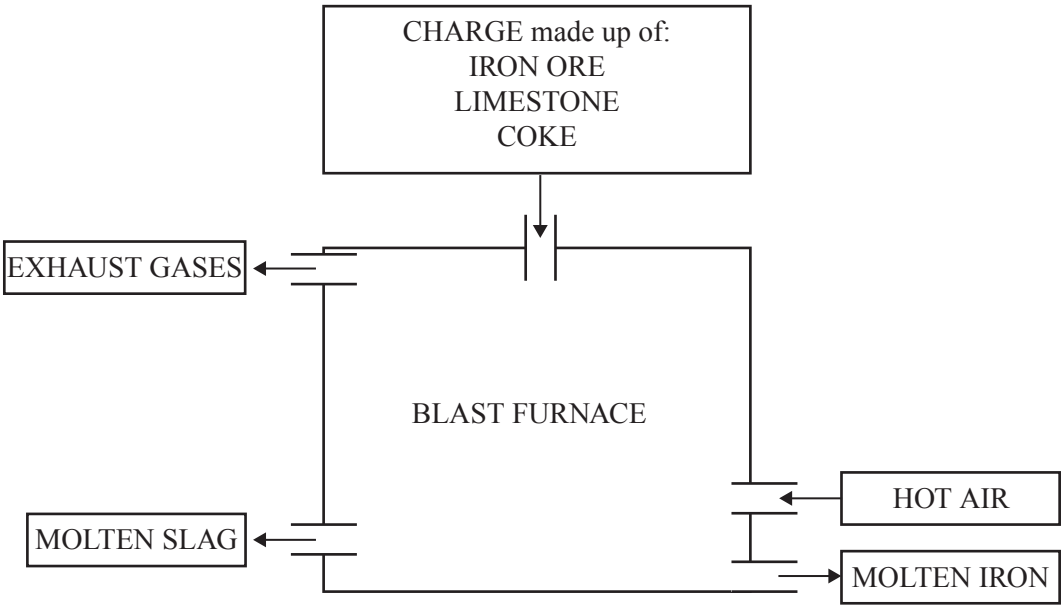
(Questions continue overleaf)

Examiner Only	
Marks	Remark

6 The blast furnace is used to produce iron from its ore. The diagram below represents the materials added to, and removed from, the blast furnace.



(a) Iron ore is reduced to iron. The reducing agent is carbon monoxide. Carbon monoxide is formed from carbon in two reactions which are shown as word equations below.

Reaction 1: carbon + oxygen → carbon dioxide

Reaction 2: carbon dioxide + carbon → carbon monoxide

(i) Name the material added to the blast furnace which is composed mainly of carbon.

_____ [1]

(ii) What is the source of oxygen in the blast furnace?

_____ [1]

(iii) Write balanced symbol equations for reactions 1 and 2 which are given above.

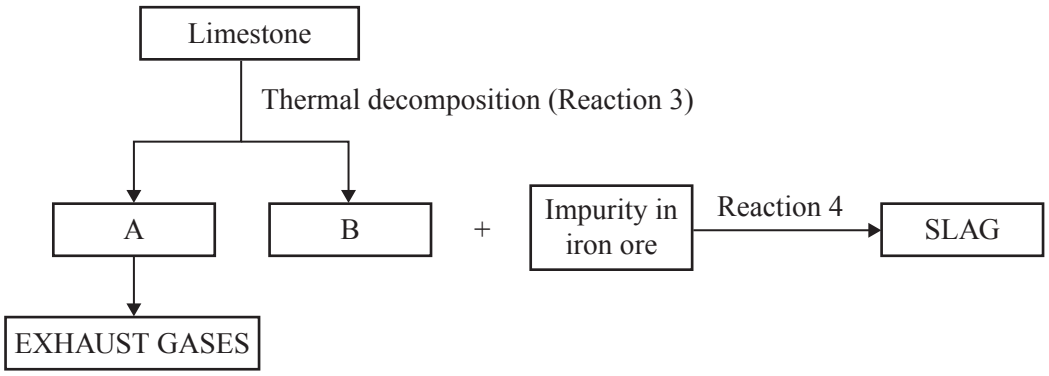
Reaction 1: _____ [2]

Reaction 2: _____ [3]

(iv) Write a balanced symbol equation for the reduction of iron ore to iron in the blast furnace.

_____ [3]

(b) The flow diagram below represents the formation of slag in the blast furnace. Substances A and B are formed by the thermal decomposition of limestone (Reaction 3) and then substance B reacts with an impurity in the iron ore to form slag. Substance A is one of the exhaust gases.



(i) Name A and B.

A _____

B _____ [2]

(ii) Name the impurity in the iron ore which reacts with B to form slag.

_____ [1]

(iii) Write a balanced symbol equation for reaction 4.

_____ [2]

(iv) Suggest the name of one other gas which could be present in the exhaust gases.

_____ [1]

Examiner Only
Marks Remark

[Turn over

7 Many chemical reactions produce gases. For a reaction which produces a gas, the rate of the reaction can be measured by two main methods.

Examiner Only
Marks Remark

(a) The following three reactions produce a gas.

Reaction A: $Mg + 2HCl \rightarrow MgCl_2 + H_2$

Reaction B: $2H2O2 \rightarrow 2H2O + O2$

Reaction C: $Na2S2O3 + 2HCl \rightarrow 2NaCl + SO2 + S + H2O$

(i) Circle the **gaseous product** in each reaction. [3]

(ii) H_2O_2 undergoes catalytic decomposition in reaction B. What is the chemical name of H_2O_2?

_____ [1]

(iii) A catalyst is required for reaction B. What is meant by the term catalyst?

_____

_____

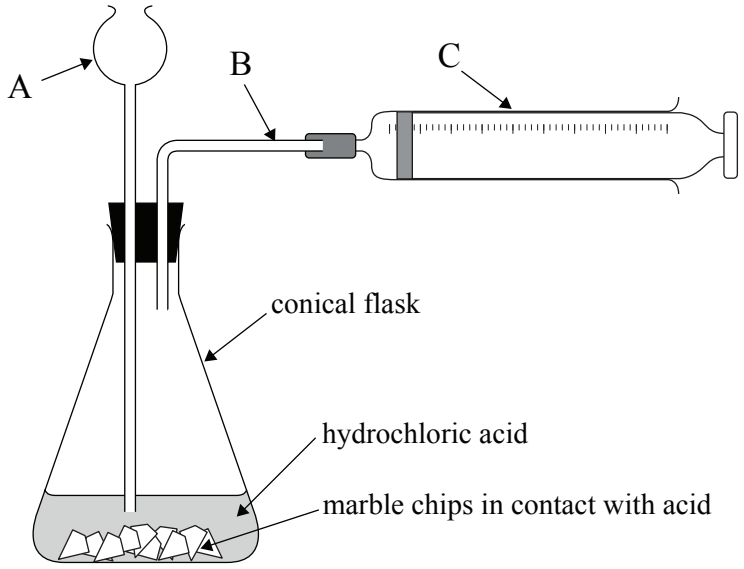
_____ [3]

(iv) Name the catalyst required for reaction B.

_____ [1]

(b) One method of measuring the rate of a reaction in which a gas is produced is to monitor the volume of gas. The apparatus shown below is often used for this purpose.

Examiner Only
Marks Remark



(i) Name the pieces of apparatus labelled A, B and C

A _____

B _____

C _____[3]

(ii) Apart from safety equipment, what other piece of apparatus would be required to carry out this experiment?

_____[1]

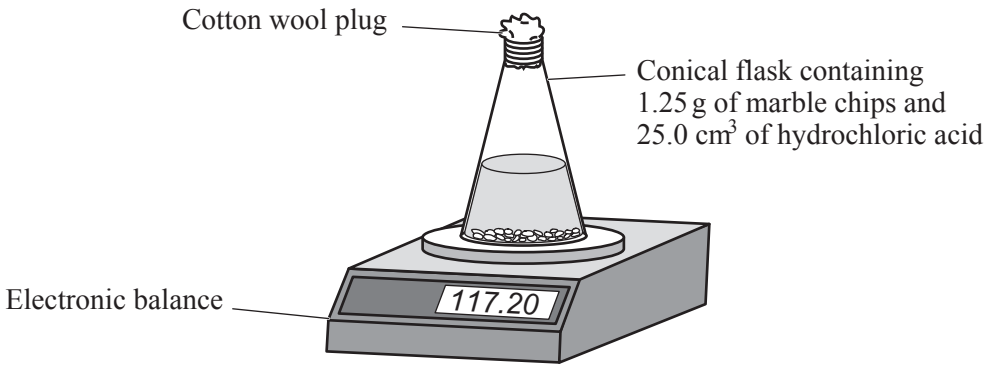
(iii) Why must A be below the level of the hydrochloric acid in the conical flask during the experiment?

_____

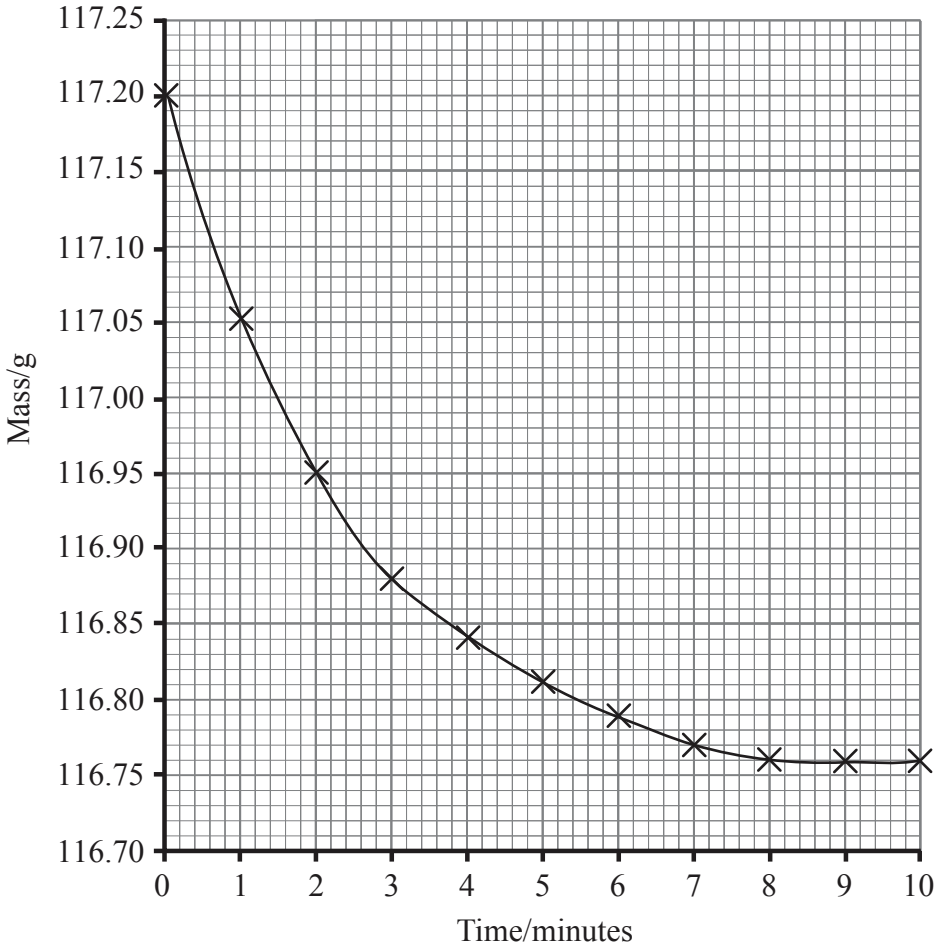
_____[1]

[Turn over

(c) The apparatus below also shows how the rate of the reaction between 1.25 g of marble chips (calcium carbonate) and 25.0 cm^3 of hydrochloric acid (an excess) may be measured. This was carried out at room temperature (20 °C).



The mass of the flask containing the marble chips and the acid is measured against time. The results obtained were plotted on the graph shown below.



(i) Calculate the total mass lost during the experiment.

_____

_____ [2]

Examiner Only
Marks Remark

(ii) What is the purpose of the cotton wool plug in the apparatus?

_____

_____[1]

(iii) The experiment was repeated at 40 °C and the rate of reaction increased. Sketch on the graph the curve you would expect to obtain if all other factors were kept the same. [2]

(iv) Explain, in terms of particles, how increasing the temperature would increase the rate of this reaction.

_____

_____

_____

_____[3]

(v) State clearly two other factors which you could change to **increase** the rate of this chemical reaction.

1. _____

2. _____[2]

(d) Catalysts are used in many industrial processes. Complete the blanks in the table below.

Industrial Process	**Equation for the reaction**	**Name of catalyst**
Catalytic oxidation of ammonia	$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$	
Haber Process		iron

[4]

Examiner Only
Marks Remark

THIS IS THE END OF THE QUESTION PAPER