| Centre Number | Candidate Number | Name |
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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

**CHEMISTRY** **9701/05**

Paper 5 Planning, analysis and evaluation

For Examination from 2007

SPECIMEN PAPER

**1 hour 15 minutes**

Candidates answer on the Question Paper.
.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
You are advised to show all working in calculations.
Use of Data Booklet is unnecessary.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

| For Examiner's Use | |
|---|---|
| 1 | |
| 2 | |
| TOTAL | |

This document consists of **9** printed pages and **1** blank page.



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**1** Hydrochloric acid reacts with solid calcium carbonate in the form of marble chips. The products of the reaction are aqueous calcium chloride, carbon dioxide gas and water.

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

You are to plan an investigation to find how changes in **one** variable affect the rate of reaction.

**(a) (i)** The concentration of the hydrochloric acid is one independent variable that could be investigated. Identify **two** other independent variables that could be investigated.

.....

..... [2]

**(ii)** Identify a dependent variable that you could measure to follow the rate of reaction.

..... [1]

**(b)** Propose a hypothesis that can be tested experimentally and that links the rate of reaction and the concentration of the hydrochloric acid.

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..... [1]

**(c)** Design a laboratory experiment that you would use to investigate your hypothesis. You should draw a labelled diagram showing the arrangement of your apparatus. Your plan should include the following.

**(i)** a step-by-step description of the procedure you would follow
**(ii)** how you would measure the independent variable
**(iii)** how you would vary the independent variable and how you will ensure accuracy in your results
**(iv)** how you would control the other two variables that you identified in part **(a)**
**(v)** any safety precautions that you would take
**(vi)** appropriate quantities (masses, volumes, concentrations) to use in the experiment

[$A_r$: Ca, 40.1; C, 12.0; O, 16.0]

Concentrated hydrochloric acid, a corrosive liquid, has an approximate concentration of 11 mol $dm^{-3}$.

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**Labelled diagram**

**Plan**

[8]

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**(d)** Prepare a table showing all of the data you wish to record in the experiment and any columns for processing the data recorded. Explain how you will use the data to confirm or reject the hypothesis proposed in **(b)**.

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..... [3]

[Total : 15]

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**2** A student makes the following prediction.

"The amount of carbon dioxide evolved when a metal carbonate, $X_2CO_3$, reacts with an excess of an acid is directly proportional to the moles/mass of the carbonate used."

If this statement is true the relative molecular mass of $X_2CO_3$ can be determined by the following simple experiment.

- The mass of a weighing bottle + $X_2CO_3$ is measured.
- 50 $cm^3$ of 2.0 mol $dm^{-3}$ hydrochloric acid (an excess) is transferred from a measuring cylinder to a 250 $cm^3$ conical flask.
- Sodium carbonate is added to the acid in the flask to saturate the acid with carbon dioxide so that none of the gas given off when $X_2CO_3$ reacts with the acid will dissolve in the acid.
- A cotton wool plug is placed in the neck of the flask and the flask + acid is weighed.
- The weighed $X_2CO_3$ is added to the acid in the flask and the cotton wool plug quickly replaced in the neck of the flask to prevent any loss of acid spray.
- The empty weighing bottle is weighed.
- When reaction in the flask has stopped, the flask is left for 10 minutes to allow carbon dioxide to diffuse from the flask.
- The flask and its contents after the reaction are weighed.

The results from a group of students are given in the table overleaf.

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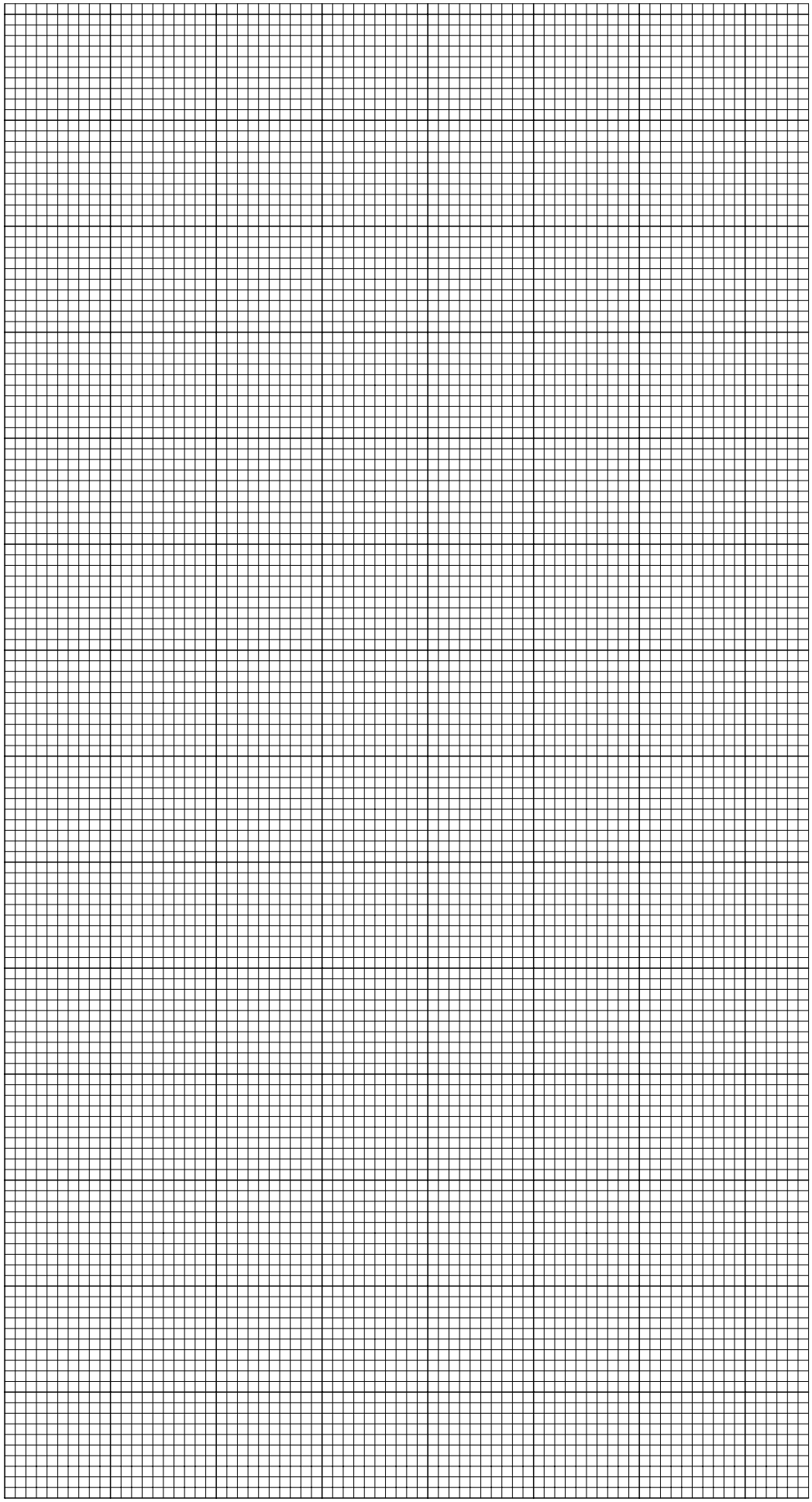
| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| mass of weighing bottle + $X_2CO_3$ /g | mass of empty weighing bottle /g | mass of flask + acid before the reaction /g | mass of flask + solution after the reaction /g | | | | |
| 14.29 | 11.48 | 221.35 | 223.21 | | | | |
| 16.41 | 11.76 | 209.71 | 212.91 | | | | |
| 12.24 | 11.34 | 210.45 | 210.97 | | | | |
| 16.77 | 11.27 | 214.38 | 217.80 | | | | |
| 16.48 | 10.68 | 211.63 | 215.59 | | | | |
| 14.85 | 11.15 | 217.18 | 219.68 | | | | |
| 13.81 | 11.61 | 212.12 | 213.76 | | | | |
| 18.81 | 11.06 | 218.65 | 224.25 | | | | |
| 16.18 | 10.94 | 206.77 | 210.31 | | | | |
| 17.93 | 11.53 | 221.49 | 225.84 | | | | |
| 14.49 | 11.09 | 217.18 | 219.68 | | | | |
| 18.19 | 10.87 | 215.33 | 220.31 | | | | |

**(a)** Use the additional columns of the table to record calculated values that will enable you to determine $M_r$ for $X_2CO_3$ graphically. You may use some or all of the columns. Label the columns you use, including the units and an equation to show how the value is calculated. You may use the column headings **A** to **H** in these equations e.g. = **C** - **B**. (Remember that the gas is lost from the flask after the weighed carbonate is added to the weighed acid.)

[2]

*For Examiner's Use*

**(b)** Present the data calculated in **(a)** in graphical form. Draw the line of best-fit.



[4]

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**(c)** Circle any anomalous points on the graph that you did not use when drawing the best-fit line. By reference to the description of the experiment, suggest an explanation for any anomaly.

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..... [2]

**(d)** Identify any part of the range of readings where the data appears to be less reliable and suggest why this should be the case.

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..... [1]

**(e)** Use data obtained from the best-fit line you have drawn to calculate $M_r$ for $X_2CO_3$.

$$X_2CO_3(s) + 2H^+(aq) \rightarrow 2X^+(aq) + CO_2(g) + H_2O(l)$$

The $M_r$ of $X_2CO_3$ is .....

[2]

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**(f)** By considering the data you have processed and the graph you have drawn, explain whether the experimental data supports the initial prediction and whether the experimental procedure described is suitable for the determination of $M_r$.

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..... [2]

**(g)** Suggest an improvement to the experimental procedure that has been described.

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..... [1]

**(h)** Use your knowledge of acid-base chemistry to describe a more appropriate way by which the $M_r$ of a metal carbonate might be determined.

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..... [1]

[Total : 15]

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