Centre Number	Candidate Number	Name

SESSION		LABORATORY

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/05**

Paper 5 Practical Test

May/June 2005

1 hour 30 minutes

Candidates answer on the Question Paper.
Additional materials: As listed in the Instructions to Supervisors.

READ THESE INSTRUCTIONS FIRST

Write your details, including practical session and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen in the spaces provided on the Question Paper.
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.
The number of marks is given in brackets [ ] at the end of each question or part question.
You are advised to show all working in calculations.
Use of a Data Booklet is unnecessary.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

For Examiner's Use	
1	
2	
3	
TOTAL	

This document consists of **10** printed pages and **2** blank pages.

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1 **FB 1** is 2.00 mol dm^{-3} hydrochloric acid, HC*l*.
FB 2 is a solid carbonate, $\mathbf{X}_2CO_3$ in a stoppered tube.
FB 2 reacts with hydrochloric acid as shown in the equation below.

$$\mathbf{X}_2CO_3(s) + 2HCl\,aq) \rightarrow 2\mathbf{X}Cl\,(aq) + H_2O(l) + CO_2(g)$$

You are to determine the mass of carbon dioxide evolved in the reaction of the carbonate **FB2** with excess hydrochloric acid and to calculate from the results of the experiment the relative atomic mass, A_r, of **X**.

(a) Use a measuring cylinder to place 100 cm^3 of **FB 1** into a 250 cm^3 conical flask. Weigh the flask and acid. Record the mass in Table 1.2.

Weigh the stoppered tube containing **FB 2**. Record the mass in Table 1.1.

Add the weighed **FB 2**, **a little at a time** with swirling, to the acid in the conical flask.
N.B. Take care to avoid excessive bubbling and loss of acid as 'spray'.

When all of the **FB 2** has been added from the tube, reweigh the empty tube (with its stopper) and record the mass in Table 1.1.

Leave the flask to stand for 2-3 minutes and then reweigh the flask and solution. Record the mass in Table 1.2.

mass of stoppered tube + **FB 2**	/ g	
mass of empty tube + stopper	/ g	

Table 1.1

mass of flask + acid	/ g	
mass of flask + solution after the reaction	/ g	

Table 1.2 [3]

(b) Calculate the mass of **FB 2** used.

..... g [1]

(c) Calculate the mass of carbon dioxide evolved.

..... g [1]

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(d) Use your answer to **(c)** and the equation for the reaction to calculate the number of moles of $\mathbf{X}_2CO_3$ that reacted.
[A_r: C, 12.0; O, 16.0.]

..... moles [1]

(e) Calculate the relative molecular mass, M_r, of $\mathbf{X}_2CO_3$.

M_r = ... [1]

(f) Calculate the relative atomic mass, A_r, of **X**.
[A_r: C, 12.0; O, 16.0.]

A_r = ... [1]

[Total : 8]

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[Turn over

2 **FB 3** is 1.50 mol dm^{-3} sodium hydroxide, NaOH.
FB 4 is an aqueous solution containing hydrochloric acid.

FB 4 has been prepared by dissolving 42.40 g of the carbonate **FB 2** in an excess of 3.00 mol dm^{-3} hydrochloric acid and making the solution up to 1 dm^3 in a graduated flask by adding more 3.00 mol dm^{-3} hydrochloric acid.

You are to perform a thermometric titration to determine the end-point for the reaction of **FB 3** and **FB 4**. In a thermometric titration the end-point is when the maximum temperature change occurs.

(a) Fill the burette with **FB 4**.

Support the plastic cup in a 250 cm^3 beaker and pipette into the cup 50.0 cm^3 of **FB 3**.

Record the steady temperature of **FB 3** in Table 2.1.

Read through the following instructions before starting the experiment.

Run 3.00 cm^3 of **FB 4** from the burette into the cup, stir the solution with the thermometer and record the new steady temperature. **Without delay** run a further 3.00 cm^3 of **FB 4** from the burette, stir and record the steady temperature as before. Continue the addition of **FB 4** in 3.00 cm^3 portions, taking and recording the steady temperature each time, until 48.00 cm^3 of solution **FB 4** have been run from the burette. Record all temperatures in Table 2.1.

The thermometer provided has a range from …….. °C to …….. °C

and has graduations at each ……. °C.

volume of **FB 4** added /cm^3	temperature / °C	Δt (temperature – initial temperature) / °C
0		0
3.00		
6.00		
9.00		
12.00		
15.00		
18.00		
21.00		
24.00		

volume of **FB 4** added /cm^3	temperature / °C	Δt (temperature – initial temperature) / °C
27.00		
30.00		
33.00		
36.00		
39.00		
42.00		
45.00		
48.00		

Table 2.1 [5]

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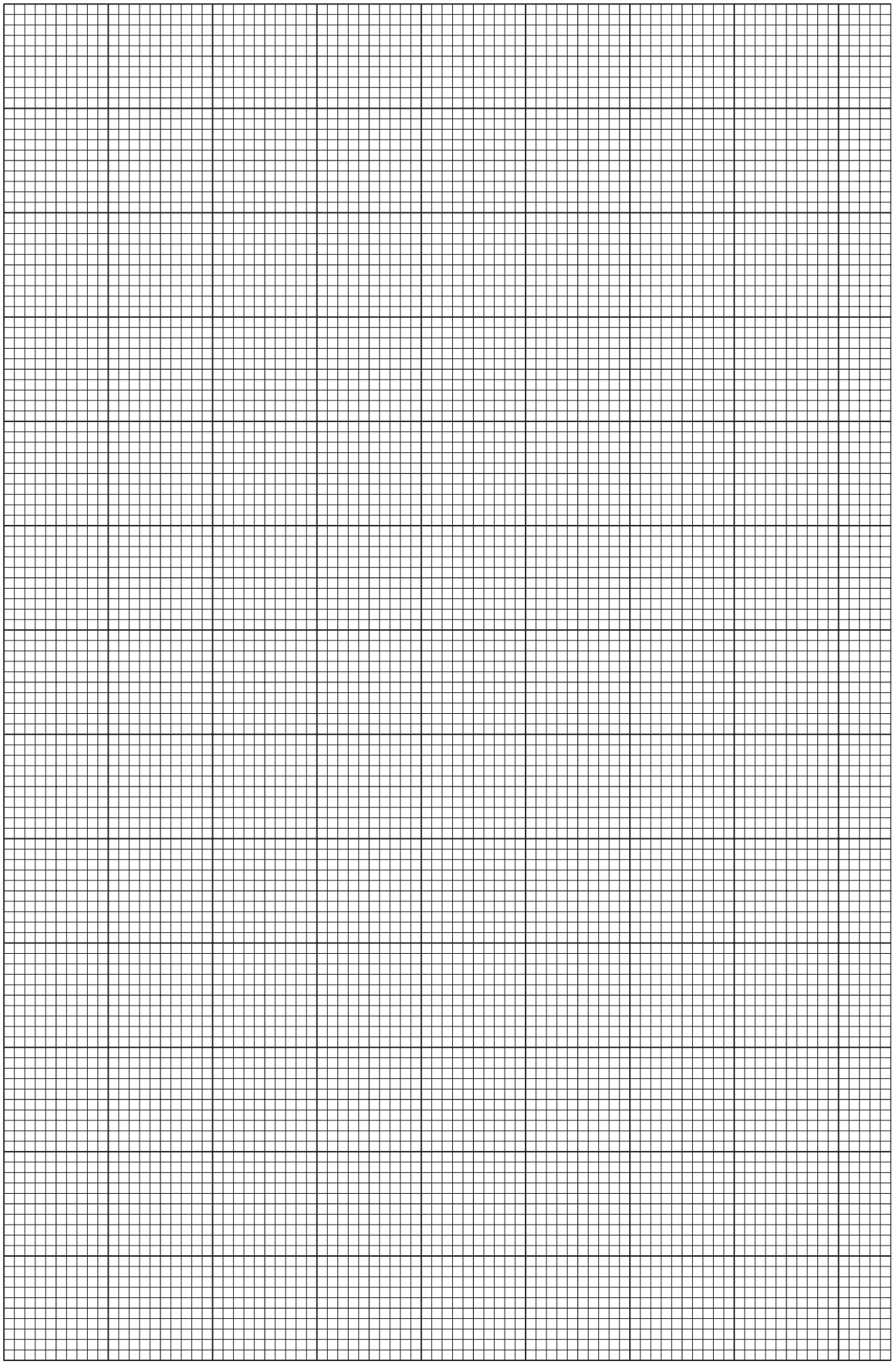
(b) Plot a graph of Δt against the volume of **FB 4** added.
Draw two smooth curves through the plotted points to find the end-point for the titration.
[3]



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(c) Read from the graph the volume of hydrochloric acid, **FB4**, at the end-point of the titration.

…….. cm^3 [1]

(d) Use your answer to **(c)** and the equation for the reaction to calculate the concentration of the hydrochloric acid in **FB 4**.

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

…… [1]

(e) The solution **FB 4** was prepared by dissolving 42.40 g of $\mathbf{X}_2CO_3$ in 1 dm^3 of 3.0 mol dm^{-3} HCl.

Use this information and your answer to **(d)** to calculate the number of moles of HCl that reacted with the dissolved $\mathbf{X}_2CO_3$.

…… [1]

(f) Calculate the relative molecular mass, M_r, of $\mathbf{X}_2CO_3$.

Calculate the relative atomic mass, A_r, of **X**.

. [A_r: C, 12.0; O, 16.0.]

A_r = …… [1]

[Total : 12]

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3 ANALYSIS AND EVALUATION

(a) Indicate the size of the error you would expect in making measurements with the thermometer in question 2.

.....

.....

.....[1]

(b) Why is it **not** necessary to consider the errors in the measuring cylinder used in question 1?

.....

.....

.....[1]

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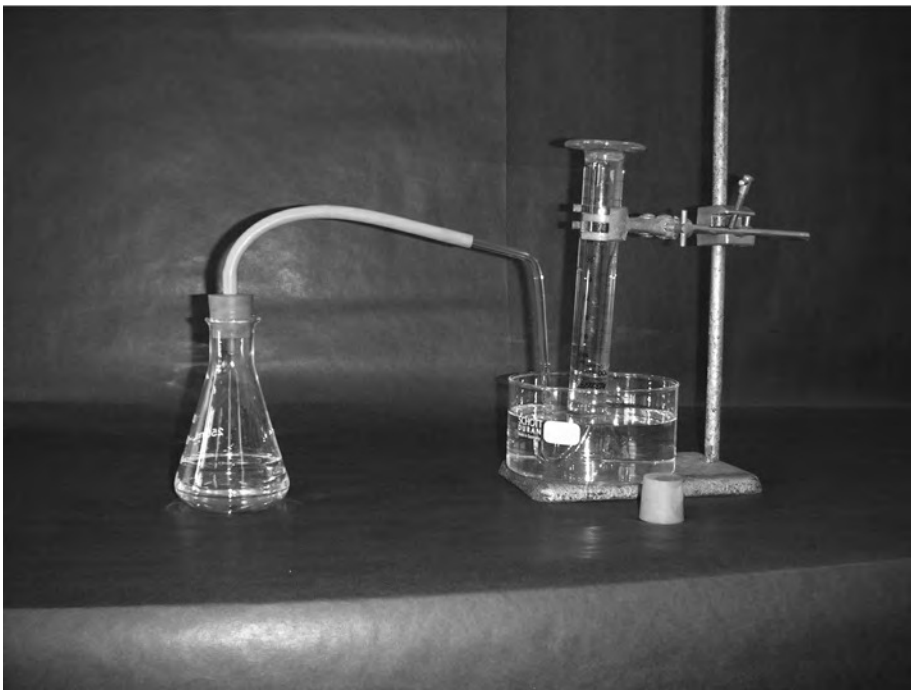
ASSESSMENT OF PLANNING SKILLS

The relative atomic mass of **X** can also be determined by an experiment in which carbon dioxide is evolved in the reaction between a weighed sample of the carbonate of **X** and excess hydrochloric acid. The sample is added to the acid and the bung quickly re-inserted in the flask. The gas displaced from the apparatus is collected and its volume measured using the apparatus below.

The acid is placed in a 250 cm^3 conical flask and the gas collected by displacing water from an inverted 100 cm^3 measuring cylinder.



(c) In both Question 1 and the experiment above, the accuracy of the measured mass or volume can be improved by dissolving a small quantity of sodium carbonate in the acid before the start of the experiment.

Suggest the reason behind this.

.....

.....

.....

.....

.....

.....[2]

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(d) For the experiment shown in the photograph, suggest **two other major** sources of error (not including that mentioned in part **(c)**) in the spaces provided on page 10.

For each source of error describe a method of reducing this error, explaining the reasoning for your method.

The data below may be relevant.

Data

Solubility of carbon dioxide gas at different temperatures

temperature / °C	solubility /g CO_2 per 100 g of water
0	0.348
25	0.145
40	0.097
60	0.058

The general gas equation $pV = nRT$

The specific heat capacity of water $= 4.18\ J\ g^{-1}\ K^{-1}$

Vapour pressure of water at different temperatures

temperature / °C	Vapour pressure /Pa
20	2388
25	3167
30	4243
35	5623
40	7376

Technical data for X_2CO_3

Minimum assay	99%
Substances insoluble in water	0.0025%
Water	0.35%
Arsenic	0.0001%
Lead	0.003%
Sulphate	0.02%
Iron	0.001%

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[Turn over

(i) first major source of error

.....

method for reducing this error

.....

.....

explanation

.....

.....[3]

(ii) second major source of error

.....

.....

method for reducing this error

.....

.....

explanation

.....

.....[3]

[Total : 10]

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