Centre Number	Candidate Number

Candidate Name ______________________________

CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CHEMISTRY **9701/3**

PAPER 3 Practical Test

MAY/JUNE SESSION 2002

1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
As listed in Instructions to Supervisors

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

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.

Qualitative analysis notes are printed on pages 6 and 7.

FOR EXAMINER'S USE	
1	
2	
TOTAL	

This question paper consists of 7 printed pages and 1 blank page.

SP (NF) S25943/2

[Turn over

1 **FA 1** is a metal carbonate, XCO_3.
FA 2 is 2.00 mol dm^{-3} hydrochloric acid, HC*l*.

The carbonate and acid react according to the following equation.

$$XCO_3(s) + 2HCl\,(aq) \rightarrow XCl_2(aq) + CO_2(g) + H_2O(l)$$

The enthalpy change, ΔH, for this reaction is –59.5 kJ mol^{-1}.

You are required to determine the temperature rise when a known mass of the solid carbonate, XCO_3, is added to an excess of hydrochloric acid and to use your results to calculate the relative atomic mass, A_r, of the metal X.

Experiment 1

(a) Weigh the weighing bottle.
Add between 3.30 g and 3.50 g of **FA 1** to the weighing bottle and accurately weigh the bottle and contents. Record this mass in Table 1.1 below.

(b) Place the plastic cup inside a 250 cm^3 beaker. Using the measuring cylinder provided add 50.0 cm^3 of hydrochloric acid, **FA 2**, to the plastic cup.

Measure the initial temperature of the acid in the cup and record this in Table 1.2 at the top of page 3.

Empty the contents of the weighing bottle into the acid and stir gently with the thermometer. Record the maximum temperature achieved when the solid has reacted with the acid in Table 1.2 at the top of page 3.

Reweigh the empty bottle, which may contain some residual **FA 1** and record this value in Table 1.1 below.

Experiment 2

(c) Repeat parts **(a)** and **(b)** using a clean dry plastic cup, fresh **FA 1** and fresh **FA 2**.

Table 1.1 Mass of **FA 1**.

	Expt 1	*Expt 2*
Mass of weighing bottle + **FA 1** / g		
Mass of weighing bottle + residual **FA 1** / g		
Mass of **FA 1** added to acid / g		

[2]

(d) Calculate the average of the two masses of **FA 1** used in *Experiment 1* and *Experiment 2*.

Table 1.2 Temperature changes.

	Expt 1	*Expt 2*
Maximum temperature achieved / °C		
Initial temperature of **FA 2** / °C		
Temperature rise / °C		

[1]

Accuracy [8]

(e) Calculate the average temperature rise for *Experiment 1* and *Experiment 2*.

(f) Using the average temperature rise from **(e)** calculate the amount of heat produced by the reaction in the plastic cup.
(Assume that 4.3 J are required to raise the temperature of 1.0 cm^3 of the solution by 1.0 °C)

[1]

(g) Using your answer to **(f)** and the ΔH value for the reaction calculate how many moles of **FA 1** have reacted.

[1]

(h) Using the average mass of **FA 1** calculated in **(d)** and your answer to **(g)** calculate the relative atomic mass, A_r, of the metal X.
[A_r; C, 12.0; O, 16.0.]

[2]

[Total 15]

2 The solution **FA 3** contains **one cation** and **two anions** from the following list: (Al^{3+}, NH_4^+, Ba^{2+}, Ca^{2+}, Cr^{3+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Pb^{2+}, Mg^{2+}, Mn^{2+}, Zn^{2+}; CO_3^{2-}, CrO_4^{2-}, Cl^-, Br^-, I^-, NO_3^-, NO_2^-, SO_4^{2-}, SO_3^{2-}.).

In all tests, the reagent should be added gradually until no further change is observed, with shaking after each addition.
Record your observations and the deductions you make from them in the spaces provided.
Your answers should include

- details of colour changes and precipitates formed,
- the names of gases evolved and details of the test used to identify each one.

You should indicate clearly at what stage in a test a change occurs, writing any deductions you make alongside the observations on which they are based.

Marks are **not** given for chemical equations.
No additional or confirmatory tests for ions present should be attempted.

Candidates are reminded that definite deductions may be made from tests where there appears to be no reaction.

Test	*Observations* [5]	*Deductions* [4]
(a) Place 4 cm depth of **FA 3** in a boiling-tube and add the contents of the tube labelled sodium carbonate		
(b) Place 1 cm depth of **FA 3** in a test-tube and add an equal depth of dilute nitric acid. Add aqueous barium nitrate.		

Test	*Observations*	*Deductions*
(c) Place 1 cm depth of **FA 3** in a test-tube and add an equal depth of dilute nitric acid. Add aqueous silver nitrate, followed by dilute aqueous ammonia.		
(d) Place 2 cm depth of **FA 3** in a test-tube and add dilute sodium hydroxide.		
(e) Place 2 cm depth of **FA 3** in a test-tube and add dilute aqueous ammonia.		
(f) Place 2 cm depth of **FA 3** in a test-tube and add dilute hydrochloric acid.		

Summary

The cation present in **FA 3** is ……………

The anions present in **FA 3** are …………… and ……………

[1]

[Total 10]

QUALITATIVE ANALYSIS NOTES

[Key: ppt. = precipitate]

1 Reactions of aqueous cations

ion	*reaction with*	
	NaOH(aq)	NH_3(aq)
aluminium, Al^{3+}(aq)	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, NH_4^+(aq)	ammonia produced on heating	
barium, Ba^{2+}(aq)	no ppt. (if reagents are pure)	no ppt.
calcium, Ca^{2+}(aq)	white ppt. with high [Ca^{2+} (aq)]	no ppt.
chromium(III), Cr^{3+}(aq)	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), Cu^{2+}(aq)	pale blue ppt. insoluble in excess	blue ppt. soluble in excess giving dark blue solution
iron(II), Fe^{2+}(aq)	green ppt. insoluble in excess	green ppt. insoluble in excess
iron(III), Fe^{3+}(aq)	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
lead(II), Pb^{2+}(aq)	white ppt. soluble in excess	white ppt. insoluble in excess
magnesium, Mg^{2+}(aq)	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), Mn^{2+}(aq)	off-white ppt. insoluble in excess	off-white ppt. insoluble in excess
zinc, Zn^{2+}(aq)	white ppt. soluble in excess	white ppt. soluble in excess

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), CrO_4^{2-}(aq)	yellow solution turns orange with H^+(aq); gives yellow ppt. with Ba^{2+}(aq); gives bright yellow ppt. with Pb^{2+}(aq)
chloride, Cl^-(aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq)); gives white ppt. with Pb^{2+}(aq)
bromide, Br^-(aq)	gives cream ppt. with Ag^+(aq) (partially soluble in NH_3(aq)); gives white ppt. with Pb^{2+}(aq)
iodide, I^-(aq)	gives yellow ppt. with Ag^+(aq) (insoluble in NH_3(aq)); gives yellow ppt. with Pb^{2+}(aq)
nitrate, NO_3^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil
nitrite, NO_2^-(aq)	NH_3 liberated on heating with OH^-(aq) and Al foil, NO liberated by dilute acids (colourless NO $\rightarrow$ (pale) brown NO_2 in air)
sulphate, SO_4^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) or with Pb^{2+}(aq) (insoluble in excess dilute strong acid)
sulphite, SO_3^{2-}(aq)	SO_2 liberated with dilute acids; gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acid)

3 Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	‘pops’ with a lighted splint
oxygen, O_2	relights a glowing splint
sulphur dioxide, SO_2	turns potassium dichromate(VI) (aq) from orange to green

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