Centre Number	Candidate Number	Name

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

CHEMISTRY **9701/03**

Paper 3 Practical Test

May/June 2004

1 hour 15 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your details, including examination 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.
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.
You are advised to show all working in calculations.
Use of a Data Booklet is unnecessary.
Qualitative Analysis notes are provided on pages 6 and 7.

SESSION
LABORATORY

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	
TOTAL	

This document consists of **7** printed pages and **1** blank page.

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1 **FA 1** is anhydrous sodium carbonate, Na_2CO_3, provided in a stoppered tube.
FA 2 is an aqueous solution of hydrochloric acid, HC*l*.

Acids and carbonates in solution react as shown in the equation.

$$2H^+(aq) + CO_3^{2-}(aq) \longrightarrow H_2O(l) + CO_2(g)$$

You are to determine the concentration, in mol dm^{-3}, of the hydrochloric acid solution **FA 2**.

(a) Weigh the stoppered tube labelled **FA 1** and record the mass in Table 1.1.

Table 1.1 Weighing of sodium carbonate

Mass of tube + **FA 1**	/ g	
Mass of tube + residual **FA 1**	/ g	
Mass of **FA 1** used	/ g	

[1]

Transfer the contents of the weighed tube into a 250 cm^3 beaker and dissolve the solid in about 100 cm^3 of distilled water.

Reweigh the tube and stopper and any residual sodium carbonate and record the mass in Table 1.1. Calculate the mass of sodium carbonate dissolved in the water.

(b) Transfer the sodium carbonate solution to the graduated flask labelled **FA 3**. Rinse the beaker with distilled water several times, adding each rinsing to the graduated flask. This ensures that all of the sodium carbonate has been transferred to the flask.
Make up the solution to 250 cm^3 with distilled water and **mix thoroughly**.

Pipette 25.0 cm^3 of **FA 3**, the sodium carbonate, into a conical flask and place the flask on a white tile. Add a few drops of the indicator provided and titrate with **FA 2**, the hydrochloric acid.

Repeat the titration as many times as you think necessary to obtain accurate results. Make certain that the recorded results show the precision of your practical work.

Table 1.2 Titration of FA 3 with FA 2

Indicator used: .....

Final burette reading / cm^3				
Initial burette reading / cm^3				
Volume of **FA 2** used / cm^3				

[2] + [6]

Summary

25.0 cm^3 of **FA 3** reacted with ..... cm^3 of **FA 2**.

Show which results you used to obtain this volume of **FA 2** by placing a tick (✓) under the readings in Table 1.2.

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You are advised to show full working in all parts of the calculations.

(c) Calculate the concentration in mol dm^{-3} of the sodium carbonate, Na_2CO_3, in **FA 3**. [A_r: Na, 23.0; C, 12.0; O, 16.0.]

[2]

(d) Calculate how many moles of sodium carbonate, Na_2CO_3, were pipetted into the conical flask.

[1]

(e) Calculate how many moles of hydrochloric acid, HC*l*, have been run from the burette.

$$2H^+(aq) + CO_3^{2-}(aq) \longrightarrow H_2O(l) + CO_2(g)$$

[1]

(f) Calculate the concentration, in mol dm^{-3}, of HC*l* in **FA 2**.

[2]

[Total: 15]

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2 **FA 4**, which is provided in a stoppered boiling-tube, is a mixture of two solids:
FA 5, which is soluble in water and
FA 6, which is insoluble in water.

Add 20 cm^3 of distilled water to the boiling-tube and carefully warm the mixture to dissolve **FA 5**. Filter the mixture and retain both the filtrate and the residue.

Carry out the following tests and identify any gases given off.

Tests on the Filtrate (FA 5)

Test	*Observations [4]*
(a) To 1 cm depth of the filtrate in a test-tube, add 1 cm depth of aqueous barium chloride;	
followed by 2 cm depth of dilute hydrochloric acid.	
(b) To 1 cm depth of the filtrate in a test-tube, add 1 cm depth of acidified aqueous potassium dichromate(VI). Leave to stand for 1 minute.	
(c) To 1 cm depth of the filtrate in a boiling-tube, add 2 cm depth of dilute hydrochloric acid. Warm the solution and identify the gas given off. **Empty and wash away the contents of the tube at the end of this test.**	
(d) To 1 cm depth of the filtrate in a test-tube, add 2 cm depth of aqueous iodine.	

Use the information in the Qualitative Analysis Table on page 7 to identify the **anion** present in **FA 5**.

The anion present in **FA 5** is .....

Which observations support your choice of this anion?

.....

.....

..... [1]

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In tests **(b)** and **(d)** the anion in **FA 5** is behaving as

..... [1]

Tests on the Residue (FA 6)

Use a spatula to transfer the residue from the filter paper to a boiling tube.

Test	*Observations [3]*
(e) Add 2 cm depth of hydrochloric acid to the residue (**FA 6**) in the boiling-tube. Use the solution formed in this test for the following tests, **(f)** and **(g)**.	
(f) To 1 cm depth of the solution made in test **(e)** in a test-tube add aqueous sodium hydroxide.	
(g) To 1 cm depth of the solution made in test **(e)** in a test-tube add 1 cm depth of aqueous ammonia.	

Use the information in the Qualitative Analysis Table on pages 6 and 7 to identify the **cation** and **anion** present in **FA 6**.

The **cation** present in **FA 6** is .....

The **anion** present in **FA 6** is .....

Which observations support your choice of these ions?

cation .....

.....

anion .....

..... [1]

[Total: 10]

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[Turn over

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.]

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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 → (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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