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

October/November 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 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.
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.

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 an aqueous solution containing 23.72 g dm^{-3} of sodium thiosulphate, $Na_2S_2O_3$.
FA 2 is a solution of an oxidant, ***X***, containing 5.15 g dm^{-3} of ***X***.
FA 3 is a solution containing potassium iodide, KI.
FA 4 is 1.00 mol dm^{-3} sulphuric acid, H_2SO_4.

In the presence of acid, the oxidant ***X*** oxidises iodide ions to iodine.

1 mole of ***X*** produces 3 moles of iodine, I_2

The iodine liberated can then be titrated with thiosulphate ions, $S_2O_3^{2-}$, to reduce the iodine back to iodide.

$$2Na_2S_2O_3(aq) + I_2(aq) \longrightarrow Na_2S_4O_6(aq) + 2NaI(aq)$$

You are to determine the relative molecular mass of the oxidant ***X***.

(a) Pipette 25.0 cm^3 of **FA 2** into a conical flask. Use the measuring cylinder provided to add an excess of iodide ions (approximately 10 cm^3 of **FA 3**), and 10 cm^3 of sulphuric acid, **FA 4**.

Titrate the iodine produced in the conical flask with **FA 1**. As the titration proceeds the colour of the iodine in solution will diminish. The end-point is reached when the colour disappears and the solution becomes colourless.

There is no need to add starch indicator to find the end-point.

Record your results in Table 1.1.

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 1.1 Titration of Iodine with FA 1

final burette reading / cm^3				
initial burette reading / cm^3				
volume of **FA 1** used / cm^3				

[2] + [6]

Summary

25.0 cm^3 of **FA 2** produced sufficient iodine to react with ..... cm^3 of **FA 1**.

Show which results you used to obtain this volume of **FA 1** by placing a tick (✓) under the readings in Table 1.1.

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

(b) Calculate how many moles of sodium thiosulphate, $Na_2S_2O_3$, were run from the burette during the titration.
[A_r: Na, 23.0; S, 32.1; O, 16.0.]

[2]

(c) Calculate how many moles of iodine, I_2, react with the sodium thiosulphate run from the burette.

[1]

(d) Calculate how many moles of oxidant ***X*** were placed in the titration flask at the beginning of the titration.

[1]

(e) Calculate the concentration, in mol dm^{-3}, of the oxidant ***X*** in **FA 2**.

[1]

(f) Calculate the relative molecular mass, M_r, of the oxidant ***X***.

[2]

[Total: 15]

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[Turn over

2 **FA 5** contains **two cations** and **one anion** 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, with shaking after each addition. Record your observations 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.

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 [7]*
(a) To 2 cm depth of **FA 5** in a test-tube, add 1 cm depth of aqueous silver nitrate. Leave the mixture to stand and continue with tests **(b)** to **(e)**.	
(b) To 2 cm depth of **FA 5** in a boiling-tube, add 4 cm depth of aqueous sodium hydroxide. Stir thoroughly with the glass rod provided. Filter the mixture and retain the filtrate for tests **(c)**, **(d)** and **(e)**.	
Observe the residue in the filter paper after it has been exposed to the air for a few minutes.	
(c) To 1 cm depth of the filtrate from **(b)** in a test-tube, add 2 cm depth of dilute nitric acid followed by aqueous silver nitrate.	
(d) To 1 cm depth of the filtrate from **(b)** in a test-tube, add 2 cm depth of dilute hydrochloric acid followed by aqueous barium chloride.	

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Test	*Observations*
(e) Place 1 cm depth of the filtrate from **(b)** in a boiling-tube and warm the tube gently. **Take care as a solution containing sodium hydroxide may 'bump' on heating and eject hot corrosive sodium hydroxide.**	
(f) Observe the mixture left to stand in test **(a)**.	
Use a teat pipette to remove the solution from the precipitate formed, then add 2 cm depth of distilled water to wash the precipitate. Allow the precipitate to settle and again use a teat pipette to remove the solution. Dissolve the solid in 2 cm depth of dilute aqueous nitric acid. You may need to cautiously warm the mixture. Use this solution in the test below.	
Add dilute hydrochloric acid to the solid dissolved in nitric acid.	

Use the information in the Qualitative Analysis Tables on pages 6 and 7 to identify the ions present in **FA 5**.

The **cations** present in **FA 5** are ..... and .....

The **anion** present in **FA 5** is ..... [1]

Which observations support your choice of these ions?

.....

..... [1]

What is the identity of the solid formed and dissolved in test **(f)**? Give a reason.

.....

..... [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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