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 2006

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 Centre number, candidate number and name, including practical session and laboratory where appropriate, in the spaces provided.
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 a Data Booklet is unnecessary.
Qualitative Analysis Notes are provided on pages 7 and 8.

At the end of the examination, fasten your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Session
Laboratory

For Examiner's Use	
1	
2	
Total	

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1 **FA 1** is an aqueous solution of hydrochloric acid, HC*l*.
FA 2 is aqueous potassium iodate(V) containing 4.93 g dm^{-3} of KIO_3.
FA 3 is aqueous potassium iodide, KI.
FA 4 is aqueous sodium thiosulphate, $Na_2S_2O_3$.

In the presence of acid, iodate(V) ions react with iodide ions to form iodine and water.

$$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \longrightarrow 3I_2(aq) + 3H_2O(l)$$

If sodium thiosulphate is present in the reaction mixture the iodine formed is immediately reduced back to iodide and the solution remains colourless.

Iodate(V) ions can therefore be titrated against acid in the presence of an excess of iodide and thiosulphate ions.

You are to use this method to determine the concentration of the hydrochloric acid, **FA 1**.

(a) Dilution of FA 1

Using a burette, run between 34.00 cm^3 and 35.00 cm^3 of **FA 1** into the 250 cm^3 graduated flask, labelled **FA 5**. Record the burette readings in Table 1.1.

Table 1.1 Dilution of FA 1

final burette reading / cm^3	
initial burette reading / cm^3	
volume of **FA 1** run into the flask / cm^3	

Make the solution up to 250 cm^3 with distilled water and **mix thoroughly**.
Fill a second burette with this diluted acid, **FA 5**.

(b) Titration of IO_3^- with H^+ in FA 5

Pipette 25.0 cm^3 of **FA 2** into a conical flask and use a measuring cylinder to add to the flask 10 cm^3 of **FA 3** and 25 cm^3 of **FA 4**.
Add five drops of bromophenol blue indicator and titrate with **FA 5** until the end-point is reached.
The colour of bromophenol blue changes to yellow at the end-point.

Record your titration results in Table 1.2.

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 2 with FA 5

final burette reading / cm^3 initial burette reading / cm^3				
volume of **FA 5** used / cm^3				

[8]

Summary

25.0 cm^3 of **FA 2** reacted with ..... cm^3 of **FA 5**.

Show which results you used to obtain this volume of **FA 5** 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 how many moles of potassium iodate(V), KIO_3, were pipetted into the conical flask.
[A_r: K, 39.1; I, 127.0; O, 16.0]

[2]

(d) Calculate how many moles of hydrogen ions, H^+, reacted with the iodate(V) ions in the flask during the titration.

$$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \longrightarrow 3I_2(aq) + 3H_2O(l)$$

[1]

(e) Calculate the concentration, in mol dm^{-3}, of hydrogen ions in **FA 5**.

[1]

(f) Calculate the concentration, in g dm^{-3}, of hydrochloric acid in **FA 1**.
[A_r: H, 1.0; C*l*, 35.5]

[3]

[Total: 15]

2 **FA 6** is a mixture of two solids provided in a stoppered boiling tube.
One of the solids, **FA 7** is soluble in water; the other, **FA 8** is insoluble in water.
Each solid contains one cation and one anion from the ions listed on pages 7 and 8.

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, precipitates formed and the solubility of any precipitate when an excess of the reagent is added,
- details of the test used to identify any gases given off in the reaction.

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 [3]*
(a) Add water to the boiling-tube labelled **FA 6** until it is about half-full. Stopper and shake the tube for 1 minute. Filter the mixture and retain both filtrate and residue for further tests.	

Tests on the filtrate which contains FA 7

(b) To 1 cm depth of the filtrate from **(a)**, in a boiling-tube, add 2 cm depth of aqueous sodium hydroxide.	
Gently warm the solution. ***Take care as a solution containing sodium hydroxide may 'bump' on heating and eject hot corrosive sodium hydroxide.***	
(c) To 1 cm depth of the filtrate from **(a)**, in a boiling-tube, add 1 cm depth of aqueous lead(II) nitrate; then	
heat the mixture to boiling point; then	
cool the tube by standing in a beaker of cold water.	

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test	*observations*
(d) To 1 cm depth of the filtrate from **(a)**, in a test-tube, add 5 drops of aqueous silver nitrate; then	
add 5 cm depth of dilute aqueous ammonia.	

Use the information in the Qualitative Analysis Notes on pages 7 and 8 to identify the ions present in **FA 7**.

The cation present in **FA 7** is .....

Which observations indicate the cation you have selected?

.....

.....

..... [1]

The anion present in **FA 7** is .....

Which observations indicate the anion you have selected?

.....

.....

..... [1]

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[Turn over

Tests on the residue which contains FA 8

test	*observations [3]*
(e) Transfer the residue to a boiling-tube and add 4 cm depth of dilute hydrochloric acid. Filter the mixture and retain the filtrate.	
(f) To 1 cm depth of the filtrate from **(e)** in a test-tube add, a little at a time, 5 cm depth of aqueous sodium hydroxide.	
(g) To 1 cm depth of the filtrate from **(e)** in a test-tube add, a little at a time, 5 cm depth of dilute aqueous ammonia.	

Use the information in the Qualitative Analysis Notes on pages 7 and 8 to identify the ions present in **FA 8**.

The cation present in **FA 8** is .....

Which observations indicate the cation you have selected?

.....

.....

..... [1]

The anion present in **FA 8** is .....

Which observations indicate the anion you have selected?

.....

.....

..... [1]

[Total: 10]

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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 $\longrightarrow$ (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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