Centre Number	Candidate Number	Name

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

CHEMISTRY **9701/03**

Paper 3 Practical Test

May/June 2003

1 hour 15 minutes

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

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 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.
Qualtitative Analysis notes are provided on pages 7 and 8.
An Insert is provided for question 1.

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 **8** printed pages and an insert.

SP (NF/SLC) S39116/3

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

1 **FA 1** is an aqueous solution of sodium thiosulphate, $Na_2S_2O_3$.
FA 2 is dilute hydrochloric acid, HCl.

When a solution of sodium thiosulphate is mixed with hydrochloric acid a reaction takes place and a fine suspension of solid sulphur is formed in the solution.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + SO_2(g) + S(s) + H_2O(l)$$

If a beaker containing the reaction mixture is placed over a marker, in this case an insert of printed text on a piece of paper, the sulphur as it forms slowly hides the marker from view.

If the depth of solution in the beaker is kept constant the marker will always disappear when the same amount of sulphur has been formed.

You are to use this reaction to investigate how the rate of reaction between sodium thiosulphate solution and hydrochloric acid changes as the concentration of the sodium thiosulphate solution is varied.

(a) Use a 50 cm^3 measuring cylinder to place 50.0 cm^3 of **FA 1** into a 250 cm^3 beaker. Measure 5.0 cm^3 of **FA 2** into the small measuring cylinder.

Dry the outside of the beaker containing **FA 1** and place it over the printed text on the insert sheet.
Pour the 5.0 cm^3 of **FA 2** from the measuring cylinder into the beaker and at the same moment start a stop-clock or note the time on a clock with a seconds sweep hand.

Swirl the beaker to mix the solutions thoroughly and place back over the insert. The insert should then be viewed from above so that the text is observed through the depth of the solution.

Stop the stop-clock or note the time when the printing on the insert is just no longer visible.

Record the time to the nearest second in Table 1.1.

Empty and rinse the beaker. Repeat the experiment placing the volumes (shown in Table 1.1) of **FA 1** and water in the beaker and then adding **FA 2**.

Table 1.1

Expt	volume of **FA 1** / cm^3	volume of water / cm^3	volume of **FA 2** / cm^3	time / s	$\frac{1000}{\text{time}}$ / $s^{-1} \times 10^3$
1	50.0	0.0	5.0		
2	40.0	10.0	5.0		
3	30.0	20.0	5.0		
4	25.0	25.0	5.0		
5	20.0	30.0	5.0		
6	15.0	35.0	5.0		

Calculate $\frac{1000}{\text{time}}$ (correct to one decimal place) for each experiment. [1]

Accuracy [6]

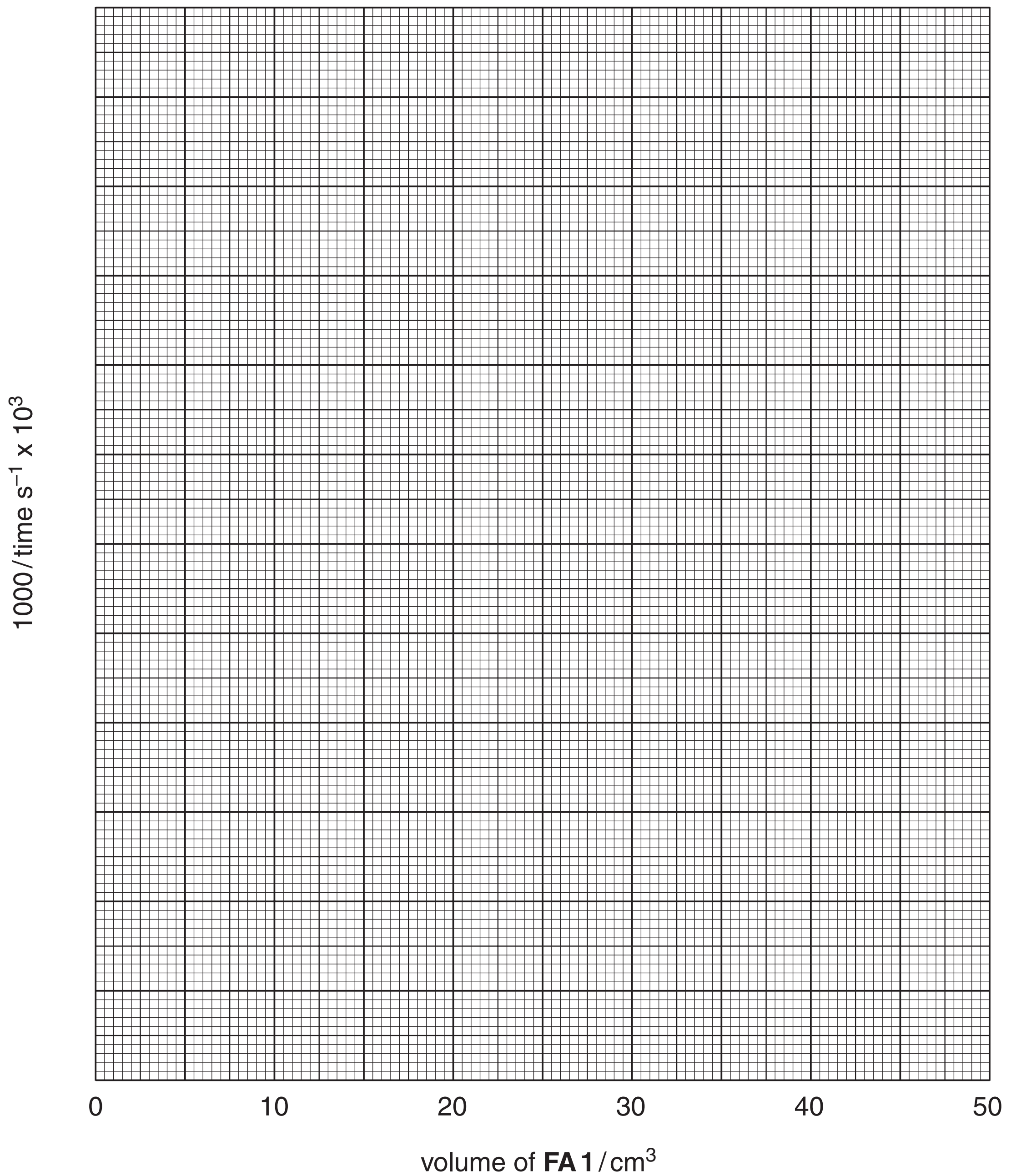
For Examiner's Use

(b) Explain why $\frac{1000}{\text{time}}$ is a measure of the rate of reaction.

....

....[1]

(c) Plot a graph of $\frac{1000}{\text{time}}$ against the volume of **FA 1** (sodium thiosulphate)



[5]

[Turn over

For Examiner's Use

(d) How is the rate of reaction related to the concentration of sodium thiosulphate solution?

....

....

....

....[1]

(e) Explain why the total volume of solution used in each experiment is kept constant.

....

....

....

....[1]

[Total 15]

2 **FA 3** is a mixture of two solids, **FA 4** which is soluble in water and **FA 5** which is insoluble in water.

Tip the solid **FA 3** into a boiling tube, add distilled water until the tube is half full, stopper and shake for about 30 seconds. Filter the mixture and retain both the filtrate and the residue.

In all tests, the reagent should be added gradually until no further change is observed, 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.

Tests on the Filtrate containing FA 4

Test	*Observations [4]*
(a) To 2 cm depth of the filtrate in a boiling-tube, add 2 cm depth of aqueous sodium hydroxide, then carefully warm the solution.	
(b) To 1 cm depth of the filtrate in a test-tube, add 1 cm depth of aqueous lead nitrate.	
(c) To 2 cm depth of the filtrate in a test-tube, add 2 cm depth of aqueous hydrogen peroxide followed by 1 cm depth of dilute sulphuric acid.	

Tests on the Residue, FA 5

Test	*Observations [3]*
(d) Transfer the solid residue from the filter paper to a boiling-tube and add a minimum quantity of dilute hydrochloric acid to dissolve the solid. Divide the solution into two parts and use one part for each of the following tests.	
To one part add aqueous sodium hydroxide.	
To the other part add dilute aqueous ammonia.	

Use the information in the Qualitative Analysis Tables on pages 7 and 8 to identify the ions present in **FA 4** and **FA 5**.

The ions present in **FA 4** were ....

What evidence has lead you to deduce the ions present in **FA 4**?

....

....

....

The ions present in **FA 5** were ....

What evidence has lead you to deduce the ions present in **FA 5**?

....

....

....
[3]

[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 A*l* foil
nitrite, NO_2^-(aq)	NH_3 liberated on heating with OH^-(aq) and A*l* 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