Centre Number	Candidate Number	Name

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

CHEMISTRY **9701/05**

Paper 5 Practical Test

May/June 2006

1 hour 30 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.
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.
You may use a calculator.
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.

SESSION
LABORATORY

For Examiner's Use	
1	
2	
TOTAL	

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

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1 **FB 1** is an aqueous solution of sodium thiosulphate, $Na_2S_2O_3$.
FB 2 is dilute hydrochloric acid, HC*l*.

When aqueous sodium thiosulphate is mixed with hydrochloric acid, a fine suspension of solid sulphur is formed.

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

If a beaker containing the reaction mixture is placed over the printed insert provided, the sulphur slowly hides the printing from view.

If the **depth of solution is constant** the printing will always disappear when the same amount of sulphur has been formed.

You are to carry out experiments to determine the order of reaction with respect to sodium thiosulphate.

(a) Use a 50 cm^3 measuring cylinder to transfer 50 cm^3 of **FB 1** into a 250 cm^3 beaker. Dry the outside of the beaker containing **FB 1** and place it over the printing on the insert sheet.

Measure 5 cm^3 of **FB 2** using a small measuring cylinder or a test-tube graduated at 5 cm^3.

Pour the 5 cm^3 of **FB 2** from the measuring cylinder/test-tube into the beaker and at the same moment start a stop-clock or note the time on a clock with a seconds display.

Swirl the beaker to mix the solutions thoroughly and place it back over the insert. Then view the insert from above so that it is observed through the depth of the solution.

When the printing on the insert just disappears, record the time to the nearest second in Table 1.1.

Empty the beaker and thoroughly rinse with distilled water.

Repeat the experiment using the volumes of **FB 1**, water and **FB 2** shown in Table 1.1.

Table 1.1

expt	volume of **FB 1** / cm^3	volume of water / cm^3	volume of **FB 2** / cm^3	time / s	$\left(\frac{1000}{\text{time}}\right)$ / $s^{-1} \times 10^3$	lg(vol **FB 1**)	$\lg\left(\frac{1000}{\text{time}}\right)$
1	50	0	5			1.70	
2	40	10	5			1.60	
3	30	20	5			1.48	
4	20	30	5			1.30	
5	15	35	5			1.18	

[6]

Calculate $\left(\frac{1000}{\text{time}}\right)$ correct to one decimal place and $\lg\left(\frac{1000}{\text{time}}\right)$ correct to two decimal places for each experiment. Record your values in Table 1.1. [lg = $\log_{10}$] [2]

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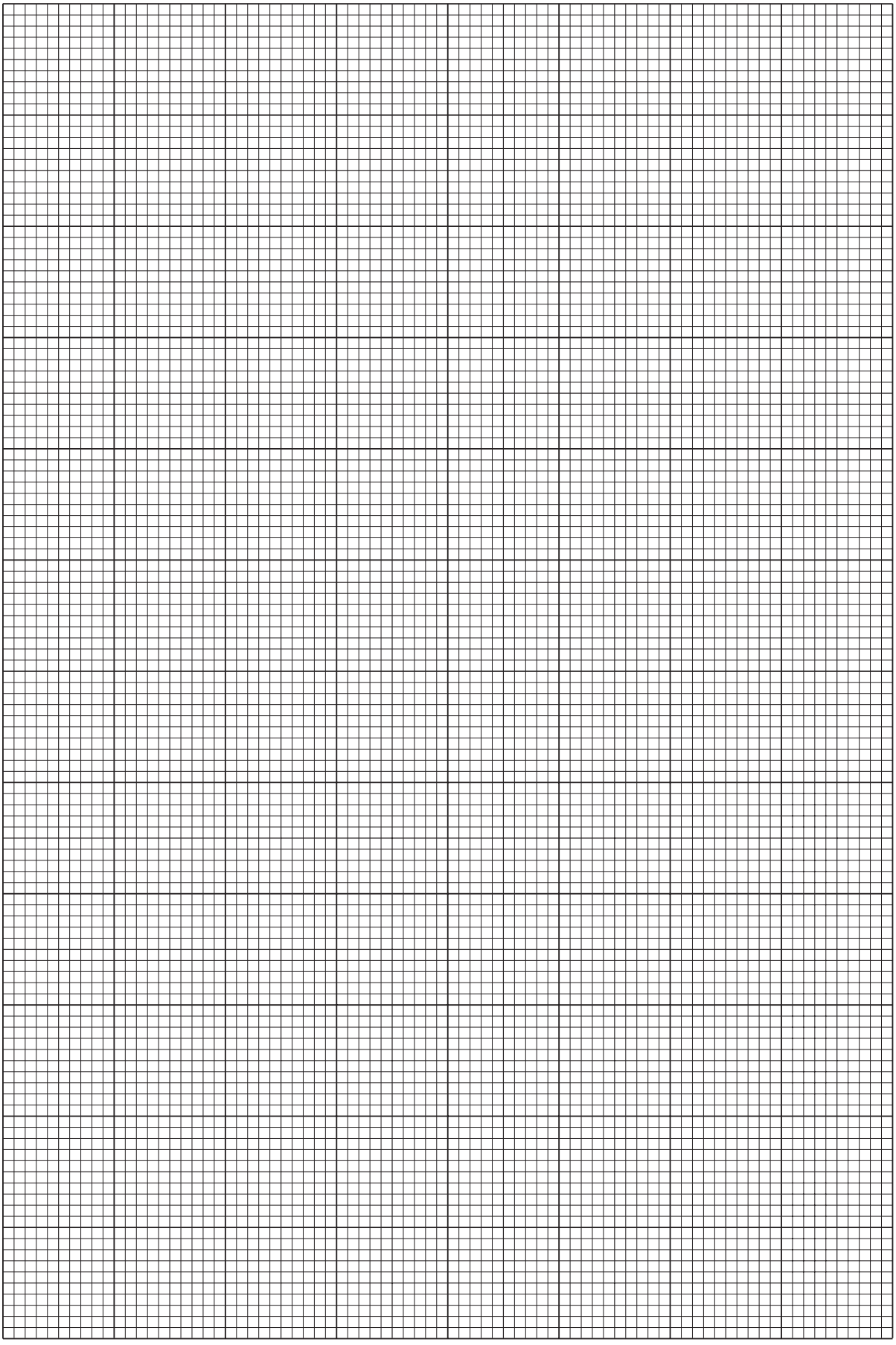
(b) Plot $\lg\left(\frac{1000}{\text{time}}\right)$ against lg(volume of **FB 1**) and draw the best-fit straight line.

Indicate clearly any point which represents an experimental error and was not considered when drawing the best-fit straight line.



[4]

The rate of reaction with respect to sodium thiosulphate is given by the equation

$$\text{rate} = k\,[Na_2S_2O_3]^{x}$$

where k is the rate constant and x is the order of reaction.

The rate equation can be converted into a log form.

$$\lg(\text{rate}) = x \lg[Na_2S_2O_3] + \lg k$$

The rate of reaction can be represented by $\left(\frac{1000}{\text{time}}\right)$, and $[Na_2S_2O_3]$ by the volume of **FB 1** used.

(c) How is the depth of solution kept constant during the experiment?

.....

.....

..... [1]

(d) Explain why the volume of **FB 1** in each experiment is a measure of $[Na_2S_2O_3]$.

.....

.....

..... [2]

(e) The equation

$$\lg(\text{rate}) = x \lg[Na_2S_2O_3] + \lg k$$

is the equation for a straight line and the order of reaction, x, is the gradient of the line.

Calculate the value of x from the graph you have drawn on page 3.

You must:

draw suitable construction lines on the graph,

show the numbers obtained from the graph and their use in the calculation.

The numerical value of x, the order of the reaction, is ..... [3]

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ASSESSMENT OF PLANNING SKILLS

The rate of reaction between aqueous sodium thiosulphate solution and hydrochloric acid may also be affected by the concentration of the hydrochloric acid.

(f) Enter, in Table 1.2, the time and the calculated rate, $\left(\frac{1000}{\text{time}}\right)$, from page 2, for *experiment 2*.

Data from two further experiments, *experiments 6 and 7*, together with that from *experiment 2*, can be used to investigate how the rate of reaction varies as the concentration of hydrochloric acid varies. Enter, in Table 1.2, the volumes of **FB 1**, water and **FB 2** that you would use in *experiments 6 and 7* to obtain this data.

Carry out *experiments 6 and 7*, and record the time and $\left(\frac{1000}{\text{time}}\right)$ for each in Table 1.2.

Table 1.2

expt	volume of **FB 1** / cm^3	volume of water / cm^3	volume of **FB 2** / cm^3	time / s	$\left(\frac{1000}{\text{time}}\right)$ / $s^{-1} \times 10^3$
2	40	10	5		
6					
7					

[3]

(g) Use your results to suggest how the rate of reaction depends on the concentration of hydrochloric acid.

.....

.....

..... [1]

[Total: 22]

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[Turn over

2 ASSESSMENT OF PLANNING SKILLS

Copper has two oxides, CuO and Cu_2O.
Each oxide can be reduced to copper metal by heating it in a stream of hydrogen gas.
The oxide turns to copper metal powder in an exothermic reaction in which the powder may be seen to glow red hot.

$$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$$

$$Cu_2O(s) + H_2(g) \rightarrow 2Cu(s) + H_2O(g)$$

(a) Draw a diagram to show the assembled apparatus you could use in a school laboratory to carry out the reduction of one of the oxides. The apparatus should enable you to:

(i) weigh the oxide before heating and the metallic copper after heating,

(ii) condense, collect and weigh the steam/water produced,

(iii) burn any excess hydrogen after it has passed through the apparatus.

You may assume that a supply of hydrogen gas is available – you do not have to prepare the gas. You need not draw a balance.

[3]

(b) At the start of the experiment the apparatus is full of air. Hydrogen and air mixtures are explosive.

What precaution could you take to prevent explosion when igniting the excess hydrogen leaving the apparatus?

.....

.....

..... [1]

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(c) Why is it necessary to continue passing hydrogen gas through the apparatus until the copper metal formed has cooled?

.....

.....

..... [1]

(d) How could you be certain that all of the copper oxide had been reduced to copper?

.....

.....

..... [1]

(e) Show how you would use the data you could obtain from the experiment in **(a)** to deduce the formula of the oxide used.
[A_r: Cu, 63.5; O, 16.0]

[2]

[Total: 8]

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