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

October/November 2004

1 hour 30 minutes

Candidates answer on the Question Paper.
Additional materials:
As listed in 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.
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.
You may use a calculator.
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 In the presence of hydrogen ions, H^+, bromate(V) ions, BrO_3^-, oxidise bromide ions, Br^-, to bromine, Br_2.

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \longrightarrow 3Br_2(aq) + 3H_2O(l)$$

The reaction is relatively slow and can be followed by adding aqueous phenol and the indicator methyl orange to the reaction mixture.
As bromine is formed it reacts rapidly with the phenol present until the latter is used up. The free bromine now in solution bleaches the methyl orange indicator. The reaction is timed from the mixing of the solutions until the colour of the indicator is lost.
You are to investigate how the rate of reaction depends on the concentrations of bromate(V), bromide and hydrogen ions.

FB 1 is aqueous phenol containing methyl orange indicator.
FB 2 is aqueous potassium bromide, KBr.
FB 3 is aqueous potassium bromate(V), $KBrO_3$.
FB 4 is 0.50 mol dm^{-3} sulphuric acid, H_2SO_4.
You will also require a supply of distilled water.

(a) Fill the burette labelled **FB 1** with the phenol/indicator solution, **FB 1**, and the burette labelled **FB 4** with the sulphuric acid, **FB 4**.

Experiment 1

Run 20 cm^3 of **FB 1** from the burette into the conical flask.
Use measuring cylinder **A** to add 50 cm^3 of **FB 2** to the flask.
From the second burette, run into the flask 20 cm^3 of **FB 4**.
Use measuring cylinder **B** to measure 50 cm^3 of **FB 3**.
Pour the **FB 3** from the measuring cylinder into the flask and at the same time start the stop-clock or note the time on a clock.
Swirl the flask to ensure a uniform solution and place the flask on the white tile. Stop the clock or note the time when the colour of the indicator just disappears to leave a colourless solution. Record the time, to the nearest second, in Table 1.1 at the top of page 3.

Experiment 2

Empty and rinse the flask used in *Experiment 1*. Shake out as much of the rinse water as possible or dry the flask using a paper towel.
Repeat the experiment using the volumes of solution shown in Table 1.1 for *Experiment 2*.

It is important that measuring cylinder **A** is only used for potassium bromide solution, **FB 2**, and water, and measuring cylinder **B** only for potassium bromate solution, **FB 3**.

Experiments 3 and 4

Repeat the experiment using the volumes of solution shown in Table 1.1 for each of these experiments and complete the table.

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Table 1.1

Expt	in flask				in measuring cylinder		
	volume of **FB 1** (phenol) /cm^3	volume of **FB 2** (KBr) /cm^3	volume of **FB 4** (H_2SO_4) /cm^3	volume of water /cm^3	volume of **FB 3** ($KBrO_3$) /cm^3	time /s	rate (1000/time) /s^{-1} x 10^3
1	20	50	20	0	50		
2	20	50	20	10	40		
3	20	30	20	20	50		
4	20	30	40	0	50		

[1] + [10]

(b) Why is the total volume used in each experiment kept constant?

.....[1]

Processing of results

(c) How is the rate of reaction affected by changing the concentration of BrO_3^- ion?

Use, **in calculations**, the experimental data from *Experiment 1* and *Experiment 2* to suggest the order of reaction with respect to the bromate(V) ion, BrO_3^-.

[3]

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[Turn over

(d) How is the rate of reaction affected by changing the concentration of Br^- ions?

Use, **in calculations**, the experimental data from *Experiment 1* and *Experiment 3* to suggest the order of reaction with respect to the bromide ion, Br^-.

[3]

(e) How is the rate of reaction affected by changing the concentration of H^+ ions?

Use, **in calculations**, selected experimental data from *a pair of experiments* to suggest the order of reaction with respect to the hydrogen ion, H^+.

Which *pair of experiments* have you selected?

.....

Calculations

[2]

[Total : 20]

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Question 2 continues overleaf.

2 ASSESSMENT OF PLANNING SKILLS

The **'solubility'** of a substance in aqueous solution is defined as
the mass of anhydrous solid that will dissolve in and just saturate 100 g of water at a fixed temperature.

- 'Solubility' changes with temperature. In most cases more solid dissolves at higher temperatures.
- A solution that is saturated at a particular temperature is one in which no more solid may be dissolved.
- A saturated solution of potassium chlorate(V) can be represented by the equilibrium:

$$KClO_3(s) \rightleftharpoons KClO_3\,(aq)$$

- A saturated solution can be recognised by undissolved solid in equilibrium with aqueous solution.

DO NOT CARRY OUT YOUR PLAN

(a) You are provided with solid potassium chlorate(V), $KClO_3$, and distilled water.

You have available all the apparatus normally used in a school laboratory.
Use the information given above to plan an experiment to

(i) prepare a solution saturated with potassium chlorate at room temperature, and then

(ii) determine the 'solubility' of the potassium chlorate in that solution.

(i) Preparation of the saturated solution

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.....[3]

a	
b	
c	

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For Examiner's Use

(ii) Determination of the 'solubility'

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Create specimen results for your experiment and show how you would use these results to calculate the 'Solubility' of potassium chlorate(V) at room temperature.

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.....[4]

d	
e	
f	
g	

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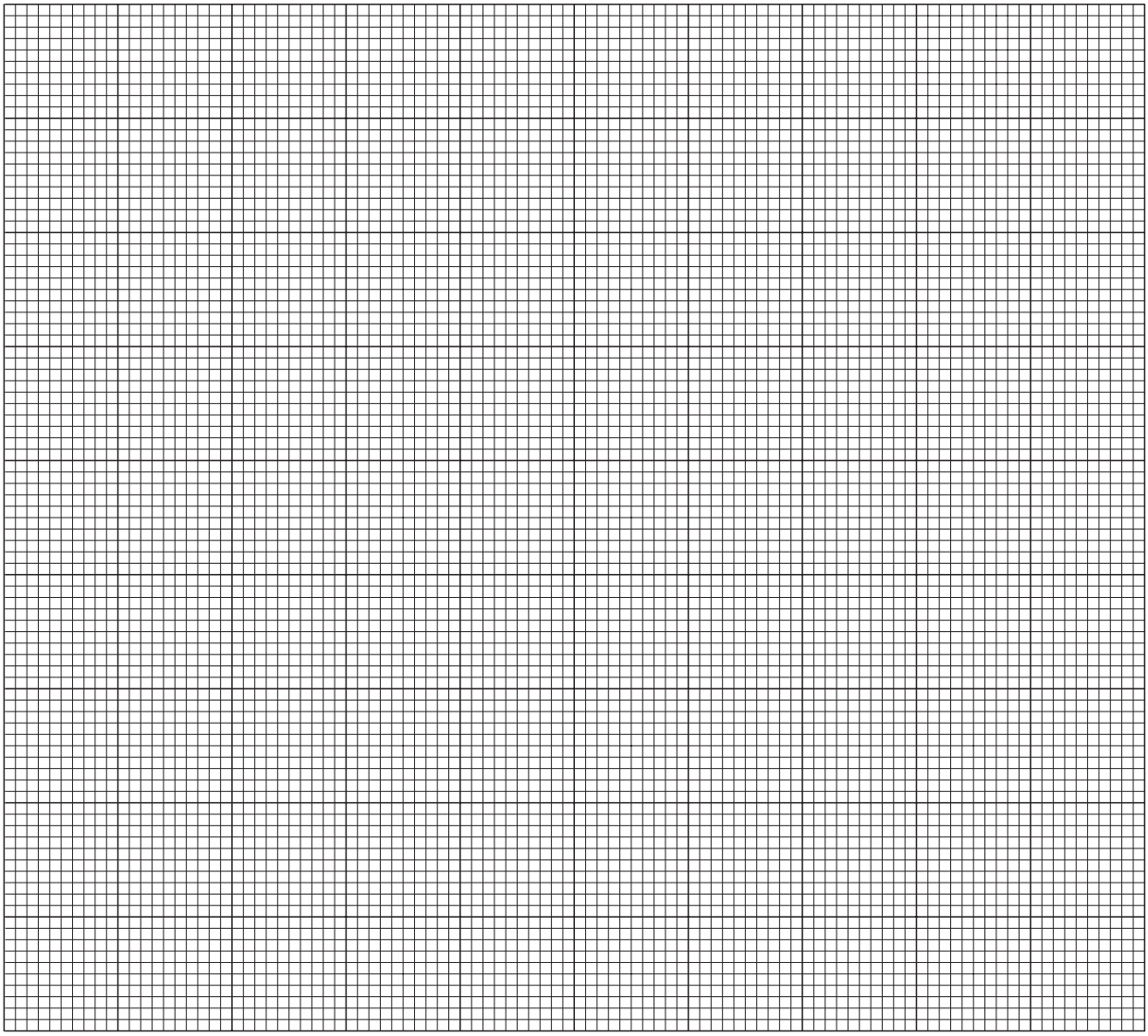
[Turn over

(b) Sodium bromide crystallises as $NaBr.2H_2O$ at low temperatures and as NaBr at higher temperatures.

$$NaBr.2H_2O(s) \rightleftharpoons NaBr(s) + 2H_2O(l)$$

Temperature / °C	10	20	30	40	50	60	70	80	90	100
'Solubility' of sodium bromide /g per 100g H_2O	84.2	90.5	97.2	105.8	116.0	116.9	117.4	118.3	119.8	121.2

Plot the 'solubility' temperature data for sodium bromide and draw one curve for the 'solubility' of $NaBr.2H_2O$ and another curve for the 'solubility' of NaBr. Estimate the transition temperature from your graph.



The estimated transition temperature is …… °C [3]

[Total : 10]

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