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 2005

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

For Examiner's Use	
1	
2	
TOTAL	

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

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1 **FB 1** is 0.200 mol dm^{-3} propanoic acid, $C_2H_5CO_2H$.
FB 2 is 0.100 mol dm^{-3} sodium hydroxide, NaOH.
S is an organic liquid which is immiscible (forms two separate layers) with water.

On shaking **FB 1** with the solvent **S,** propanoic acid is transferred from the aqueous layer to the organic layer until equilibrium is reached.
You are to investigate this equilibrium in the following experiments.

(a) Preparation of the equilibrium mixtures

Experiment A

Use a measuring cylinder to place 50 cm^3 of **FB 1** into the stoppered conical flask labelled **A**.
Use the measuring cylinder to add 20 cm^3 of **S** to the flask and replace the stopper.

Experiment B

Use the measuring cylinder to place 50 cm^3 of **FB 1** into the stoppered conical flask labelled **B**.
Use the measuring cylinder to add 40 cm^3 of **S** into the flask and replace the stopper.

Shake the flasks vigorously for 3 minutes, then leave to stand.
START YOUR ANSWER TO QUESTION 2, but shake the flasks vigorously for 1 minute after each 5 minutes, returning to Question 1 after a minimum of 15 minutes or when you have completed Question 2. You are attempting to establish an equilibrium mixture of propanoic acid dissolved in water and in solvent **S** in each flask.

One of the two following equilibrium mixtures is established.

I $C_2H_5CO_2H(\text{aqueous layer}) \rightleftharpoons C_2H_5CO_2H(\text{organic layer})$

For this equilibrium, $K_c = \dfrac{[C_2H_5CO_2H(\text{organic layer})]}{[C_2H_5CO_2H(\text{aqueous layer})]}$

II $C_2H_5CO_2H(\text{aqueous layer}) \rightleftharpoons \frac{1}{2}(C_2H_5CO_2H)_2\ (\text{organic layer})$

For this equilibrium, $K_c = \dfrac{\sqrt{[C_2H_5CO_2H(\text{organic layer})]}}{[C_2H_5CO_2H(\text{aqueous layer})]}$

You are to determine which of the two K_c expressions is supported by the results of your experiment.

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(b) Titration of Flask A

Allow the layers to separate after the final shake. Fill the burette with **FB 2**. Tilt the flask and carefully pipette 10 cm^3 of the **lower** (aqueous) layer into a titration flask. Place your finger over the top of the pipette, or fit pipette filter if available, before lowering into the solution. This will minimise the amount of the top layer that enters the pipette. Withdraw 10 cm^3 of the lower layer.

Add two drops of phenolphthalein indicator and titrate with **FB 2** until a faint permanent pink colour is obtained.

Repeat the titration two more times and record the results of each titration in Table 1.1 below.

Table 1.1 Titration of Flask A

final burette reading / cm^3 initial burette reading / cm^3			
volume of **FB 2** used / cm^3			

[3] + [3]

Summary

10 cm^3 of the aqueous layer in Flask **A** react with ……. cm^3 of **FB 2**.

Show which results you used to obtain this volume of **FB 2** by placing a tick (✔) under the readings in Table 1.1.

(c) Titration of Flask B

Titrate three 10 cm^3 portions of the **lower** (aqueous) layer in the same way as for Flask **A**.
Record the results of each titration in Table 1.2 below.

Table 1.2 Titration of Flask B

final burette reading / cm^3 initial burette reading / cm^3			
volume of **FB 2** used / cm^3			

[1] + [2]

Summary

10 cm^3 of the aqueous layer in Flask **B** react with ……. cm^3 of **FB 2**.

Show which results you used to obtain this volume of **FB 2** by placing a tick (✔) under the readings in Table 1.2.

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[Turn over

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

(d) Calculate how many moles of propanoic acid were contained in 50 cm^3 of **FB 1**.

[1]

(e) For each flask, calculate how many moles of propanoic acid remain in 50 cm^3 of the aqueous layer after shaking with solvent **S**.

$$C_2H_5CO_2H + NaOH \rightarrow C_2H_5CO_2Na + H_2O$$

Flask A	Flask B

[1]

(f) For each flask, calculate how many moles of propanoic acid have transferred to the organic layer **S**.

Flask A	Flask B

[1]

(g) For each flask, calculate the concentration, in mol dm^{-3}, of propanoic acid in the aqueous layer.

Flask A	Flask B

[1]

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(h) For each flask, calculate the concentration, in mol dm^{-3}, of propanoic acid in the organic layer **S**.

Flask A	Flask B

[2]

(i) Use your results to **(g)** and **(h)** to investigate which of the K_c expressions, **I** or **II** on page 2, is correct.

Equation …… is correct.

[2]

(j) Suggest **two** reasons why the calculated values for K_c may still vary even when the correct equilibrium expression is used.

Reason 1 .....

.....

Reason 2 .....

.....[2]

(k) The concentration of propanoic acid in the organic layer can be determined by direct titration. 10 cm^3 of the organic layer is pipetted into a titration flask. 15 cm^3 of distilled water is added and the mixture is titrated with **FB 2**, shaking between each addition of **FB 2**. Suggest why the 15 cm^3 of distilled water is added to the titration flask.

.....

..... [1]

[Total: 20]

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2 ASSESSMENT OF PLANNING SKILLS

You are provided with solutions **FB 3**, **FB 4** and **FB 5**.

The solutions are:
1.0 mol dm^{-3} sodium hydroxide
1.0 mol dm^{-3} sulphuric acid
0.5 mol dm^{-3} sulphuric acid

You are to plan experiments that will enable you to identify the solution that matches each of **FB 3**, **FB 4** and **FB 5**.

You have available the following apparatus:
–10 °C to 110 °C thermometer,
100 cm^3 beaker,
the measuring cylinder from question 1.
The measuring cylinder should be rinsed thoroughly before each use.

(a) You are to identify, by the **minimum number** of practical steps, which of the solutions contains sodium hydroxide.

Your experiment(s) must use only the solutions and apparatus above.

Outline your method – with an explanation of the expected results.

.....

.....

.....

.....

.....

..... [2]

Carry out your plan.

Results

[2]

DO NOT FORGET TO SHAKE YOUR FLASKS FOR QUESTION 1

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(b) Plan and carry out further experiments to find which of the remaining solutions is 1 mol dm^{-3} sulphuric acid and which is 0.5 mol dm^{-3} sulphuric acid.

Outline your method – with an explanation of the expected results.

.....

.....

.....

.....

.....

.....

..... [2]

Carry out your plan and present your results in a suitable table.

Results

[3]

Identity of the solutions

FB 3 contains .....

FB 4 contains .....

FB 5 contains ..... [1]

[Total: 10]

NOW GO BACK AND COMPLETE QUESTION 1 IF YOU HAVE NOT ALREADY DONE SO

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