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 2006

1 hour 30 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and candidate number, 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.
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 and **1** blank page.

SP (SLM) T20656/2
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1 **FB 1** is a solution of sulphuric acid.
FB 2 is 2.00 mol dm^{-3} sodium hydroxide, NaOH.

Determining the concentration of sulphuric acid by thermometric titration.

Record the temperature of each solution, taking care to wash and dry the thermometer before measuring the temperature of the second solution. Read the temperature to the nearest 0.5 °C, and record the temperature of each solution in Table 1.1. Calculate the average temperature of the two solutions.

Table 1.1

	/ °C
temperature of solution **FB 1**	
temperature of solution **FB 2**	
average temperature	

[2]

Support the plastic cup in a 250 cm^3 beaker. Use one of the measuring cylinders to transfer 40 cm^3 of **FB 2**, sodium hydroxide solution, into the plastic cup.
Replace the stopper or cover over **FB 2** to prevent any reaction of carbon dioxide in the air with the sodium hydroxide.

Using the second measuring cylinder transfer 10 cm^3 of **FB 1**, sulphuric acid, into the sodium hydroxide in the plastic cup. Stir the mixture with the thermometer and note the highest temperature obtained.
This temperature should be recorded in Table 1.2 for experiment 1.

Empty, rinse and dry the plastic cup. Repeat the experiment with the other mixtures shown in Table 1.2 and record the highest temperature reached in each mixture.

Table 1.2

	experiment	1	2	3	4	5	6	
	volume of **FB 2** / cm^3	40	35	30	25	20	15	
*	volume of **FB 1** / cm^3	10	15	20	25	30	35	*
	maximum temperature / °C							

For each experiment use the average initial temperature from Table 1.1 to calculate and record the temperature rise after mixing the solutions.

	experiment	1	2	3	4	5	6	
*	moles of sodium hydroxide	0.08	0.07	0.06	0.05	0.04	0.03	*
	temperature rise / °C							

[4]

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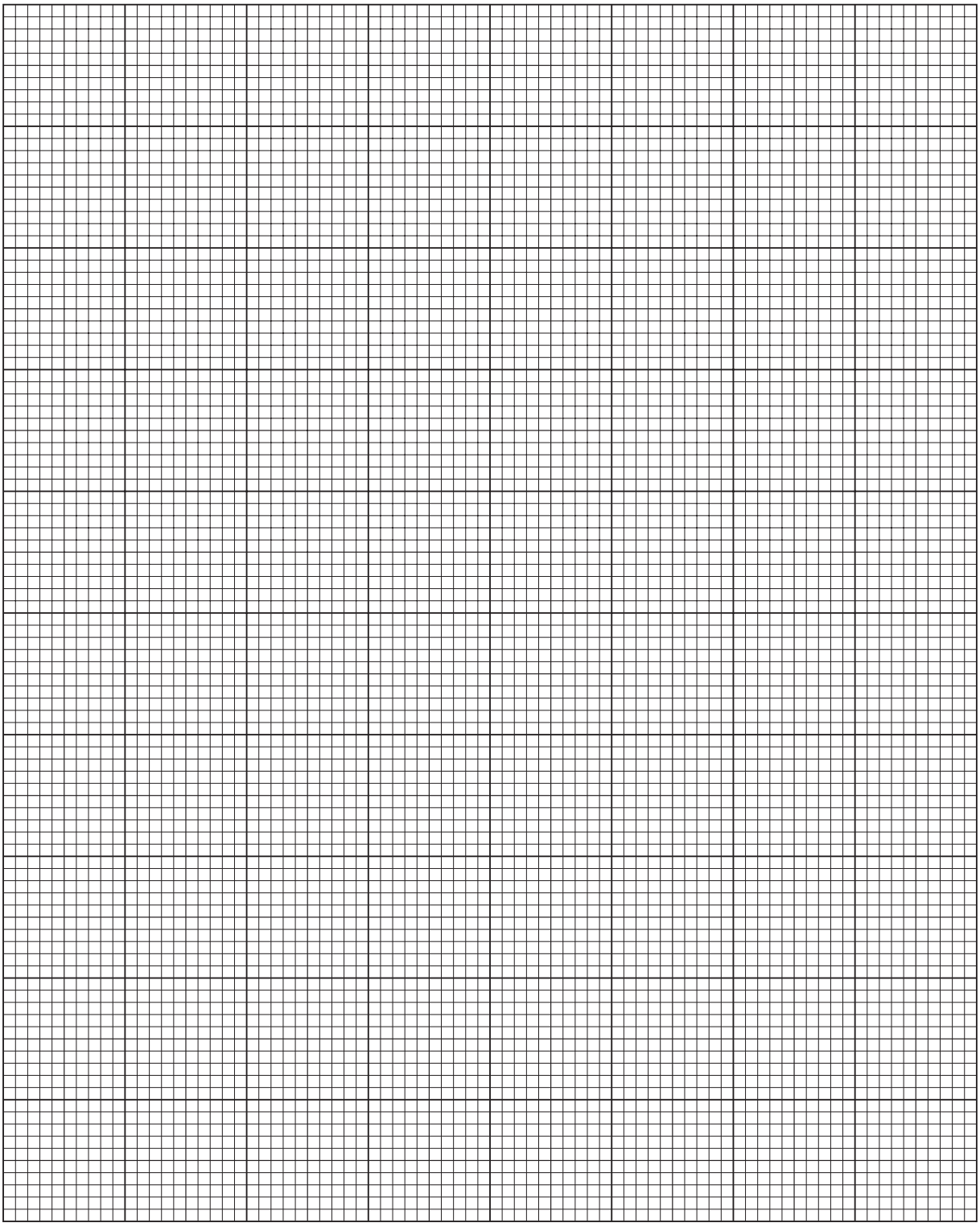
(a) Plot the temperature rise against moles of sodium hydroxide on the grid below. [2]



(b) Draw **two appropriate straight lines** through your plotted points to show an end-point for the neutralisation. [1]

(c) Deduce from your graph, the number of moles of sodium hydroxide that reacted at the end-point.

.....mol
[1]

(d) Use your answer to **(c)** and data from the lines in Table 1.2 marked with asterisks (✱) to calculate the volume of sulphuric acid, **FB 1**, reacting at the end-point.

[1]

(e) Calculate how many moles of sulphuric acid reacted with the sodium hydroxide at the end-point.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

[1]

(f) Calculate, in mol dm^{-3}, the concentration of the sulphuric acid in **FB 1**.

[1]

Determining the enthalpy change for the reaction $H^+(aq) + NaOH(s) \rightarrow H_2O(l) + Na^+(aq)$

Empty, rinse and dry the plastic cup used in the first part of the question. Using a measuring cylinder transfer 50 cm^3 of **FB 1** into the cup. When the temperature is steady, record its value in Table 1.3.

Weigh the tube labelled **FB 3** which contains solid sodium hydroxide. Record the mass in Table 1.3. Tip the contents of the tube into the plastic cup, stir, and record the highest temperature achieved in Table 1.3.

Weigh the empty tube and record its mass in Table 1.3.

Table 1.3

initial temperature of **FB 1** / °C	
maximum temperature after mixing **FB 1** and **FB 3** / °C	
mass of tube + **FB 3** / g	
mass of empty tube / g	

Complete the table by calculating the temperature rise and mass of **FB 3** added.

temperature rise / °C	
mass of **FB 3** added / g	

[4]

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(g) Calculate the heat energy released during the reaction of **FB 1** and **FB 3** in the cup.
[Assume that 4.3 J are required to raise the temperature of 1 cm^3 of solution by 1 °C.]

energy released ....
[1]

(h) Use data from Table 1.3 and your answer to **(f)** to calculate which of sodium hydroxide or sulphuric acid is in excess.
If you are unable to obtain a value in **(f)** use 1.50 mol dm^{-3} as the concentration of the sulphuric acid.

$$2NaOH(s) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

[A_r: Na, 23.0; O, 16.0; H, 1.0]

..... is in excess.
[1]

(i) Calculate the enthalpy change, ΔH, for the following reaction.

$$H^+(aq) + NaOH(s) \rightarrow H_2O(l) + Na^+(aq)$$

ΔH = ... kJ mol^{-1}
[1]

[Total: 20]

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2 ASSESSMENT OF PLANNING SKILLS

A sample of a mineral is found, on analysis, to contain the four elements, carbon, copper, hydrogen and oxygen.

The mineral is believed to be **either** azurite, $2CuCO_3.Cu(OH)_2$

or malachite, $CuCO_3.Cu(OH)_2$

Both of these minerals decompose on heating to form copper(II) oxide (CuO), carbon dioxide and water vapour.

(a) Complete the equation, including state symbols, for the thermal decomposition of each mineral.

azurite $2CuCO_3.Cu(OH)_2(s) \rightarrow$

malachite $CuCO_3.Cu(OH)_2(s) \rightarrow$

[2]

(b) Using **only** a chemical balance, a boiling-tube and a Bunsen burner, outline **all** the steps, in the correct order, that you would take to determine if the sample was azurite or malachite.

DO NOT CARRY OUT YOUR PLAN

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.....

.....[5]

a	
b	
c	
d	
e	

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(c) Using the equations you have written in **(a)**, explain **by calculation**, how you would process your experimental results to show if the sample of mineral was azurite or malachite.
[A_r: C, 12.0; Cu, 63.5; H, 1.0; O, 16.0]

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.....[2]

f	
g	

(d) If additional apparatus was available, what further measurement could be made during the thermal decomposition to confirm the identity of the mineral?

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.....[1]

[Total: 10]

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