Cambridge Pre-U

Cambridge International Examinations
Cambridge Pre-U Certificate

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0123456789

CHEMISTRY (PRINCIPAL) **9791/04**

Paper 4 Practical **For Examination from 2016**

SPECIMEN PAPER

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces of the top of this page.
Give details of the practical session and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen in the spaces provided.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer all questions.
Electronic calculators may be used.
You are advised to show all working in calculations.
A Data Booklet is provided.

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

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document consists of **9** printed pages and **1** blank page.

CAMBRIDGE International Examinations

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1 A student suggests that the concentration of sulfuric acid can be determined by measuring the temperature of the solution as the acid is added in small amounts to a known volume of sodium hydroxide solution in a plastic cup.

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

The student proposes the following hypothesis.

As the acid is added to the alkali the temperature rise will be directly proportional to the volume of acid added until the end-point of the reaction is reached. Upon further addition of acid there will be a reduction in the temperature of the solution in the cup as the acid added is not reacting and is at a lower temperature than the solution in the plastic cup.

The following reagents are provided.

FA 1 is 2.00 mol dm^{-3} sodium hydroxide, NaOH.
FA 2 is **approximately** 0.75 mol dm^{-3} sulfuric acid, H_2SO_4.

(a) Use the equation for the reaction to estimate the volume of **FA 2** that will neutralise 25.0 cm^3 of **FA 1**.

volume of **FA 2** = ... cm^3 [1]

(b) In the experiment you will add **FA 2** from the burette to 25.0 cm^3 of **FA 1** in a plastic cup. You will measure the temperature of the solution after each addition of a certain volume of acid. You will then plot a graph of the temperature rise against the volume of acid added and use this to determine the end-point. You will then be able to calculate the concentration of H_2SO_4 in **FA 2**.

In order to obtain precise information about the end-point of the reaction, you will need to decide:

- the volume of acid to be added each time (do not use a volume which is less than 2.00 cm^3)
- the total volume of acid to be added.

volume of acid to be added each time = ... cm^3

total volume of acid to be added = ... cm^3 [2]

(c) Method

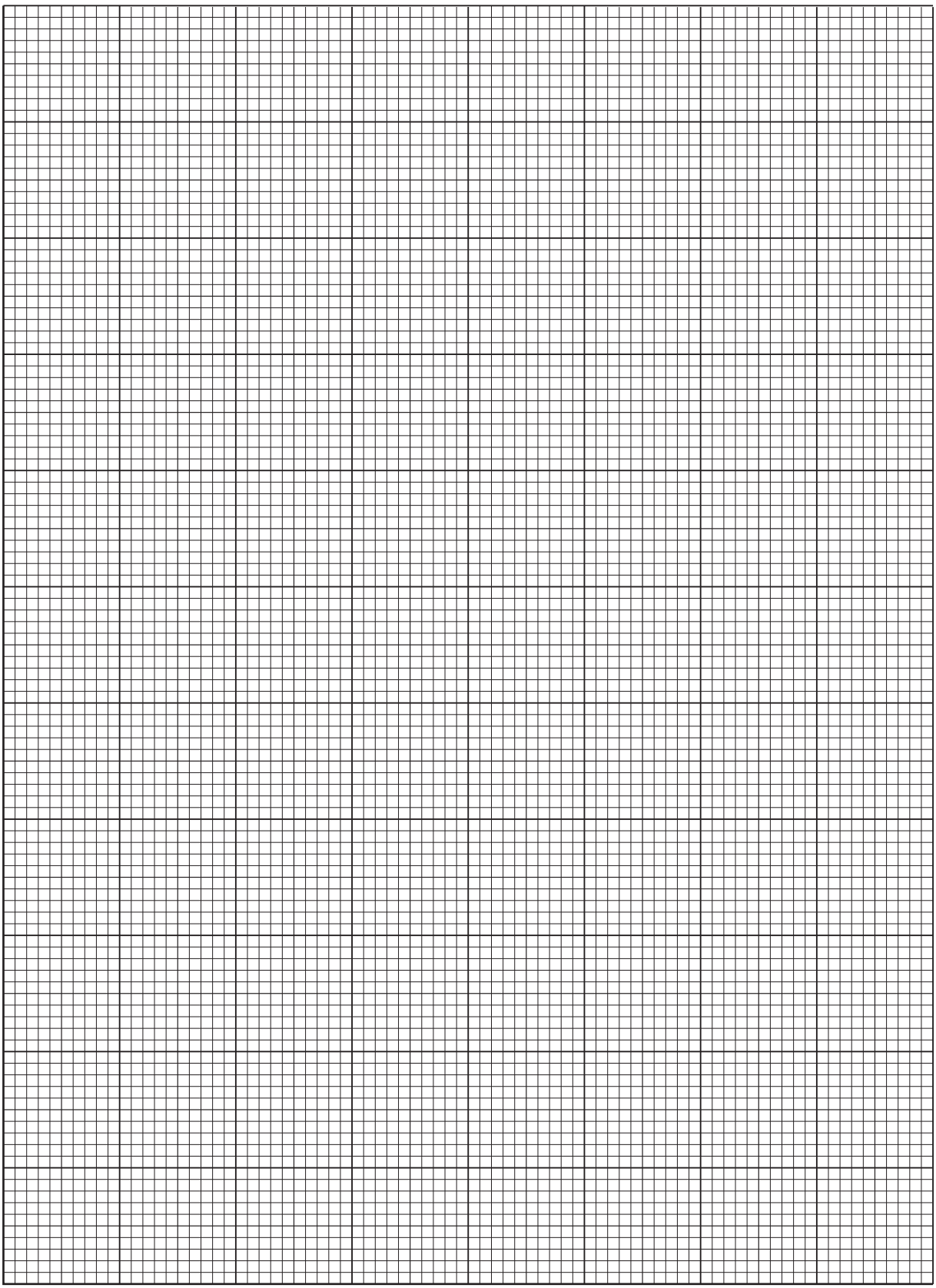
1. Fill the burette with **FA 2**.
2. Support the plastic cup in the 250 cm^3 beaker.
3. Pipette 25.0 cm^3 of **FA 1** into the plastic cup.
4. Measure and record the temperature of **FA 1** in the plastic cup.
5. Add the first volume of **FA 2** from the burette into the plastic cup. Stir the solution and record the highest temperature that is observed.
6. Continue to add each volume of **FA 2** and record the highest temperature observed.

Record in the space below:

- the initial temperature of **FA 1**
- the total volume of **FA 2** added at each stage in the experiment
- the temperature of the solution in the plastic cup after each addition of acid
- the temperature rise, ΔT, where ΔT = highest temperature of the solution after each addition of acid – initial temperature of **FA 1**.

[6]

(d) On the grid below plot the temperature rise, ΔT, (y-axis) against the volume of **FA 2** added (x-axis).



[4]

(e) (i) Use your graph to obtain a value for the volume of **FA 2** added at the end-point of the titration.

volume of **FA 2** at the end-point = ... cm^3 [1]

(ii) Use your answer to **(i)** to calculate the concentration of H_2SO_4 in **FA 2**.
Show your working.

concentration of **FA 2** = ... $mol\,dm^{-3}$ [2]

(f) Explain how the results of your experiment support or do not support each part of the hypothesis proposed by the student.

.....

.....

.....

..... [2]

(g) Calculate the % error in the total volume of **FA 2** added from the burette for the volume which is closest to the end-point.

..... % [2]

(h) A student carrying out the same experiment noticed that each subsequent temperature rise became less as the end-point was approached. Give **two** reasons why this was the case.

reason 1 .....

.....

reason 2 .....

..... [2]

(i) Another student put forward the hypothesis that the heat energy produced in the reaction, rather than the temperature rise, is proportional to the volume of acid added.

Calculate the total heat produced by the addition of **FA 2** at the end-point.
Assume that it takes 4.2 J to raise the temperature of 1.0 cm^3 of solution by 1.0 °C.

heat produced = ... J [1]

[Total: 23]

2 (a) **FA 3** is a solution containing three unknown **cations**. By choosing appropriate reagents you will be able to identify the cations that are present.

Carry out tests to identify the three cations. Record your observations in the space below.

Where gases are released they should be identified by a test, **described in the appropriate place in your observations**.

If any solution is warmed a boiling tube MUST be used.

Results

The three cations in **FA 3** are ....., ... and ..... [7]

(b) Solution **FA 3** contains either the sulfate or sulfite anion.

(i) State reagents that will allow you to determine which anion is present.

.....

..... [1]

(ii) Use these reagents to test solution **FA 3**. Record your tests and observations in the space below and hence determine which anion is present.

The anion in **FA 3** is ..... [3]

(iii) A student analysed a solid sample which was known to contain the sulfite ion. He made up a solution of the salt but then left it for a number of days in an open beaker before carrying out his tests. He found his results were incorrect in that they showed the presence of the sulfate ion. Explain why this was the case and outline how he should have analysed the sample.

.....

.....

..... [1]

(c) (i) Carry out the following tests.

test	observations
To a 1 cm depth of **FA 3** in a boiling tube add a 1 cm depth of hydrogen peroxide, then	
add to the mixture a 1 cm depth of sodium hydroxide. Stir the contents of the boiling tube carefully.	

[3]

(ii) Suggest an explanation for your observations.

.....

.....

.....

..... [2]

[Total: 17]