Cambridge Assessment International Education

Cambridge Pre-U

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

1258619739

CHEMISTRY **9791/04**

Paper 4 Practical **October/November 2020**

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions
Data booklet

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Give details of the practical session and laboratory, where appropriate, in the boxes provided.

Session
Laboratory

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

For Examiner's Use	
1	
2	
3	
Total	

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

This document has **12** pages. Blank pages are indicated.

[Turn over

1 Neutralisation reactions between acids and alkalis are exothermic. In this experiment you will determine the concentration of **FA 1**, dilute sulfuric acid, by measuring the temperature rise when different volumes of **FA 1** are added to a fixed volume of **FA 2**, aqueous sodium hydroxide.

The reaction between sulfuric acid and sodium hydroxide is shown.

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

The following reagents are provided.
FA 1 is dilute sulfuric acid, H_2SO_4.
FA 2 is 2.00 mol dm^{-3} sodium hydroxide, NaOH.

(a) Method
Before starting any practical work, read through all the instructions and prepare a suitable table for your results in the space provided.

- Support the plastic cup in the 250 cm^3 beaker.
- Use a pipette to transfer 25.0 cm^3 of **FA 2** into the plastic cup.
- Record the initial temperature, T_i, of **FA 2**. You may need to tilt the beaker to make sure the bulb of the thermometer is completely covered.

T_i = ... °C

- Fill the burette with **FA 1**.
- Add 5.00 cm^3 of **FA 1** from the burette to the solution in the plastic cup.
- Stir the mixture thoroughly and record the maximum temperature of the solution.
- Add a further 5.00 cm^3 of **FA 1** to the plastic cup. Stir the mixture thoroughly and again record the maximum temperature of the solution.
- Repeat the addition of 5.00 cm^3 portions of **FA 1** until you have added a total of 50.00 cm^3 of **FA 1** to the plastic cup. Stir the mixture thoroughly after each addition and record the maximum temperature of the solution after each addition.

[3]

(b) At the neutralisation point the alkali will have all reacted and further additions of acid will not cause any more heat to be given out. To find the volume of acid that corresponds to the neutralisation point you will calculate the total heat given out after every 5.00 cm^3 addition of **FA 1**.

The total heat given out after every 5.00 cm^3 addition of **FA 1** is given by the equation

$$q = 4.18 \times \Delta T \times V_t$$

where:
q is the total heat given out in J.

ΔT is the temperature rise; ΔT = the temperature recorded – T_i.

V_t is the total volume of solution in the plastic cup.

Draw a table to include the following for every addition of **FA 1**.
- the total volume of **FA 1** added to the plastic cup
- the total volume of solution in the plastic cup, V_t
- the temperature rise, ΔT
- the total heat given out, q

[2]

(c) **(i)** On the grid, plot the value of *q* on the *y*-axis against the volume of **FA 1** on the *x*-axis. [3]

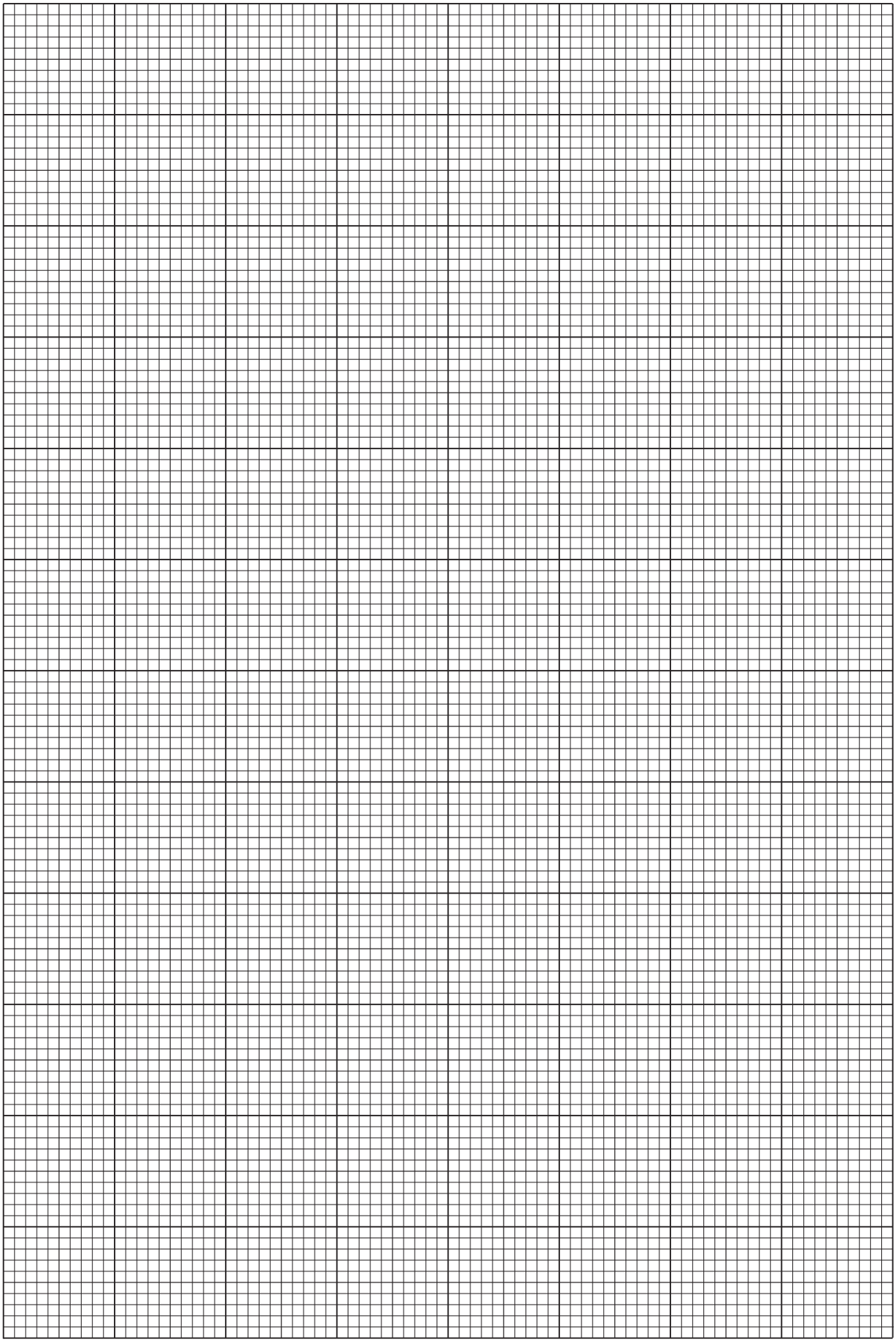
(ii) Draw a **straight** line of best fit through the points where the values of *q* are increasing. Draw a second **straight** line of best fit through the points where the values of *q* are decreasing.

Determine the volume of **FA 1** where the lines intersect. This corresponds to the neutralisation point.

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

(d) Calculate the concentration of **FA 1**.

concentration of **FA 1** = ... $mol\,dm^{-3}$ [1]



(e) (i) The volume in **(c)(ii)** could have been determined more accurately if you had recorded the temperature rise for additional volumes of **FA 1**. Suggest three additional volumes of **FA 1** that you would choose. Explain how these volumes would improve the accuracy of your result.

Do not carry out these measurements.

.....

.....

..... [1]

(ii) A student suggests that one error in this method is that the specific heat capacity of water, $4.18\,J\,K^{-1}\,mol^{-1}$, cannot be used for this solution.
Discuss whether you agree with the student that this is a source of error and describe how the volume measured in **(c)(ii)** might be affected.

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.....

.....

..... [1]

(iii) State the uncertainty in a single temperature reading.

uncertainty = ± ..... °C

Calculate the percentage uncertainty in your value for ΔT corresponding to the addition of $25.00\,cm^3$ of **FA 1**.
You must show your working.

percentage uncertainty = ± ..... % [1]

[Total: 14]

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2 In this experiment you will use a second method to determine the concentration of dilute sulfuric acid, **FA 1**. You will measure the mass loss when the acid reacts with **FA 3**, an excess of anhydrous sodium carbonate.
The equation for this reaction is shown.

$$H_2SO_4(aq) + Na_2CO_3(s) \rightarrow Na_2SO_4(aq) + H_2O(l) + CO_2(g)$$

The following reagents are provided.
FA 1 is dilute sulfuric acid, H_2SO_4.
FA 3 is anhydrous sodium carbonate, Na_2CO_3.

(a) Method
Before starting any practical work, read through all the instructions and prepare a table for your results in the space provided.

- Fill the burette with **FA 1**.
- Run 20.00 cm^3 of **FA 1** from the burette into the conical flask.
- Weigh the conical flask containing **FA 1** and record the mass.
- Weigh the container with **FA 3** and record the mass.
- Add a spatula-measure of **FA 3** to the acid in the conical flask. Swirl the flask until no further effervescence is seen. Repeat until all the **FA 3** has been added.
- Reweigh the conical flask and its contents and record the mass.
- Reweigh the container with any residual **FA 3** and record the mass.
- Calculate the mass of **FA 3** added to the acid and record this value.
- Calculate the mass of carbon dioxide given off and record this value.

[5]

(b) Use your results in **(a)** to calculate the concentration of **FA 1**.
You must show your working.

concentration of **FA 1** = ... $mol\,dm^{-3}$ [2]

(c) Apart from errors involving measurements, suggest one other possible source of error in this experiment and an improvement you would make to reduce that error.

.....

.....

..... [2]

[Total: 9]

3 **(a)** **FA 4** and **FA 5** are solids and **FA 6** is a solution. Each contains one cation and one anion from those listed in the Qualitative Analysis Notes.

Place a small spatula-measure of **FA 4** in a hard-glass test-tube and heat gently with a Bunsen burner.
Place a small spatula-measure of **FA 5** in a hard-glass test-tube and heat gently with a Bunsen burner.
Record your observations.

	observations on heating
FA 4	
FA 5	

[2]

(b) Place a small spatula-measure of **FA 4** in a test-tube. Add a 1 cm depth of '20 volume' hydrogen peroxide followed by a 1 cm depth of aqueous sodium hydroxide.
Carry out a test to identify any gas produced.
Record your observations.

[2]

(c) For the following tests make up two separate solutions.
Dissolve the remaining solid sample of **FA 4** in approximately 50 cm^3 of distilled water.
Dissolve the remaining solid sample of **FA 5** in approximately 50 cm^3 of distilled water.

Keep the solutions of FA 4 and FA 5 for use in (d).

test	*observations*		
	solution of FA 4	**solution of FA 5**	**FA 6**
To an approximately 1 cm depth of solution in a test-tube, add aqueous silver nitrate, then, if there is a positive result,			
add aqueous ammonia.			
To an approximately 1 cm depth of solution in a test-tube, add approximately 1 cm of aqueous barium chloride, then, if there is a positive result,			
add dilute hydrochloric acid.			

[5]

(d) Select reagent(s) to identify the cations in **FA 4**, **FA 5** and **FA 6**.
Carry out tests using your selected reagent(s) and record your observations.

[4]

(e) From your observations in **(a)**–**(d)**, state what you can conclude about **FA 4**, **FA 5** and **FA 6**.

FA 4: .....

.....

FA 5: .....

.....

FA 6: .....

.....

[4]

[Total: 17]