Cambridge Assessment International Education

Cambridge Pre-U

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8202794154

CHEMISTRY **9791/04**

Paper 4 Practical **May/June 2023**

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 **8** pages. Any blank pages are indicated.

DC (CJ) 324829

1 In this experiment you will determine the concentration of a strong acid in a mixture containing the strong acid and a weak acid. You will first dilute the mixture of acids and then carry out a titration. In this titration, the end-point using bromocresol green indicator corresponds to the complete neutralisation of the strong acid.

The following reagents are provided:
FA 1 is a mixture of the strong acid and a weak acid.
FA 2 is 0.100 mol dm^{-3} sodium hydroxide, NaOH.
bromocresol green indicator

(a) Method

Before starting any practical work, read through all the instructions and prepare suitable tables for your results in the spaces provided.

Dilution of FA 1

- Label a burette **FA 1**.
- Fill the burette with **FA 1**.
- Run between 24.00 and 26.00 cm^3 of **FA 1** into the 250 cm^3 volumetric flask.
- Record all your burette readings in the space below.
- Fill the volumetric flask to the line with distilled water. Stopper the flask and invert several times to ensure thorough mixing.
- Label this flask **FA 3**.

- Leave the **FA 1** in the burette for use in **Question 2**.

Titration

- Label the second burette **FA 2**.
- Fill this burette with **FA 2**.
- Use a pipette to transfer 25.0 cm^3 of **FA 3** into a conical flask.
- Add 10–15 drops of bromocresol green indicator.
- Titrate the solution in the conical flask with **FA 2**. The end-point is marked by a change from yellow to green. On addition of an excess of **FA 2** the solution will turn blue.
- Repeat the titration as many times as you feel are necessary to obtain consistent results.
- Record your results in the space below.

[8]

(b) From your titration results, obtain a volume of **FA 2** to be used in the following calculations. Show clearly how you obtained this value.

25.0 cm^3 of **FA 3** required ..... cm^3 of **FA 2**. [1]

(c) Calculations
You must show your working.

(i) Calculate the concentration, in mol dm^{-3}, of the H^+ ions from the strong acid in **FA 3**.

..... mol dm^{-3} [1]

(ii) Calculate the concentration, in mol dm^{-3}, of the H^+ ions from the strong acid in **FA 1**.

..... mol dm^{-3} [1]

(d) Calculate the highest possible concentration of the H^+ ions from the strong acid in **FA 1**. Assume the only error is in the measurement of the volume of **FA 1** used to prepare **FA 3**.

..... mol dm^{-3} [2]

(e) The strong acid is either hydrochloric acid, HC*l*, or sulfuric acid, H_2SO_4.
To a 1 cm depth of **FA 3** in a test-tube add a 1 cm depth of aqueous silver nitrate.

(i) Record your observation.

.....

..... [1]

(ii) Suggest the identity of the acid and state any assumptions you have made.

..... [1]

[Total: 15]

2 In this question you will determine the enthalpy change of neutralisation for solution **FA 1**. You will then use this to calculate the concentration of the weak acid in **FA 1**. The weak acid is monoprotic.

The following reagents are provided:
FA 1 is a mixture of the strong acid and the weak acid.
FA 4 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.
- Transfer 20.00 cm^3 of **FA 1** from the burette into the plastic cup.
- Measure the temperature of **FA 1** in the cup.
- Use the measuring cylinder to measure 25.0 cm^3 of **FA 4**.
- Add the **FA 4** to the **FA 1** in the plastic cup.
- Use the thermometer to stir the mixture.
- Measure the maximum temperature that is reached.
- Record the two temperature readings and the increase in temperature.

[2]

(b) (i) Calculate the energy given out, in kJ, when **FA 4** was added to **FA 1**.
(Assume that 4.2 J of heat energy corresponds to an increase in the temperature of 1.0 cm^3 of solution by 1.0 °C.)

energy given out = ... kJ [1]

(ii) The concentration of H^+ ions from the strong acid in **FA 1** was calculated in **1(c)(ii)**.
The standard enthalpy change of neutralisation of H^+ ions from the strong acid in **FA 1** when reacted with **FA 4** is –57.9 kJ mol^{-1}.

Use these two values to calculate the energy given out in **(a)**, in kJ, by the reaction of H^+ ions from the strong acid with **FA 4**.

energy given out = ... kJ [2]

(iii) The standard enthalpy change of neutralisation of H^+ ions from the weak acid in **FA 1** when reacted with **FA 4** is $-56.1\,kJ\,mol^{-1}$.
Use this value to calculate the concentration, in $mol\,dm^{-3}$, of the H^+ ions from the weak acid in **FA 1**.

..... $mol\,dm^{-3}$ [2]

(c) Apart from assumptions involving heat loss, give **two** further assumptions that have been made.
Describe how you might test these assumptions.

.....

.....

.....

.....

.....

..... [4]

[Total: 11]

3 (a) **FA 5**, **FA 6**, **FA 7** and **FA 8** are aqueous solutions each of which contains a single cation and a single anion.

(i) Carry out the following tests and record your observations.
For each test use a 1 cm depth of **FA 5**, **FA 6**, **FA 7** or **FA 8** in a test-tube.

test	*observations*			
	FA 5	**FA 6**	**FA 7**	**FA 8**
Add aqueous sodium hydroxide.				
Add dilute nitric acid.				
Add a few drops of acidified aqueous potassium manganate(VII).				
Add approximately 1 cm depth of aqueous silver nitrate, then,				
add aqueous ammonia.				
Add approximately 1 cm depth of **FA 8**.				

[6]

(ii) The cation in **FA 8** is Ba^{2+}. Suggest the identity of as many of the other ions as you can.

FA 5: .....

FA 6: .....

FA 7: .....

FA 8: .....

[3]

(b) **FA 9** and **FA 10** are aqueous solutions, each of which contains a single cation from those listed in the Qualitative Analysis Notes.

(i) Select reagents to identify the cation present in each solution.
Carry out each test and record your observations.

[4]

(ii) Identify the two cations.

FA 9 contains ..... .

FA 10 contains ..... .

[1]

[Total: 14]

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