Cambridge Assessment International Education

Cambridge Pre-U

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

9238195491

CHEMISTRY **9791/04**

Paper 4 Practical **May/June 2022**

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.

[Turn over

1 A student studied the rate of reaction between iodine and propanone in the presence of an acid catalyst.

$$CH_3COCH_3(aq) + I_2(aq) \rightarrow CH_3COCH_2I(aq) + HI(aq)$$

The student mixed together the following solutions.

100.0 cm^3 of 0.0400 mol dm^{-3} iodine, I_2
50.0 cm^3 of 1.00 mol dm^{-3} propanone, CH_3COCH_3
50.0 cm^3 of 1.00 mol dm^{-3} sulfuric acid, H_2SO_4

After 90 seconds, the student removed 50.0 cm^3 of the reaction mixture and added this to 60.0 cm^3 of aqueous sodium hydrogencarbonate, $NaHCO_3$. The student then made the resulting solution up to 150.0 cm^3 with distilled water using a volumetric flask and labelled it **FA 1**.

In this experiment you will determine the concentration of iodine in **FA 1** and so determine the average rate of reaction for the first 90 seconds. You will do this by titration using aqueous sodium thiosulfate.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \longrightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

The following reagents are provided:

FA 1 is a sample from the volumetric flask labelled **FA 1**.
FA 2 is 0.0100 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$.
starch indicator

(a) Method

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

- Fill the burette with **FA 2**.
- Pipette 25.0 cm^3 of **FA 1** into the conical flask.
- Run **FA 2** from the burette into the conical flask until the red/brown colour of the iodine becomes pale yellow.
- Add 10 drops of starch indicator to the solution in the conical flask. The solution will turn blue-black due to the presence of iodine.
- Continue to add **FA 2** until the solution turns colourless.
- Repeat the titration as many times as you feel are necessary to obtain consistent results.
- Record your results in the space below.

[7]

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

(c) Calculations
You must show your working.

(i) Calculate the amount, in mol, of iodine present in 150.0 cm^3 of **FA 1**.

..... mol [2]

(ii) Calculate the concentration, in mol dm^{-3}, of iodine in the 50.0 cm^3 sample that the student removed from the reaction mixture.

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

(iii) Calculate the initial concentration of iodine in the reaction mixture.

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

(iv) Calculate the average rate of reaction for the first 90 seconds.

$$\text{average rate of reaction} = \frac{\text{change of iodine concentration}}{\text{time}}$$

average rate of reaction = ... [2]
value *units*

(d) The aqueous sodium hydrogencarbonate reacts with the acid present in the 50.0 cm^3 sample that the student removed from the reaction mixture.

(i) Calculate the minimum concentration of aqueous sodium hydrogencarbonate that is needed to react completely with the sulfuric acid present in the 50.0 cm^3 sample.

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

(ii) Suggest why it is necessary to react all the acid.

..... [1]

(iii) The accuracy with which the average rate of reaction is calculated is **not** improved if the volume of aqueous sodium hydrogencarbonate is measured using a burette rather than a measuring cylinder.
Explain why this is the case.

.....

.....

..... [1]

[Total: 18]

2 In this question you will determine the enthalpy change of solution of an organic compound, **FA 3**.

(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 the measuring cylinder to transfer 30 cm^3 of distilled water into the plastic cup.
- Weigh between 7.4 and 7.6 g of **FA 3**. Record the mass.
- Record the temperature of the water in the cup.
- Add the weighed sample of **FA 3** to the distilled water.
- Use the thermometer to stir the mixture gently.
- Record the minimum temperature that is reached.

Keep the solution in the plastic cup for further tests.

Keep the remaining solid FA 3 for further tests.

[3]

(b) (i) Calculate the heat taken in when **FA 3** dissolved in water.
(Assume that 4.2 J of heat correspond to a decrease in the temperature of 1.0 cm^3 of solution by 1.0 °C.)

heat taken in = ... [1]

(ii) Calculate the molar enthalpy change of solution of **FA 3**.
The relative molecular mass of **FA 3** is 210.

molar enthalpy change of solution = ... [1]
value *units*

(c) Suggest two improvements to this experiment that would allow you to determine the molar enthalpy change of solution of **FA 3** more accurately.
Explain your answer.

improvement 1 .....

.....

improvement 2 .....

.....
[2]

(d) You will now carry out tests to allow you to determine a functional group present in organic compound **FA 3**.

(i) Measure the temperature of the solution in the plastic cup.
Use the measuring cylinder to add 20 cm^3 of aqueous sodium hydroxide and record the effect on the temperature of the solution.

..... [1]

(ii) Place a spatula measure of **FA 3** in a test-tube and add approximately 2 cm depth of distilled water. Shake the tube to dissolve the solid.
Use this solution to carry out a chemical test to determine a functional group present in **FA 3**.
Record the details of your test and your observations.

The functional group present is ..... . [2]

[Total: 10]

3 **(a)** **FA 4** is a solid that contains one anion from those listed in the Qualitative Analysis Notes.

Place approximately half of the sample of **FA 4** in a hard-glass test-tube and heat strongly with a Bunsen burner.
Record your observations. Identify any gas produced.

	observations on heating
FA 4	

[2]

(b) Place the remaining **FA 4** in a boiling tube and dissolve in approximately 2 cm depth of distilled water.

(i) Carry out the following test.

test	*observations*
To approximately 1 cm depth of a solution of **FA 4** in a fresh boiling tube, add approximately 1 cm depth of aqueous sodium hydroxide and a small piece of aluminium foil. Warm the tube.	

[1]

(ii) Carry out a further test on the solution of **FA 4** to help confirm the identity of the anion present.
Record details of your test.

The anion present is ..... . [2]

(c) **FA 5** is acidified aqueous iron(III) chloride, $FeCl_3$.
FA 6 is 0.10 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$.

(i) Carry out the following tests and record your observations.

test	*observations*
To approximately 1 cm depth of **FA 5** in a test-tube, add approximately 1 cm depth of **FA 6**. Leave to stand until there is no further change, then	
add aqueous sodium hydroxide.	

[3]

(ii) Explain the observations you made in **(i)**.

.....

.....

..... [2]

(iii) Carry out the following tests and record your observations.

test	*observations*
To approximately 1 cm depth of **FA 6** in a test-tube, add approximately 1 cm depth of aqueous silver nitrate, leave to stand, then	
add aqueous ammonia.	

[2]

[Total: 12]