Cambridge International Examinations
Cambridge Pre-U Certificate

CANDIDATE NAME	

CENTRE NUMBER							CANDIDATE NUMBER					

6519764215

CHEMISTRY (PRINCIPAL) **9791/04**

Paper 4 Practical **May/June 2018**

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 at 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.
You may use an HB pencil for any diagrams or graphs.
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 may lose marks if you do not show your working or if you do not use appropriate units.
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

For Examiner's Use	
1	
2	
3	
Total	

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

This document consists of **11** printed pages and **1** blank page.

DC (RW/SW) 145236/3

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[Turn over

1 Peroxodisulfate anions, $S_2O_8^{2-}$, can oxidise iodide ions, I^-, to iodine, I_2, as shown in the equation.

$$2I^-(aq) + S_2O_8^{2-}(aq) \rightarrow I_2(aq) + 2SO_4^{2-}(aq)$$

You will carry out experiments to investigate how the rate of this reaction is affected by changing the concentration of iodide ions.

In order to measure the rate of this reaction, thiosulfate ions, $S_2O_3^{2-}$, and starch solution are both added to the reaction mixture. As $S_2O_8^{2-}$ oxidises I^- to I_2, the I_2 reacts immediately with the thiosulfate and is reduced back to I^- ions.

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

Only when all the thiosulfate has reacted will the iodine persist in the mixture and cause the starch indicator to turn blue-black. The rate of reaction can then be measured by timing how long it takes the reaction mixture to turn blue-black.

The following reagents are provided:

FA 1 0.250 mol dm^{-3} potassium iodide, KI
FA 2 0.100 mol dm^{-3} potassium peroxodisulfate, $K_2S_2O_8$
FA 3 0.00500 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$
starch indicator

Read carefully through all the instructions in (a). Before starting any practical work prepare a table for your results as instructed on page 4.

(a) Method

Experiment 1

- Fill the burette labelled **FA 1** with **FA 1**.
- Add 20.00 cm^3 of **FA 1** from the burette into the conical flask.
- Use the 10 cm^3 measuring cylinder to add 10 cm^3 of **FA 3** into the conical flask.
- Use the 10 cm^3 measuring cylinder to add 10 cm^3 of starch indicator into the conical flask.
- Use the 25 cm^3 measuring cylinder to measure 20 cm^3 of **FA 2**.
- Add the 20 cm^3 of **FA 2** from the measuring cylinder to the mixture in the conical flask and start timing immediately.
- Swirl the mixture once and place the conical flask on a white tile.
- Stop timing as soon as the solution turns blue-black.
- Record this reaction time to the nearest second.
- Wash out the conical flask.

Experiment 2

- Fill a second burette with distilled water.
- Add 10.00 cm^3 of **FA 1** from the first burette into the conical flask.
- Add 10.00 cm^3 of distilled water from the second burette into the conical flask.
- Use the 10 cm^3 measuring cylinder to add 10 cm^3 of **FA 3** into the conical flask.
- Use the 10 cm^3 measuring cylinder to add 10 cm^3 of starch indicator into the conical flask.
- Use the 25 cm^3 measuring cylinder to measure 20 cm^3 of **FA 2**.
- Add the 20 cm^3 of **FA 2** from the measuring cylinder to the mixture in the conical flask and start timing immediately.
- Swirl the mixture once and place the conical flask on a white tile.
- Stop timing as soon as the solution turns blue-black.
- Record this reaction time to the nearest second.
- Wash out the conical flask.

Experiments 3 – 5

Carry out three further experiments to investigate how the reaction time changes with different volumes of **FA 1**.
Note that the combined volume of **FA 1** and distilled water must always be 20.00 cm^3.
Do not use a volume of **FA 1** that is less than 6.00 cm^3.

Calculating the rate of reaction

For these experiments, the rate of the reaction is represented by the formula shown.

$$\text{rate of reaction} = \frac{500}{\text{reaction time}}$$

Use this formula to calculate the rate of reaction for each of your five experiments.

Results

Record all your results in a single table. You should include the volume of **FA 1**, the volume of distilled water, the reaction time and the rate of reaction for each of your five experiments.

[10]

(b) On the grid, plot the rate of reaction against the volume of **FA 1**. Include the origin in your plot. Draw a line of best fit.

[4]

(c) What conclusion can you draw from your graph about the relationship between the rate of reaction and the concentration of potassium iodide?

....

.... [1]

(d) Assume that the error in the reaction time you recorded in Experiment 1 was $\pm 0.5\,s$. Calculate the range of possible values for the rate of this reaction. As in **(a)**, use the formula shown.

$$\text{rate of reaction} = \frac{500}{\text{reaction time}}$$

Rate of reaction lies between .... and ....
[1]

(e) A student reasoned that if an experiment were carried out using the following solutions then the rate of reaction in this experiment would be ¼ × the rate in Experiment 1.

- 10.00 cm^3 of **FA 1**
- 20 cm^3 of **FA 2**
- 20 cm^3 of **FA 3**
- 10 cm^3 of starch

Explain how the student may have come to this conclusion.

....

....

....

.... [3]

[Total: 19]

2 In this question you will measure the enthalpy change of solution of **FA 4**. To do this you will measure the temperature change when a sample of **FA 4** is dissolved in water. You will also identify the cation in **FA 4**.

(a) Method

- Support the plastic cup in a 250 cm^3 beaker.
- Rinse the 25 cm^3 measuring cylinder with distilled water.
- Use the 25 cm^3 measuring cylinder to pour 25 cm^3 of distilled water into the plastic cup.
- Measure the temperature of the water in the cup.
- Weigh the bottle containing **FA 4**.
- Add the contents of the bottle to the distilled water.
- Use the thermometer to stir the mixture gently.
- Measure the minimum temperature that is reached.
- Reweigh the bottle.

KEEP YOUR SOLUTION OF **FA 4** FOR USE IN **(b)**.

Record all the measurements from your experiment.

[3]

(b) Use the 25 cm^3 measuring cylinder to add 25 cm^3 distilled water to your solution of **FA 4** from **(a)**. Stir the solution.

The anion in **FA 4** is Cl^-.

FA 4 contains a single cation from those listed in the *Data Booklet*.
Choose reagents to identify the cation in **FA 4**.
Record the results of your tests.

When the tests are completed, pour any solution containing **FA 4** away and rinse all apparatus thoroughly.

The formula of **FA 4** is .... [2]

(c) **(i)** Using your formula from **(b)**, calculate the amount, in moles, of **FA 4** that was dissolved in the water.

moles of **FA 4** = ...
[1]

(ii) Calculate the heat taken in when **FA 4** dissolved in water.
(Assume that 4.2 J of heat corresponds to a decrease in the temperature of 1.0 cm^3 of solution by 1.0 °C.)

heat taken in = ...
[1]

(iii) Calculate the molar enthalpy change of solution of **FA 4**.

molar enthalpy change of solution = ...
[1]

(d) A student suggests that the experiment could be made more accurate by:

- using 50 cm^3 of distilled water rather than 25 cm^3 of distilled water
- measuring the volume of water using a burette.

The student plans to keep all other apparatus the same and to use the same mass of **FA 4**.

(i) Explain why using a burette would make the experiment more accurate.

....

....
[1]

(ii) Use of the student's two suggestions together would in fact give a **less** accurate value for the enthalpy change of solution of **FA 4**. Explain why.

....

....

....

....
[2]

[Total: 11]

3 **FA 5** and **FA 6** are solutions.

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

test	observations	
	FA 5	**FA 6**
(i) To approximately 1 cm depth of solution in a test-tube, add aqueous sodium carbonate.		
(ii) To approximately 1 cm depth of solution in a test-tube, add aqueous sodium hydroxide.		
(iii) To approximately 1 cm depth of solution in a test-tube, add aqueous ammonia.		
(iv) To approximately 1 cm depth of solution in a test-tube, add aqueous silver nitrate.		
(v) To approximately 1 cm depth of solution in a test-tube, add aqueous barium chloride, then,		
add hydrochloric acid.		

[7]

(b) Suggest the formula for each of the compounds used to make up the solutions.

The formula of the compound used to prepare **FA 5** is ....

The formula of the compound used to prepare **FA 6** is ....

[2]

(c) A student carried out all the tests in **(a)** except for test **(iii)**. Would the student have been able to identify the cation in **FA 5**? Explain your answer.

....

....

....

[1]

[Total: 10]

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