Cambridge Pre-U

Cambridge International Examinations
Cambridge Pre-U Certificate

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8299134686

CHEMISTRY (PRINCIPAL) **9791/04**

Paper 4 Practical **May/June 2017**

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	

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 **10** printed pages and **2** blank pages.

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1 In this question you will determine the value of x in the formula of hydrated ammonium iron(II) sulfate, $(NH_4)_2Fe(SO_4)_2.xH_2O$, where x is an integer. To do this you will first prepare a solution of the salt and then carry out a titration using potassium manganate(VII). The iron(II) ions, Fe^{2+}, are oxidised by the manganate(VII) ions, MnO_4^-.

$$5Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$$

The end-point of the titration occurs when all the Fe^{2+} ions have been oxidised and the presence of unreacted MnO_4^- causes the colour of the solution to become a permanent pale pink.

The following reagents are provided.

FA 1 is hydrated ammonium iron(II) sulfate, $(NH_4)_2Fe(SO_4)_2.xH_2O$.
FA 2 is 0.0100 mol dm^{-3} manganate(VII) ions, MnO_4^-.
FA 3 is 1 mol dm^{-3} sulfuric acid, H_2SO_4.

(a) Method

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

Preparing the solution

1. Weigh the weighing bottle containing **FA 1**.
2. Tip the contents of the weighing bottle into the 250 cm^3 beaker.
3. Reweigh the weighing bottle.
4. Add approximately 150 cm^3 of distilled water to the beaker and stir until **FA 1** has dissolved.
5. Transfer the contents of the beaker into the 250 cm^3 volumetric flask.
6. Rinse the beaker with a little distilled water and add these washings to the volumetric flask.
7. Fill the volumetric flask to the line with distilled water. Stopper the flask and invert several times to ensure thorough mixing.
8. Label this solution **FA 4**.
9. Record in the space provided both weighings and the mass of **FA 1** added.

Titration

10. Fill the burette with **FA 2**.
11. Use a pipette to transfer 25.0 cm^3 of the solution **FA 4** into the conical flask.
12. Use the 25 cm^3 measuring cylinder to add 25 cm^3 of **FA 3** to the conical flask.
13. Titrate the solution in the flask with **FA 2**.
14. Repeat the titration as many times as you feel are necessary to obtain consistent results.
15. Record your results in a suitable form in the space provided.

[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 the solution **FA 4** required ..... cm^3 of **FA 2**.

[1]

(c) By performing the following calculations you will determine the value of x in $(NH_4)_2Fe(SO_4)_2.xH_2O$.

You must show your working.

(i) Calculate the amount, in mol, of MnO_4^- present in the volume of **FA 2** calculated in **(b)**.

..... mol

(ii) Calculate the amount, in mol, of $(NH_4)_2Fe(SO_4)_2.xH_2O$ present in 25.0 cm^3 of **FA 4**.

..... mol

(iii) Calculate the amount, in mol, of $(NH_4)_2Fe(SO_4)_2.xH_2O$ present in the mass of **FA 1** that you used in **(a)**.

..... mol

(iv) Calculate the value of x in $(NH_4)_2Fe(SO_4)_2.xH_2O$.

x = ...
[4]

[Total: 13]

[Turn over

2 In this question you will determine the value of *y* in the formula of basic copper(II) carbonate, $CuCO_3.yCu(OH)_2$. To do this you will measure the mass lost when the compound undergoes thermal decomposition.

$$CuCO_3.yCu(OH)_2(s) \rightarrow (1 + y)CuO(s) + CO_2(g) + yH_2O(g)$$

The following reagent is provided.

FA 5 is basic copper(II) carbonate $CuCO_3.yCu(OH)_2$.

(a) Method

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

1. Place a plug of ceramic wool in the neck of a clean, dry boiling tube.
2. Weigh the boiling tube with the ceramic wool plug and record your reading.
3. Remove the ceramic wool plug and place all of the contents of the container of **FA 5** in the boiling tube. Replace the ceramic wool plug in the neck of the boiling tube.
4. Reweigh the boiling tube with the ceramic wool plug and **FA 5**. Record your reading.
5. Warm **FA 5** gently and then heat more strongly. Carefully warm the sides of the boiling tube to make sure that all the water is lost. When no further reaction occurs and all the water has been driven out of the boiling tube, stop heating and allow the boiling tube to cool.
   While the tube is cooling you are advised to start Question 3.
6. When the boiling tube is cool enough to touch, reweigh the boiling tube with its contents and the ceramic wool plug. Record your reading.
7. Calculate and record the initial mass of **FA 5** and the mass lost during heating.

[5]

(b) By performing the following calculations you will determine the value of *y* in the formula $CuCO_3.yCu(OH)_2$.

You must show your working in each step of your calculations.

(i) By calculating the relative formula mass of $CuCO_3$ and of $Cu(OH)_2$, write an expression in terms of *y* for the relative formula mass of $CuCO_3.yCu(OH)_2$.

relative formula mass of $CuCO_3$ = ...

relative formula mass of $Cu(OH)_2$ = ...

relative formula mass of $CuCO_3.yCu(OH)_2$ = ...

(ii) Use your answers to **(i)** and the initial mass of **FA 5** to write an expression, in terms of *y*, for the amount, in mol, of carbon dioxide produced during heating.

$$CuCO_3.yCu(OH)_2(s) \rightarrow (1 + y)CuO(s) + CO_2(g) + yH_2O(g)$$

(iii) Write an expression, in terms of *y*, for the amount, in mol, of water produced during heating.

(iv) Use your answers to **(ii)** and **(iii)** to write an expression, in terms of *y*, for the total **mass** lost during heating.
[M_r: CO_2, 44.0; H_2O, 18.0]

(v) Use your answer to **(iv)** and your results from **(a)** to calculate the value of *y*.

The value of *y* is not necessarily an integer. Give your answer to 1 decimal place.

y = ...
[5]

(c) What change to the experimental procedure could you make in order to be more certain that thermal decomposition was complete and that all the water had been driven from the boiling tube?

.....

.....
[1]

[Total: 11]

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3 **(a)** **FA 6** and **FA 7** are solutions, each of which contains a single cation from those listed in the Qualitative Analysis Notes. You will identify the cation present in each salt.

(i) Choose a reagent or reagents to identify the cation present in each salt. Record the results of your tests in a single table in the space below.

(ii) Identify the two cations.

The cation in **FA 6** is ..... .

The cation in **FA 7** is ..... .

[8]

(b) **FA 8** and **FA 9** are solutions, each of which contains a single anion from those listed in the Qualitative Analysis Notes. You will identify the anion present in each salt.

Carry out the following tests and record your observations.

test	observations	
	FA 8	**FA 9**
(i) To approximately 1 cm depth of solution in a test-tube, add drops of acidified aqueous potassium manganate(VII).		
(ii) To approximately 1 cm depth of solution in a test-tube, add approximately 2 cm depth of aqueous silver nitrate, then,		
add aqueous ammonia.		
(iii) To approximately 1 cm depth of solution in a test-tube, add approximately 2 cm depth of dilute nitric acid. Keep your solution for use in test **(iv)**.		
(iv) To approximately 1 cm depth of your solution from test **(iii)** in a test-tube, add approximately 1 cm depth of aqueous silver nitrate.		
When you have made your observations, rinse the test-tubes used in tests (iii) and (iv).		

(v) Identify the two anions.

The anion in **FA 8** is ..... . The anion in **FA 9** is ..... .

(vi) Explain the observations made in tests **(ii)**, **(iii)** and **(iv)** for **FA 8**.

.....

.....

.....

[8]

[Total: 16]

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