UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **9701/34**

Paper 34 Advanced Practical Skills **October/November 2009**

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Give details of the practical session and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
You are advised to show all working in calculations.
Use of a Data Booklet is unnecessary.

Qualitative Analysis Notes are printed on pages 9 and 10.

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 document consists of **9** printed pages and **3** blank pages.

DC (SJF5337) 11762/3

UNIVERSITY *of* CAMBRIDGE International Examinations

[Turn over

BLANK PAGE

For Examiner's Use

1 Read through question 1 before starting any practical work.

You are provided with the following reagents.

- **FB 1**, hydrated copper(II) sulfate
- **FB 2**, aqueous copper(II) sulfate
- **FB 3**, aqueous sodium thiosulfate
- **FB 4**, aqueous potassium iodide
- **FB 5**, starch indicator solution

The formula of hydrated copper(II) sulfate is $CuSO_4.\boldsymbol{x}H_2O$ where ***x*** shows the number of molecules of water of crystallisation present.

The value of ***x*** can be found by two different methods.
Method 1 involves heating to drive off water of crystallisation while **Method 2** uses a titration to determine the concentration of Cu^{2+}(aq).

(a) Method 1

- Weigh a crucible and record the mass.
- Add between 2.50 g and 2.70 g of **FB 1** and record the new mass.
- Place the crucible containing **FB 1** on a pipe clay triangle and heat gently for about four minutes with a Bunsen burner.
- Allow the crucible to cool. You should continue with **Method 2** while the crucible is cooling.
- Weigh the crucible and its contents.

Record all masses in the space below.

[3]

(b) Calculate the mass of water lost and the mass of copper(II) sulfate that remained after heating.

mass of water lost = ... g

mass of copper(II) sulfate remaining = ... g
[1]

[Turn over

For Examiner's Use

(c) Use your answer to **(b)** to calculate how many moles of water were lost and the moles of copper(II) sulfate, $CuSO_4$, remaining after heating.
Show all of your working.
[A_r : Cu, 63.5; H, 1.0; O, 16.0; S, 32.1]

The hydrated copper(II) sulfate contained .... mol of water

and .... mol of $CuSO_4$. [2]

(d) Use your answer to **(c)** to determine the value of ***x*** in the formula of hydrated copper(II) sulfate, $CuSO_4.\boldsymbol{x}H_2O$.

x = ……………….. [2]

(e) **Method 2**

- Fill the burette with **FB 3**, aqueous sodium thiosulfate.
- Pipette 25.0 cm^3 of **FB 2** into a conical flask and use a measuring cylinder to add 10 cm^3 of **FB 4.**
- Titrate this solution with **FB 3** from the burette until the mixture becomes yellow-brown. Do **not** add too much **FB 3** at this stage.
- An off-white precipitate is also present in the flask and this will mask the colour of the solution.
- Add approximately 1 cm^3 of **FB 5**. The solution will become blue-black as a starch iodine complex is formed.
- Continue the titration until the blue-black colour of the complex just disappears leaving the off-white precipitate.
- Perform sufficient further titrations to obtain accurate results.
- Record your titration results in the space below. Make certain that your recorded results show the precision of your working.

i	
ii	
iii	
iv	
v	
vi	
vii	
viii	
ix	
x	
xi	

Summary

25.0 cm^3 of **FB 2** reacted with ……………..…… cm^3 of **FB 3**.

Show which results you used to obtain the value of the volume of **FB 3** by placing a tick (✓) under the readings used in your results. [11]

(f) **(i)** In **Method 1** a student was advised to carry out all weighings using the same balance. What type of error might be introduced if more than one balance was used?

....

....[1]

(ii) In **Method 2**, 10 cm^3 of **FB 4** was added during the titration process. Assume that the measuring cylinder used could be read to ± 0.5 cm^3. Calculate the percentage error in the measurement of this volume.

………….. % error [1]

(g) **Method 1** is usually less accurate than **Method 2** for finding the value of ***x*** in the formula of hydrated copper(II) sulfate, $CuSO_4.\boldsymbol{x}H_2O$.

A group of students carried out **Method 1** correctly but calculated a value of 4 for ***x***. The true value for ***x*** is 5.

Suggest an error in the practical procedure of the experiment that could account for this difference.

....

.... [1]

(h) Suggest a modification that could be made to the practical procedure in **Method 1** to reduce this error.

Explain why this modification should give an answer nearer to 5.

modification ....

....

explanation ....

.... [2]

[Total: 24]

For Examiner's Use

2 In this question you should use information from the Qualitative Analysis Notes on pages 9 and 10.

For Examiner's Use

(a) Solutions **FB 6**, **FB 7** and **FB 8** are known to be either chlorides or sulfates of aluminium, magnesium or calcium. The addition of aqueous sodium hydroxide and aqueous ammonia can be used to give information about the cation present.
Add NaOH(aq) and NH_3(aq) separately to each of the solutions **FB 6**, **FB 7** and **FB 8**.

Rinse and reuse test-tubes where possible.

Record both the tests and your observations in an appropriate form in the space below.

i	
ii	
iii	
iv	
v	
vi	
vii	

From your observations identify the solutions containing aluminium, magnesium and calcium ions. In each case give evidence to support your answer.

Solution ……………… contains the aluminium ion.

supporting evidence ....

Solution ……………… contains the magnesium ion.

supporting evidence ....

Solution ……………… contains the calcium ion.

supporting evidence .... [7]

(b) Choose a pair of reagents that, used together, would identify which solution or solutions contain(s) the sulfate ion.

For Examiner's Use

Carry out the tests and record, in the space below, the reagents used and the observations made.

The sulfate ion is present in .... [2]

[Total: 9]

3 **(a)** You are to carry out the tests given in the table below on solid **FB 9**.

Record details of any gases that are released in the reactions. These gases should be identified by a test, **described in the appropriate part of the table**.
No additional tests should be attempted.

	test	*observations*
(i)	Place a spatula measure of **FB 9** in the small hard-glass test-tube labelled **FB 9** and heat the solid strongly.	
(ii)	To 1 cm depth of aqueous sodium hydroxide in a boiling-tube, add 1 spatula measure of **FB 9**, then	
	gently heat the mixture, **do not boil** **Care is needed when heating aqueous sodium hydroxide.**	
(iii)	To 1 cm depth of aqueous sodium hydroxide in a boiling-tube, add 1 spatula measure of **FB 9** and a piece of aluminium foil, then	
	gently heat the mixture. **Care is needed when heating aqueous sodium hydroxide.**	

[4]

(b) What elements **must** be present in **FB 9** to give the results you have obtained in test **(i)** and test **(iii)**?

.... [1]

(c) What is the function of the aluminium foil in test **(iii)**?

.... [1]

(d) **Do not carry out this test**
What would you expect to see if 1 cm depth of dilute hydrochloric acid was added to a spatula measure of **FB 9**?

....

.... [1]

[Total: 7]

Qualitative Analysis Notes

Key: [ppt. = precipitate.]

1 Reactions of aqueous cations

	reaction with	
	$NaOH(aq)$	$NH_3(aq)$
aluminium, $Al^{3+}(aq)$	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, $NH_4^+(aq)$	no ppt. ammonia produced on heating	
barium, $Ba^{2+}(aq)$	no ppt. (if reagents are pure)	no ppt.
calcium, $Ca^{2+}(aq)$	white ppt. with high [$Ca^{2+}(aq)$]	no ppt.
chromium(III), $Cr^{3+}(aq)$	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), $Cu^{2+}(aq)$	pale blue ppt. insoluble in excess	blue ppt. soluble in excess giving dark blue solution
iron(II), $Fe^{2+}(aq)$	green ppt. turning brown on contact with air insoluble in excess	green ppt. turning brown on contact with air insoluble in excess
iron(III), $Fe^{3+}(aq)$	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
lead(II), $Pb^{2+}(aq)$	white ppt. soluble in excess	white ppt. insoluble in excess
magnesium, $Mg^{2+}(aq)$	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), $Mn^{2+}(aq)$	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess
zinc, $Zn^{2+}(aq)$	white ppt. soluble in excess	white ppt. soluble in excess

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride.]

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chromate(VI), CrO_4^{2-} (aq)	yellow soln turns orange with H^+(aq); gives yellow ppt. with Ba^{2+}(aq); gives bright yellow ppt. with Pb^{2+}(aq)
chloride, Cl^- (aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq)); gives white ppt. with Pb^{2+}(aq)
bromide, Br^- (aq)	gives cream ppt. with Ag^+(aq) (partially soluble in NH_3(aq)); gives white ppt. with Pb^{2+}(aq)
iodide, I^- (aq)	gives yellow ppt. with Ag^+(aq) (insoluble In NH_3(aq)); gives yellow ppt. with Pb^{2+}(aq)
nitrate, NO_3^- (aq)	NH_3 liberated on heating with OH^-(aq) and A*l* foil
nitrite, NO_2^- (aq)	NH_3 liberated on heating with OH^-(aq) and A*l* foil, NO liberated by dilute acids (colourless NO $\rightarrow$ (pale) brown NO_2 in air)
sulfate, SO_4^{2-} (aq)	gives white ppt. with Ba^{2+}(aq) (insoluble in excess dilute strong acid); gives white ppt. with Pb^{2+}(aq)
sulfite, SO_3^{2-} (aq)	SO_2 liberated with dilute acids; gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acid)

3 Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	"pops" with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium dichromate(VI) from orange to green

BLANK PAGE

BLANK PAGE