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

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

CHEMISTRY **9701/33**

Paper 33 Practical Test **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 10 and 11.

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

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1 Read through question 1 before starting any practical work.

For Examiner's Use

You are provided with the following reagents.

- **FA 1**, hydrated iron(II) sulfate
- **FA 2**, aqueous iron(II) sulfate
- **FA 3**, aqueous potassium manganate(VII)
- **FA 4**, sulfuric acid

The formula of hydrated iron(II) sulfate is $FeSO_4.\boldsymbol{x}H_2O$ 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 $Fe^{2+}(aq)$.

(a) Method 1

- Weigh a crucible and record the mass.
- Add between 1.80 g and 2.00 g of **FA 1** and record the new mass.
- Place the crucible containing **FA 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 iron(II) sulfate that remained after heating.

mass of water lost = ... g

mass of iron(II) sulfate remaining = ... g

[1]

(c) Use your answer to **(b)** to calculate how many moles of water were lost and the moles of iron(II) sulfate, $FeSO_4$, remaining after heating.
Show all of your working.
[A_r : Fe, 55.8; H, 1.0; O, 16.0; S, 32.1]

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The hydrated iron(II) sulfate contained …… mol of water

and …… mol of $FeSO_4$. [2]

(d) Use your answer to **(c)** to determine the value of ***x*** in the formula of hydrated iron(II) sulfate, $FeSO_4.xH_2O$.

x = …….. [2]

(e) Method 2

- Fill the burette with **FA 3**, aqueous potassium manganate(VII).
- Pipette 25.0 cm^3 of **FA 2** into a conical flask and use a measuring cylinder to add approximately 20 cm^3 of **FA 4.**
- Titrate this solution with **FA 3** from the burette until the first permanent pink colour remains in the solution.
- 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 **FA 2** reacted with …… cm^3 of **FA 3**.

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

(f) All experimental methods contain errors, some of which are concerned with uncertainty of measurements.

Complete the table below to show the uncertainties in measuring the volume of potassium manganate(VII) used in **Method 2**.

maximum uncertainty in a single reading with a burette	± ..... cm^3
volume of potassium manganate(VII), **FA 3**, from the summary in **(e)**	..... cm^3
maximum percentage error in the volume of potassium manganate(VII) used	..... %

[2]

(g) **Method 1** is usually less accurate than **Method 2** for finding the value of ***x*** in the formula of hydrated iron(II) sulfate, $FeSO_4.xH_2O$.

A group of students carried out **Method 1** correctly but calculated a value of 9 for ***x***. The true value for ***x*** is 7.

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 7.

modification .....

.....

explanation .....

..... [2]

[Total: 24]

BEFORE STARTING QUESTION 2, heat a half-full 250 cm^3 beaker of water for use as a hot water-bath in question 3.

2 The four solutions **FA 5**, **FA 6**, **FA 7** and **FA 8** each contain one of the following anions.

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- chloride, Cl^-
- iodide, I^-
- nitrate, NO_3^-
- nitrite, NO_2^-

Use information from the Qualitative Analysis Notes on page 11 to answer the following questions.

(a) Which single reagent could you use to identify the solution containing the nitrite ion?

.....

Which single reagent could you use to identify the solutions containing the chloride and the iodide ion?

.....[1]

(b) Use the reagents selected in **(a)** to test each of the solutions.

Rinse and reuse test-tubes where possible.

Record in an appropriate form in the space below, the reagents used and the observations made.

i	
ii	
iii	
iv	
v	
vi	
vii	

From your observations identify the solutions containing chloride, iodide and nitrite ions. In each case give evidence to support your answer.

solution …… contains the chloride ion.

supporting evidence .....

solution …… contains the iodide ion.

supporting evidence .....

solution …… contains the nitrite ion.

supporting evidence ..... [7]

(c) Do not carry out this test.

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State another test that you could use to confirm the presence of chloride and iodide ions.

.....

.....[1]

[Total: 9]

3 **(a)** You are to carry out the tests given in the table below on solutions **FA 9** and **FA 10**. You should record details of colour changes seen and the formation of any precipitate.

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No additional tests should be attempted.

Reheat your water bath until the water boils. Turn off the Bunsen burner.

	test	*observations*
(i)	To 1 cm depth of **FA 9** in a test-tube, add 1 cm depth of dilute hydrochloric acid.	
(ii)	To 1 cm depth of **FA 9** in a test-tube, add 1 cm depth of dilute sulfuric acid.	
(iii)	To 1 cm depth of **FA 10** in a boiling-tube, add dilute sulfuric acid until no further change occurs. **Use this solution for test (iv)**.	
(iv)	To the solution left after test **(iii)** add 1 cm depth of ethanol. Place the mixture in your hot water bath and leave for approximately 3 minutes.	
(v)	To 1cm depth of **FA 9** in a test-tube add 1 cm depth of **FA 10**.	

[4]

(b) From your observations in **(a)** identify the cation present in **FA 9**. Give evidence to support your answer.

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Solution **FA 9** contains the …… ion.

supporting evidence .....

.....[2]

(c) What chemical change, involving ethanol, takes place in reaction **(iv)**? Give evidence to support your answer.

chemical change .....

supporting evidence .....

.....[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 Al foil
nitrite, NO_2^- (aq)	NH_3 liberated on heating with OH^-(aq) and Al foil, NO liberated by dilute acids (colourless NO → (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

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