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

CANDIDATE NAME	

CENTRE NUMBER							CANDIDATE NUMBER					

8383886562

CHEMISTRY **9701/34**

Advanced Practical Skills 2 **October/November 2013**

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.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
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 **11** printed pages and **1** blank page.

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International Examinations

[Turn over

For Examiner's Use

1 **FB 1** is 0.125 mol dm^{-3} hydrochloric acid, HCl.
FB 2 is an aqueous solution containing sodium hydroxide, NaOH, and sodium carbonate, Na_2CO_3.
bromophenol blue acid-base indicator

By carrying out titrations, you are to determine the percentage by mass of sodium carbonate in the mixture of sodium hydroxide and sodium carbonate in solution **FB 2**.

(a) Titration

- Fill a burette with **FB 1**.
- Pipette 25.0 cm^3 of **FB 2** into a conical flask.
- Add a few drops of bromophenol blue indicator.
- Titrate the mixture in the flask with **FB 1** until the blue-violet colour of the solution changes to yellow.
- Perform a **rough titration** and record your burette readings in the space below.

The rough titre is ……………… cm^3.

- Carry out as many accurate titrations as you think necessary to obtain consistent results.
- Make certain any recorded results show the precision of your practical work.
- Record in a suitable form below all of your burette readings and the volume of **FB 1** added in each accurate titration.

I	
II	
III	
IV	
V	
VI	
VII	

[7]

(b) From your accurate titration results, obtain a suitable value to be used in your calculations. Show clearly how you have obtained this value.

25.0 cm^3 of **FB 2** required …………….. cm^3 of **FB 1** [1]

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(c) Calculations

When the titrations were repeated using phenolphthalein as the indicator, 25.0 cm^3 of **FB 2** required 23.25 cm^3 of **FB 1**.

The following explains why different results are obtained using two different indicators.

- When **phenolphthalein** is used as the indicator, the following reactions have taken place at the end-point of the titration.

  1. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
  2. $Na_2CO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + NaHCO_3(aq)$

- When **bromophenol blue** is used as the indicator in **(a)**, the following reactions have taken place at the end-point of the titration.

  1. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
  2. $Na_2CO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + NaHCO_3(aq)$
  3. $NaHCO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$

Show your working and use appropriate significant figures in the final answer to all steps of your calculations.

(i) Calculate the number of moles of hydrochloric acid in the volume of **FB 1** calculated in **(b)**.

moles of HCl in volume in **(b)** = ... mol

(ii) Calculate the number of moles of hydrochloric acid in 23.25 cm^3 of **FB 1**.

moles of HCl in 23.25 cm^3 = ... mol

(iii) Use the following formula to calculate the number of moles of hydrochloric acid that react with the Na_2CO_3 in the titration using phenolphthalein indicator.

moles HCl = answer **(i)** – answer **(ii)** = ... mol

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(iv) Use your answer to **(iii)** to calculate the mass of sodium carbonate present in 25.0 cm^3 of **FB 2**.
[A_r : C, 12.0; O, 16.0; Na, 23.0]

mass of Na_2CO_3 in 25.0 cm^3 **FB 2** = ... g

(v) The **overall** equation for the reaction of Na_2CO_3 with HCl when bromophenol blue is used as indicator is given below.

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

Calculate the number of moles of HCl that reacted with the Na_2CO_3 in the above equation in 25.0 cm^3 of **FB 2**.

moles of HCl = ... mol

I	
II	
III	
IV	
V	
VI	

(vi) Use your answers to **(i)** and **(v)** to calculate the mass of sodium hydroxide in 25.0 cm^3 of **FB 2**.
[A_r : H, 1.0; O, 16.0; Na, 23.0]

mass of NaOH = ... g

(vii) Calculate the percentage by mass of sodium carbonate in the mixture of sodium hydroxide and sodium carbonate in **FB 2**.

FB 2 contains .... % by mass Na_2CO_3
[6]

[Total: 14]

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2 The percentage by mass of sodium carbonate in a mixture with sodium chloride can be estimated by adding a weighed sample of the mixture to a weighed **excess** of hydrochloric acid and measuring the mass of carbon dioxide evolved.
Sodium chloride does not react with hydrochloric acid.

FB 3 is 2.00 mol dm^{-3} hydrochloric acid, HC*l*.
FB 4 is a mixture of solid sodium carbonate, Na_2CO_3, and solid sodium chloride, NaC*l*.

You are to determine the mass of carbon dioxide given off when the sodium carbonate in the mixture, **FB 4**, reacts with excess hydrochloric acid.

(a) Method

Record **all** weighings, in an appropriate form, in the space below.

- Use the measuring cylinder to transfer 75 cm^3 of **FB 3** into a 250 cm^3 conical flask.
- Weigh the flask and acid, and record the mass.
- Weigh the labelled tube containing **FB 4** and record the mass.
- Tip the **FB 4** into the acid in the flask, **a little at a time**.
- When the reaction slows down, swirl the flask for 2 to 3 minutes. Reweigh the flask and its contents, and record the mass.
- Reweigh the tube labelled **FB 4** with its stopper and any residual mixture not added to the acid, and record the mass.
- Calculate the mass of the mixture, **FB 4**, added to the acid.
- Record the mass of carbon dioxide given off in the reaction. This may be calculated using the following formula.

mass of CO_2 = (mass of flask + acid) + (mass **FB 4** added) – (final mass of flask + contents)

I	
II	
III	
IV	
V	
VI	

[6]

(b) The reaction of sodium carbonate with hydrochloric acid is shown in the equation.

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

(i) Calculate the mass of sodium carbonate that reacts with the hydrochloric acid to give the mass of carbon dioxide recorded in **(a)**.
[A_r : C, 12.0; O, 16.0; Na, 23.0]

mass of Na_2CO_3 = ... g

(ii) Calculate the percentage by mass of sodium carbonate in **FB 4**.

FB 4 contains .... % by mass Na_2CO_3
[2]

(c) Mixtures of solids containing sodium carbonate can be analysed either by the procedure you used in **Question 1** or the procedure you used in **Question 2**.

The procedure used in **Question 2** is likely to give a less accurate value for the percentage of sodium carbonate.

(i) Suggest a significant source of error in the experimental method used in **Question 2**.

....

....

(ii) State whether the error identified above would increase or decrease the calculated percentage by mass of Na_2CO_3 in the mixture. Explain your answer.

....

....

....

(iii) Suggest an improvement to the experimental method or apparatus used in **Question 2** that would reduce the error given in **(i)**.

....

....
[3]

[Total: 11]

3 Qualitative Analysis

At each stage of any test you are to record details of the following.

- colour changes seen
- the formation of any precipitate
- the solubility of such precipitates in an excess of the reagent added

Where gases are released they should be identified by a test, **described in the appropriate place in your observations**.

You should indicate clearly at what stage in a test a change occurs.
Marks are **not** given for chemical equations.
No additional tests for ions present should be attempted.

If any solution is warmed, a boiling tube MUST be used.

Rinse and reuse test-tubes and boiling tubes where possible.

Where reagents are selected for use in a test, the name or correct formula of the element or compound must be given.

(a) You are provided with two solids in boiling tubes labelled **FB 5** and **FB 6**. Each solid contains one cation and one anion from those listed on pages 10 and 11.

(i) Add dilute nitric acid slowly to each boiling tube until the tube is approximately one third full. Record your observations in the space below. Keep these solutions for use in **(a)(ii)**.

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(ii) Use the solutions from **(i)** in the following tests.

test	*observations*	
	solution from **FB 5**	solution from **FB 6**
To a 1 cm depth of solution in a test-tube add aqueous sodium hydroxide, then		
add excess aqueous sodium hydroxide.		
To a 1 cm depth of solution in a test-tube add aqueous ammonia, then		
add excess aqueous ammonia.		
To a 1 cm depth of solution in a test-tube, add aqueous potassium iodide.		

(iii) From your observations, identify the cations present.

FB 5 contains .... **FB 6** contains ....

(iv) From your observations, what conclusions can be made about the anions present in **FB 5** and **FB 6**? Explain your reasoning.

....

....

....

....

[9]

(b) (i) Dissolve half of the solid **FB 7** provided in a 4 cm depth of water in a boiling tube. Carry out the following tests and complete the table.

test	*observations*	deductions about **FB 7**
To a 2 cm depth of the solution of **FB 7** in a test-tube, add a 2 cm length of magnesium ribbon.		
To a 2 cm depth of the solution of **FB 7** in a **boiling tube**, add a 1 cm depth of dilute sulfuric acid. Warm the solution and add five drops of aqueous potassium manganate(VII).		

(ii) Tip the remaining solid **FB 7** into a hard-glass test-tube. Heat the solid strongly and observe any changes. Do **not** test any gases given off. Record your observations in the space below.

(iii) Suggest a further deduction you can make about **FB 7** from your observations in **(ii)**.

....

....

[6]

[Total: 15]

Qualitative Analysis Notes

Key: [ppt. = precipitate]

1 Reactions of aqueous cations

ion	*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 solution 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 $\rightarrow$ (pale) brown NO_2 in air)
sulfate, SO_4^{2-}(aq)	gives white ppt. with Ba^{2+}(aq) or with Pb^{2+}(aq) (insoluble in excess dilute strong acids)
sulfite, SO_3^{2-}(aq)	SO_2 liberated with dilute acids; gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acids)

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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