Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY **9701/32**

Paper 3 Advanced Practical Skills 2 **May/June 2015**

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

MODIFIED LANGUAGE

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 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.
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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[Turn over

1 In this question you will determine the percentage purity of a sample of contaminated sodium carbonate. **FB 1** is a solution of the contaminated sodium carbonate. You will first dilute **FB 1** and then titrate the diluted solution using hydrochloric acid.

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

FB 1 was prepared by dissolving 125 g of contaminated sodium carbonate, Na_2CO_3, in distilled water and making the solution up to 1 dm^3.
FB 2 is 0.100 mol dm^{-3} hydrochloric acid, HCl.
methyl orange indicator

(a) Method

Dilution

- Fill the burette with **FB 1**.
- Run between 13.00 and 13.50 cm^3 of **FB 1** into the 250 cm^3 volumetric (graduated) flask. Record the volume in the space below.

volume of **FB 1** = ... cm^3

- Fill the volumetric flask to the line with distilled water. Stopper the flask and shake it to ensure thorough mixing.
- Label this flask **FB 3**.

Titration

- Rinse the burette thoroughly with distilled water and then with a little of solution **FB 2**.
- Fill the burette with **FB 2**.
- Use the pipette to transfer 25.0 cm^3 of **FB 3** into a conical flask.
- Add 5-10 drops of methyl orange indicator.
- Perform a **rough titration** and record your burette readings in the space below.

The rough titre is .... cm^3.

- Do 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 2** added in each accurate titration.

I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

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

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

(c) Calculations

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

(i) Calculate the number of moles of hydrochloric acid present in the volume of **FB 2** calculated in **(b)**.

moles of HCl = ... mol

(ii) Calculate the number of moles of sodium carbonate present in 25.0 cm^3 of **FB 3**.

moles of Na_2CO_3 = ... mol

(iii) Calculate the concentration, in mol dm^{-3}, of sodium carbonate in **FB 3**.

concentration of Na_2CO_3 in **FB 3** = ... mol dm^{-3}

(iv) Calculate the concentration, in mol dm^{-3}, of sodium carbonate in **FB 1**.

concentration of Na_2CO_3 in **FB 1** = ... mol dm^{-3}

(v) Calculate the percentage purity by mass of the sodium carbonate in the contaminated sample used to prepare solution **FB 1**.
(A_r: C, 12.0; O, 16.0; Na, 23.0)

I	
II	
III	
IV	
V	

percentage purity by mass = ... %
[5]

[Total: 14]

2 In this experiment you will determine the percentage by mass of magnesium in a mixture of magnesium and iron. To do this you will measure the heat given out by the reaction of the mixture with excess hydrochloric acid. You should assume that only the magnesium in the mixture will react with the acid.

FB 4 is the mixture of magnesium and iron.
FB 5 is 2.00 mol dm^{-3} hydrochloric acid, HCl.

(a) Method

Read through the instructions carefully and prepare a table below for your results before starting any practical work.

- Support the plastic cup in a 250 cm^3 beaker.
- Use the measuring cylinder to transfer 40 cm^3 of **FB 5** into the plastic cup.
- Weigh the stoppered container with the **FB 4** and record the mass.
- Measure and record the initial temperature of the solution in the plastic cup.
- Add all the sample of **FB 4** to the acid in the plastic cup carefully to minimise acid spray.
- Stir the mixture and record the maximum temperature that is reached.
- Weigh the stoppered container and any residual metal mixture. Record the mass.
- Record the mass of metal added to the acid.

I	
II	
III	
IV	

[4]

(b) Calculations

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

(i) Use your value for the maximum temperature rise to calculate the heat energy produced in the reaction.
(Assume that **4.2 J** are required to increase the temperature of 1.0 cm^3 of solution by 1.0 °C.)

heat energy produced = ... J

(ii) The molar enthalpy change, ΔH, for the reaction shown below is $-457\,\text{kJ mol}^{-1}$.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

Use this value and your answer to **(i)** to calculate the number of moles of magnesium in your reaction.

moles of Mg = ... mol

(iii) Use your answer to **(ii)**, to calculate the percentage by mass of magnesium in **FB 4**.
(A_r: Mg, 24.3)

percentage by mass of Mg in **FB 4** = ... %

(iv) You have assumed that only the magnesium reacts with the acid. What other assumption have you made in using this method to determine the percentage by mass of magnesium in the mixture?

....

....
[4]

(c) **(i)** Calculate the maximum percentage error in the temperature rise.

maximum percentage error = ... %

(ii) Using the same **FB 4**, the same **FB 5** and no additional apparatus, describe how you could modify the experiment to reduce this maximum percentage error in the temperature rise. Explain your answer.

....

....

....
[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) **FB 6** is a solution containing two cations and one anion. Both of the cations are listed in the Qualitative Analysis Notes on page 10.

(i) Select reagents to identify the cations in **FB 6**. Do tests using these reagents and record your results in the space below.

The cations in **FB 6** are .... and ....

(ii) The anion in **FB 6** is the nitrate ion, NO_3^-. Explain why it is difficult to confirm the presence of the nitrate ion in **FB 6** using the method outlined in the Qualitative Analysis Notes on page 11.

....

....

....
[6]

Before starting part (b), half fill a 250 cm^3 beaker with water and heat with a Bunsen burner to approximately 60 °C. You will use this as a hot water bath.
Turn off the Bunsen burner.

(b) **FB 7** is a halogenoalkane. Do the following test to determine the halogen present in **FB 7**.

test	*observations*
(i) To a 1 cm depth of ethanol in a test-tube, add a 1 cm depth of silver nitrate followed by 10 drops of **FB 7**, then	
place the test-tube in the hot water bath.	

The halogen present in **FB 7** is ....

(ii) What type of reaction has the halogenoalkane undergone?

....
[4]

(c) **FB 8** and **FB 9** each contain a single cation and a single anion. Do the following tests and record your observations.

test	*observations*
(i) To a 1 cm depth of **FB 8** in a test-tube, add **FB 9** until there is no further reaction, then	
add aqueous barium chloride or aqueous barium nitrate.	

(ii) Suggest possible identities for the ions present. You will only be able to identify one of the cations.

cation ....

anions ....

[5]

[Total: 15]

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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
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

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chloride, Cl^-(aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq))
bromide, Br^-(aq)	gives cream ppt. with Ag^+(aq) (partially soluble in NH_3(aq))
iodide, I^-(aq)	gives yellow ppt. with Ag^+(aq) (insoluble in NH_3(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) (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 manganate(VII) from purple to colourless

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