Centre Number | Candidate Number

Candidate Name _____

CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education Advanced Subsidiary Level

CHEMISTRY 8701/3

PAPER 3 Practical Test

OCTOBER/NOVEMBER SESSION 2001 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
As listed in Instructions to Supervisors

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You may use a calculator.
You are advised to show all working in calculations.
Use of a Data Booklet is unnecessary.
Qualitative analysis notes are printed on pages 6 and 7.

FOR EXAMINER'S USE	
1	
2	
TOTAL	

This question paper consists of 7 printed pages and 1 blank page.

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

[Turn over

For Examiner's Use

1 **FC 1** is a solution containing 16.75 g dm^{-3} of hydrated sodium carbonate, $Na_2CO_3.xH_2O$.
FC 2 is 0.125 mol dm^{-3} hydrochloric acid, HC*l*.

You are required to titrate the sodium carbonate solution with the acid and use your results to determine the mass of water in the hydrated sodium carbonate.

(a) Pipette 25.0 cm^3 of **FC 1** into a conical flask and add a few drops of the indicator provided.

Run **FC 2** from the burette until the appropriate colour change for the indicator you are using is achieved. This is the end-point of the titration.
Record your burette readings in Table 1.1.

Repeat the titration as many times as you think necessary to obtain accurate results.
Make certain that the recorded results show the precision of your practical work.

Table 1.1 Titration of FC 1 with FC 2

The indicator used in the titration was ……

Final burette reading / cm^3 Initial burette reading / cm^3				
Volume of **FC 2** used / cm^3				

[10]

Summary

25.0 cm^3 of **FC 1** reacted with …… cm^3 of **FC 2**.

Show which results you used to obtain this volume of **FC 2** by placing a tick (✓) under the readings in Table 1.1.

For Examiner's Use

You are advised to show full working in all parts of the calculations

(b) Calculate how many moles of the acid were run from the burette into the conical flask during the titration of **FC 1** with **FC 2**.

[1]

(c) Calculate the number of moles of anhydrous sodium carbonate, Na_2CO_3, in 25.0 cm^3 of **FC 1**.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

[1]

(d) Calculate the concentration, in mol dm^{-3}, of sodium carbonate, Na_2CO_3, in **FC 1**.

[1]

(e) Calculate the mass of anhydrous sodium carbonate present in 1.00 dm^3 of **FC 1**.
[A_r: Na, 23.0; C, 12.0; O, 16.0.]

[1]

(f) Calculate the mass of water present in the hydrated sodium carbonate.

[1]

[Total : 15]

[Turn over

For Examiner's Use

2 The solution **FC 3** contains **two cations** and **one anion** from the following list: (Al^{3+}, NH_4^+, Ba^{2+}, Ca^{2+}, Cr^{3+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Pb^{2+}, Mg^{2+}, Mn^{2+}, Zn^{2+}; CO_3^{2-}, CrO_4^{2-}, Cl^-, Br^-, I^-, NO_3^-, NO_2^-, SO_4^{2-}, SO_3^{2-}).

In all tests, the reagent should be added gradually until no further change is observed, with shaking after each addition.
Record your observations and the deductions you make from them in the spaces provided.
Your answers should include

- details of colour changes and precipitates formed,
- the names of gases evolved and details of the test used to identify each one.

You should indicate clearly at what stage in a test a change occurs, writing any deductions you make alongside the observations on which they are based.

Marks are **not** given for chemical equations.
No additional or confirmatory tests for ions present should be attempted.

Candidates are reminded that definite deductions may be made from tests where there appears to be no reaction.

Test	*Observations* [5]	*Deductions* [4]
(a) To 2 cm depth of **FC 3** in a test-tube, add dilute nitric acid.		
(b) To 2 cm depth of **FC 3** in a boiling-tube, add aqueous sodium hydroxide. Warm the solution and retain for test **(c)**.		
(c) Cool the solution remaining from test **(b)**, add aluminium foil and cautiously warm again.		

Test	*Observations*	*Deductions*
(d) To 2 cm depth of **FC 3** in a test-tube, add aqueous potassium iodide.		
(e) To 2 cm depth of **FC 3** in a boiling-tube, add dilute aqueous ammonia until in excess. Filter the mixture and then add dilute nitric acid drop by drop to neutralise the solution and then in excess.		

Summary

The cations present in **FC 3** are …… and ……

The anion in **FC 3** is ……

[1]

[Total : 10]

[Turn over

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)	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. insoluble in excess	green ppt. 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. insoluble in excess	off-white ppt. 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 → (pale) brown NO_2 in air)
sulphate, $SO_4^{2-}(aq)$	gives white ppt. with $Ba^{2+}(aq)$ or with $Pb^{2+}(aq)$ (insoluble in excess dilute strong acid)
sulphite, $SO_3^{2-}(aq)$	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
sulphur dioxide, SO_2	turns potassium dichromate(VI) (aq) from orange to green

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