Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

* 4 1 4 7 2 7 8 6 5 9 *

CHEMISTRY **9701/34**

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

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 **11** printed pages and **1** blank page.

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CAMBRIDGE
International Examinations

[Turn over

1 The concentration of aqueous ammonia used in qualitative analysis is 2 mol dm^{-3} but it is supplied in a much more concentrated form. This is referred to as '.880 ammonia'. You are to determine the concentration of '.880 ammonia' by titration of a solution of ammonia, **FB 1**, with hydrochloric acid of known concentration. The equation for the reaction is given below.

$$NH_3(aq) + HCl(aq) \rightarrow NH_4Cl(aq)$$

FB 1 is a dilute solution of ammonia, NH_3(aq). It was prepared by measuring out 5.91 cm^3 of the '.880 ammonia' and then adding distilled water until the solution had a volume of 1 dm^3.
FB 2 is 0.100 mol dm^{-3} hydrochloric acid, HCl(aq).
methyl orange indicator

(a) Method

- Fill the burette with **FB 2**.
- Use the pipette to transfer 25.0 cm^3 of **FB 1** into a conical flask.
- Add a few drops of methyl orange indicator.
- 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 achieve 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	

[7]

(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 1** 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) Use your answer to **(i)** to determine the number of moles of ammonia present in 25.0 cm^3 of **FB 1**, pipetted into the conical flask.

moles of NH_3 = ... mol

(iii) Use your answer to **(ii)** to calculate the concentration, in $mol\,dm^{-3}$, of the diluted ammonia, **FB 1**.

concentration of NH_3 (diluted) in **FB 1** = ... $mol\,dm^{-3}$

(iv) Use your answer to **(iii)** and the information on page 2 to calculate the concentration, in $mol\,dm^{-3}$, of '.880 ammonia'.

concentration of '.880 ammonia' = ... $mol\,dm^{-3}$
[3]

(d) A student analysed a different sample of concentrated ammonia and determined the concentration to be 15.0 $mol\,dm^{-3}$. Calculate the percentage difference in concentration of the '.880 ammonia' you have determined compared with that of the student.
(If you have been unable to complete the calculation, assume the concentration of '.880 ammonia' was 9.35 $mol\,dm^{-3}$. This is not the correct value.)

percentage difference in concentration = ... % [1]

[Total: 12]

2 You are to determine the enthalpy change of solution, in kJ mol^{-1}, of ammonium chloride.

FB 3 is approximately 9 g of solid ammonium chloride, NH_4Cl.
distilled water

(a) Method

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

- Weigh the plastic cup and record the balance reading.
- Add between 2.9 and 3.1 g of ammonium chloride, **FB 3**, and record the new balance reading.
- Place the plastic cup in the 250 cm^3 beaker.
- Pour 25 cm^3 of distilled water into the measuring cylinder.
- Place the thermometer in the water and record the initial temperature in the table of results.
- Pour the 25 cm^3 of distilled water into the plastic cup.
- Stir the contents of the cup and record the lowest temperature of the solution. Tilt the cup if necessary to ensure the thermometer bulb is fully immersed.
- Repeat the procedure using the other plastic cup. Use between 4.9 and 5.1 g of **FB 3** for this experiment.
- Record the mass of **FB 3** used and the change in temperature for **each** experiment.

Results

I	
II	
III	
IV	
V	

[5]

(b) **(i)** Calculate the mean mass of **FB 3** used. Give your answer to **two** decimal places.

mean mass of **FB 3** = ... g

(ii) Calculate the mean temperature change. Give your answer to **one** decimal place.

mean temperature change = ... °C

[2]

(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 NH_4Cl present in the mass of **FB 3** calculated in **(b)(i)**.
[A_r: H, 1.0; N, 14.0; C*l*, 35.5]

moles of NH_4Cl = ... mol

(ii) Use your answers to **(b)(ii)** and **(c)(i)** to calculate the enthalpy change of solution, in $kJ\,mol^{-1}$, of NH_4Cl.
(Assume that **4.2 J** of heat energy changes the temperature of $1.0\,cm^3$ of solution by 1.0 °C.)

enthalpy change = ... $kJ\,mol^{-1}$
(sign) (value)

[4]

(d) (i) Which of the two experiments in **(a)**, the first or the second, had the greater percentage error in the value calculated for the temperature change?

....

(ii) Given that the error in a single thermometer reading is $\pm 0.5\,°C$, calculate the percentage error in the temperature change for the experiment you gave in **(d)(i)**.

percentage error = ... %
[1]

(e) (i) A student suggested that it would have been better to calculate the enthalpy change for each experiment separately. What would be the advantage of this suggestion? Explain your answer fully.

....

....

....

(ii) Another student suggested that the procedure would be improved by covering the plastic cup with a lid. Explain whether this would improve the procedure.

....

....
[2]

[Total: 14]

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 4** and **FB 5** are solutions of salts each containing one cation and one anion from those listed in the Qualitative Analysis Notes on pages 10 and 11. Carry out the following tests and record your observations in the table below.

test	*observations*	
	FB 4	**FB 5**
(i) To a 1 cm depth of solution in a test-tube, add aqueous ammonia.		
(ii) To a 1 cm depth of solution in a test-tube, add a few drops of aqueous silver nitrate.		
(iii) To a 1 cm depth of solution in a test-tube add a few drops of aqueous barium chloride or barium nitrate.		

(iv) Identify both ions in **FB 4**.

cation .... anion ....

(v) Suggest the ions which may be present in **FB 5**.

cations .... anions ....

(vi) Select a reagent which could be used in a further test on **FB 5** to identify the **cation** present. Carry out your test and record your observations.

test	*observations*
To a 1 cm depth of **FB 5** in a test-tube, add	

The cation in **FB 5** is ....

[7]

(b) **FB 6** is a pale purple salt containing two cations.

(i) What does this suggest about the identity of one of the cations in **FB 6**?

....

Carry out the following tests and complete the table below.

test	*observations*
(ii) Place a spatula measure of **FB 6** in a hard-glass test-tube. Heat gently.	
(iii) Dissolve a small spatula measure of **FB 6** in a 2 cm depth of distilled water in a test-tube. Use this solution for tests **(iv)** and **(v)**.	
(iv) Pour about half the solution prepared in **(iii)** into a boiling tube and add aqueous sodium hydroxide, then	
gently warm the mixture.	
(v) To the remainder of the solution prepared in **(iii)**, add a few drops of aqueous potassium iodide, then	
add a few drops of starch solution.	

(vi) Identify the cations present in **FB 6**.

FB 6 contains .... and ....

(vii) What type of reaction occurred when potassium iodide was added to **FB 6** in **(v)**?

....

[7]

[Total: 14]

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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