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

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

8516348356

CHEMISTRY **9701/34**

Advanced Practical Skills 2 **October/November 2011**

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 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	
Total	

This document consists of **11** printed pages and **1** blank page.

DC (KN/DJ) 34822/4

UNIVERSITY *of* CAMBRIDGE International Examinations

[Turn over

For Examiner's Use

1 You are to determine the enthalpy change of neutralisation of sodium hydroxide by an acid and also the concentration of hydrogen ions in the acid. These can be found by measuring the temperature change when solutions of the acid and alkali are mixed.

FB 1 is 1.50 mol dm^{-3} sodium hydroxide, NaOH.
FB 2 is an aqueous solution of an acid.

(a) Method

- Fill a burette with **FB 1**. **[Care: FA1 is corrosive]**
- Support the plastic cup in a 250 cm^3 beaker.
- Run 10.0 cm^3 of **FB 1** from the burette into the plastic cup.
- Measure and record, in the table below, the temperature of the **FB 1** in the cup. You may need to tilt the beaker to ensure that the bulb of the thermometer is covered.
- Measure 40 cm^3 of **FB 2** using the measuring cylinder.
- Pour this volume of **FB 2** into the plastic cup containing **FB 1**. Stir carefully and measure the highest temperature obtained.
- Record this temperature in the table.
- Rinse the plastic cup with water.
- Repeat the experiment using 15.0 cm^3 of **FB 1** and 35 cm^3 of **FB 2** as shown for experiment **2** in the table.
- Carry out experiments **3** to **7** in the same way.
- Complete the table for each experiment.

Results

experiment number	1	2	3	4	5	6	7		
volume of **FB 1** / cm^3	10.0	15.0	20.0	25.0	30.0	35.0	40.0	50.0	0.0
volume of **FB 2** / cm^3	40	35	30	25	20	15	10	0	50
initial temperature **FB 1** / °C									
highest temperature / °C									
temperature change / °C								0.0	0.0

[8]

I	
II	
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VII	
VIII	

For Examiner's Use

(b) On the grid below plot the temperature **change** (y-axis) against the volume of **FB 1** (x-axis). Use **all** the results in the table including those provided in the final two columns.

Using these points, draw two straight lines that intersect.

[4]

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(c) **(i)** Use your graph and the intersection of the two lines to determine the largest temperature change which could occur in the reaction between **FB 1** and **FB 2**.

largest temperature change = ... °C

(ii) From your graph, read the volume of **FB 1** required to produce the temperature change in **(i)**.

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

(iii) Calculate how many moles of sodium hydroxide are present in the volume of **FB 1** recorded in **(ii)**.

moles of sodium hydroxide present = ... mol

(iv) Use the temperature change from **(i)** to calculate the amount of heat energy produced in the reaction.

[Assume that 4.3 J are required to raise the temperature of 1 cm^3 of any solution by 1 °C]

heat energy produced = ... J

(v) Use your answers from **(iii)** and **(iv)** to calculate the enthalpy change of neutralisation of sodium hydroxide by the acid.

Give your answer in $kJ\,mol^{-1}$ and include the relevant sign.

enthalpy change of neutralisation = ... $kJ\,mol^{-1}$

sign *value*

[7]

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VI	
VII	

(d) Identify a source of error, other than heat loss, in the experimental method. Suggest an improvement which would reduce this source of error.

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....

....

....

.... [2]

(e) (i) Calculate the concentration of hydrogen ions, H^+, in $mol\,dm^{-3}$, present in **FB 2**.

concentration of hydrogen ions in **FB 2** = ... $mol\,dm^{-3}$

(ii) If the acid present in **FB 2** is sulfuric acid, calculate its concentration.

concentration of sulfuric acid = ... $mol\,dm^{-3}$

(iii) Describe a chemical test by which you could prove that the acid in **FB 2** is sulfuric acid.

Do not carry out the test.

....

....

....

....

[4]

[Total: 25]

I	
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2 **Qualitative Analysis**

At each stage of any test you are to record the 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 full name or correct formula of the reagents must be given.

(a) **(i)** **FB 3**, **FB 4** and **FB 5** are aqueous solutions of sodium compounds. None of these compounds contains sulfur.

To about 1 cm depth of each of the solutions in separate test-tubes add the same depth of dilute sulfuric acid.

To another 1 cm depth of each of the solutions in separate test-tubes add a few drops of aqueous lead(II) nitrate.

Record your observations for these tests in an appropriate form in the space below.

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Using the Qualitative Analysis Notes printed on pages 10 and 11 and your observations identify the anions in **FB 3** and **FB 4**.

For Examiner's Use

FB 3 contains ....

FB 4 contains ....

[6]

(ii) Select a reagent or pair of reagents that would enable you to determine the identity of the anion in **FB 5**.

reagent(s) ....

Carry out a test on **FB 5** using the reagent(s) given above. Record your observations below.

....

....

....

The anion present in **FB5** is .... [3]

I	
II	
III	

(b) You are provided with solid **FB 6.** Complete the following table.

For Examiner's Use

	test	*observations*
(i)	To 1 cm depth of aqueous hydrogen peroxide in a test-tube, add a very small spatula measure of **FB 6**.	
(ii)	To 1 cm depth of aqueous iron(II) sulfate in a boiling tube, add the same depth of dilute sulfuric acid. Add a very small spatula measure of **FB 6** to the tube. Warm the mixture gently using a Bunsen burner for about 20 seconds, then filter the warm mixture and collect the filtrate.	
	To the filtrate, add aqueous sodium hydroxide.	
(iii)	To 2 cm depth of aqueous potassium manganate(VII) in a test-tube, add the same depth of aqueous sodium hydroxide and then a small spatula measure of **FB 6**. Stir the contents of the test-tube for about 20 seconds. Filter the mixture and collect the filtrate.	
	To the filtrate, add dilute sulfuric acid.	

Suggest a conclusion that could be made about the chemical behaviour of **FB 6** from the observations in **(i).** Explain the reasons for your answer.

....

....

What conclusion can be made about the chemical behaviour of **FB 6** from the observations in **(ii)**?

....

....

[6]

[Total: 15]

For Examiner's Use

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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
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 → (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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