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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1626130202

CHEMISTRY **9701/34**

Paper 32 Advanced Practical Skills **May/June 2010**

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Instructions to Supervisors

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 (SJF5449/CGW) 11614/4

UNIVERSITY *of* CAMBRIDGE
International Examinations

[Turn over

1 **Read through question 1 before starting any practical work**.

You are provided with the following reagents.

- weighing bottles/tubes labelled **FB 1**, **FB 2** and **FB 3**; each containing a different mass of sodium hydrogencarbonate, $NaHCO_3$
- additional solid sodium hydrogencarbonate (approximately 10 g)
- **FB 4**, 3.0 mol dm^{-3} hydrochloric acid, HCl

The reaction of sodium hydrogencarbonate with hydrochloric acid is endothermic.

By measuring the maximum temperature decrease when the different masses of sodium hydrogencarbonate react with hydrochloric acid you are to determine the enthalpy change of neutralisation for 1 mol of $NaHCO_3$ with HCl.

(a) Method

- Weigh the bottle/tube containing the sodium hydrogencarbonate labelled **FB 1**.
- Support the plastic cup in the 250 cm^3 beaker.
- Use the measuring cylinder to transfer 30 cm^3 of **FB 4** into the plastic cup.
- Place the thermometer in the acid in the plastic cup and record the steady temperature of the acid.
- Add the contents of the weighed tube, **FB 1**, to the acid in the plastic cup, a little at a time with constant stirring.
- You should add the solid as quickly as possible – taking care to minimise any acid spray from the plastic cup.
  Avoid breathing any fumes from the experiment.
- Record the minimum temperature obtained in the reaction.
- Reweigh the emptied tube, **FB 1**, containing any remaining solid that was not tipped from the tube.
- Empty and rinse the plastic cup. Rinse the thermometer. Shake dry the plastic cup.
- Repeat the experiment using tubes labelled **FB 2** and **FB 3**. In each experiment use 30 cm^3 of **FB 4**.

Carry out **two further experiments**.
Using the empty weighing bottles/tubes, labelled **FB 5** and **FB 6**, weigh two further masses of sodium hydrogencarbonate. Choose masses to enable you to plot an appropriate graph of temperature change against mass of sodium hydrogencarbonate.

Results
Record your results in an appropriate form showing, for each experiment, the measurements of mass and temperature and the calculated temperature fall.

i	
ii	
iii	
iv	
v	
vi	
vii	
viii	
ix	

[9]

(b) Use the grid below to plot a graph of decrease in temperature (*y-axis*) against the of sodium hydrogencarbonate added (*x-axis*).
Draw a line of best fit through the plotted points.
You should consider if the best-fit line passes through the origin (0,0) of the graph.

[4]

i	
ii	
iii	
iv	

(c) Explain why the mass of $NaHCO_3$ is plotted on the *x-axis* rather than on the *y-ax*

....

.... [1]

(d) Construct the balanced equation for the reaction of $NaHCO_3$ with hydrochloric acid.

.... [1]

(e) Calculate the gradient of your graph.
Show all of your working clearly, both construction lines on the graph and working in the calculation.

[3]

(f) Although there is insufficient acid in 30 cm^3 of **FB 4** to neutralise 1 mol of $NaHCO_3$ it is possible to calculate the theoretical fall in temperature for this reaction.
Use your answer from **(e)** to calculate this value.
[A_r: C, 12.0; H, 1.0; Na, 23.0; O, 16.0]

The theoretical fall in temperature for 1 mol of $NaHCO_3$ = ………………………. °C [1]

(g) Calculate the theoretical enthalpy change for the neutralisation of 1 mol of $NaHCO_3$ by hydrochloric acid. Give your answer in $kJ\,mol^{-1}$ and include the correct sign for the reaction.
[4.3 J are absorbed or released when the temperature of 1 cm^3 of solution changes by 1 °C.]

ΔH = ……………………… $kJ\,mol^{-1}$ [2]

(h) Suggest **two** ways in which your apparatus could be modified to reduce transfer from the surroundings to the solution in the apparatus.

modification 1 ....

....

modification 2 ....

.... [1]

(i) State and explain why the experiment would be more accurate if the volumes of **FB 4** had been measured using a burette instead of a measuring cylinder.

....

.... [1]

(j) The mass of $NaHCO_3$ used in a further experiment and its associated temperature change are shown in the tables below.

- The mass was obtained on a balance reading to 1 decimal place.
- The thermometer used was graduated at 1 °C.

Complete the table to show the errors in these results.

mass of $NaHCO_3$	5.6 g
maximum error in a single balance reading	± ………… g
% error in measured mass	………… %

temperature change	–12.0 °C
maximum error in a single thermometer reading	± ………… °C
% error in temperature change	………… %

[2]

(k) Two students add 6.0 g of sodium carbonate to 50.00 cm^3 of 2.0 mol dm^{-3} hydrochloric acid. Each student repeats the experiment a number of times.
The thermometer readings and temperature changes obtained consistently by each student are shown below.

	initial temperature / °C	final temperature / °C	temperature rise / °C
student 1	20.0	28.0	8.0
student 2	19.0	27.0	8.0

Suggest the type of error shown by these results.

.... [1]

[Total: 26]

2 **FB 7** and **FB 8** are aqueous solutions of salts. One of these contains **two** cations a
anion.
The other contains one cation and one anion.
Both **FB 7** and **FB 8** have a common cation.

You will carry out tests to deduce the following.

- the cations present in each solution
- whether a sulfate ion is present in either solution

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

- colour changes seen
- the formation of any precipitate and the colour of the precipitate

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 directly with a Bunsen burner a boiling-tube MUST be used.

Rinse and reuse test-tubes where possible.

(a) Use information from the Qualitative Analysis Notes on page 11 to select a pair of reagents that, **used together**, determine whether a sulfate ion is present in either solution.

The reagents are ………………………………………….

followed by …………………………………………. . [1]

(b) Use your chosen reagents to carry out tests on **FB 7** and **FB 8**.
Record your results in an appropriate form in the space below.

[2]

(c) From your observations in **(b)** show with a tick which of the following statements

FB 7 contains the sulfate ion	
FB 8 contains the sulfate ion	
neither solution contains the sulfate ion	

Explain the evidence that supports your conclusion.

....

.... [1]

(d) Carry out the following tests on the solutions **FB 7** and **FB 8**.
Record your observations below.

test	*observations*	
	FB 7	**FB 8**
To 1 cm depth of solution in a boiling-tube, add 2 cm depth of aqueous sodium hydroxide; then		
warm the solution gently. **Care is needed when heating aqueous sodium hydroxide.**		
To 1 cm depth of solution in a test-tube, add 2 cm depth of aqueous ammonia.		

[3]

(e) To 1 cm depth of **FB 7** in a test-tube add 1 cm depth of sodium hydroxide.
Leave to stand for a few minutes.

observation

....

.... [1]

(f) From your observations in **(d)** and **(e)** you should be able to identify the common cation in the solutions and the second cation in **one** of the solutions.

The common cation present in both solutions is ………………………. .

The second cation contained in one of the solutions is ………………………. .

Explain how your observations support your conclusions for

(i) the common cation,

....

....

(ii) the second cation.

....

....

[1]

Read through the remainder of question 2 before starting further practical work.

Heat a half-full 250 cm^3 beaker of water for use as a hot water-bath.

(g) **FB 9**, **FB 10**, **FB 11** and **FB 12** are organic compounds. Each contains one of the following different functional groups.

- primary alcohol
- secondary alcohol
- aldehyde
- ketone

You are to react each of these compounds with some of the following reagents.

- acidified aqueous potassium dichromate(VI)
- 2,4-dinitrophenylhydrazine (2,4-DNPH) reagent
- ammoniacal silver nitrate (Tollens' reagent)

You are provided with the first two reagents. You must prepare the last of these reagents, Tollens' reagent, immediately before use. Follow the instructions in the box below.

To 2 cm depth of aqueous silver nitrate in a boiling-tube add ½ cm depth of aqueous sodium hydroxide. This will produce a brown precipitate of silver(I) oxide. Add aqueous ammonia a little at a time, with continuous shaking, until the brown precipitate **just** dissolves. **Do not add an excess of aqueous ammonia**.

In each of the following tests add a few drops of the reagent to 1 cm depth o
FB 10, **FB 11** and **FB 12** in separate test-tubes.

In the tests using acidified potassium dichromate(VI) and Tollens' reagent, if no initial reaction is seen, warm that tube and its contents in your hot water-bath. There is no need to heat any tube to which you have added 2,4-DNPH reagent.

Do **not** heat any tube with a naked flame.

Record your results in the table below.

Do **not** carry out tests for the shaded boxes.

reagent	*observations*			
	FB 9	**FB 10**	**FB 11**	**FB 12**
acidified potassium dichromate(VI)				
2,4-DNPH reagent				
Tollens' reagent				

[3]

(h) State which of the solutions contain alcohols. Explain the observations leading to your conclusion.

FB …………… and **FB** …………… contain alcohols.

explanation ....

....

State which solution contains the ketone. Explain the observations leading to your conclusion.

FB …………… contains the ketone.

explanation ....

....

[2]

[Total: 14]

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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