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

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

* 1 6 1 6 3 8 6 8 3 2 *

CHEMISTRY **9701/35**

Advanced Practical Skills 1 **October/November 2012**

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 11 and 12.

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	

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1 You are to investigate the temperature change when a piece of magnesium ribbon is added to hydrochloric acid. You will measure the temperature at regular intervals during the reaction.

FA 1 is approximately 2 mol dm^{-3} hydrochloric acid, HC*l*.
You are also provided with magnesium ribbon.

Read through the instructions carefully before starting any practical work.

(a) Method

- Curl or fold the magnesium ribbon so that it will just fit in the bottom of the plastic cup. **Remove the magnesium from the cup**.
- Support the plastic cup in a 250 cm^3 beaker.
- Use a measuring cylinder to transfer 50 cm^3 of **FA 1** into the **empty** plastic cup.
- Measure and record in the table below, the initial temperature of the acid in the cup.
- Start the stop watch. Measure and record the temperature of **FA 1** in the cup after 1 minute, 2 minutes and 3 minutes.
- At time 3½ minutes, add the curled or folded magnesium to the **FA 1** in the cup and stir the mixture. Make sure the magnesium is submerged in the acid.
- From time 4 minutes, continue to measure the temperature of the contents of the cup to complete the table.

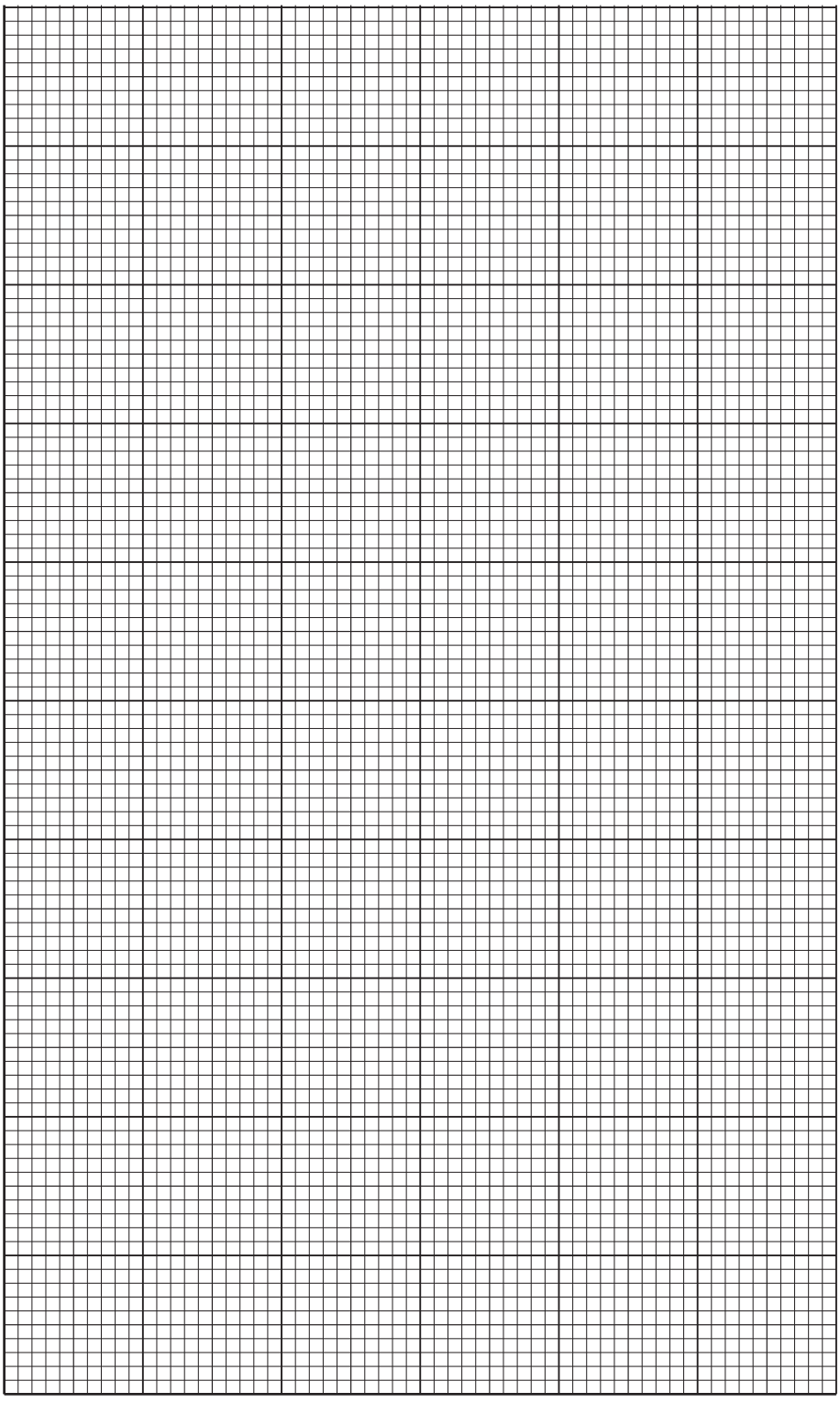
Results

time / min	0	1	2	3	4	5	6	7	8	9	10
temperature / °C											

[1]

(b) (i) On the axes opposite, plot the temperature (*y*-axis) against time (*x*-axis). The temperature axis should allow you to include a point at least 5 °C greater than the maximum temperature recorded.

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(ii) Complete the graph to show how the temperature of the contents of the cup varies with time.

- Draw one straight line through the points between time 0 minutes and 3 minutes.
- Draw one straight line through the points between time 5 minutes and 10 minutes.
- Extrapolate these two lines and draw a vertical line at time 3½ minutes.

[4]

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(c) Calculation

(i) Use your graph to determine the change in temperature at 3½ minutes.

change in temperature = ……. °C

(ii) In the experiment you have just carried out, explain how you know that the hydrochloric acid was in excess.

.....

.....

(iii) One source of error in this experiment is due to the accuracy to which the thermometer can be read.

What is the maximum error in a single temperature reading on a thermometer with graduations at 1 °C?

maximum error = ... °C

Calculate the maximum percentage error when measuring a temperature **rise** of 7.5 °C.

maximum percentage error = ... %

(iv) Apart from errors associated with the thermometer, suggest one significant source of error in the procedure used in this experiment. Suggest an improvement that could be made to reduce this error.

.....

.....

.....

(v) The experiment was repeated on another day when the temperature of the room was much higher than when the original experiment was carried out.

Discuss the effect of this higher room temperature on the results of the experiment.

.....

.....

.....

.....

[7]

[Total: 12]

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2 The concentration of the acid, **FA 2**, can be found by titrating it against aqueous sodium carbonate of known concentration.

FA 2 is hydrochloric acid, HC*l*.
FA 3 is sodium carbonate, Na_2CO_3.
methyl orange indicator

You are to determine the concentration of **FA 2**.

(a) Method

- Weigh a 100 cm^3 beaker.
- Weigh out between 1.3 g and 1.5 g of **FA 3** into this beaker.
- Record the weighings and the mass of **FA 3** added.

mass of **FA 3** = ... g

- Add about 50 cm^3 of distilled water to the beaker.
- Stir with a glass rod until all the solid has dissolved.
- Pour the solution from the beaker into the 250 cm^3 graduated (volumetric) flask.
- Wash the beaker with distilled water and add the washings to the flask.
- Make up the contents of the graduated flask to the 250 cm^3 mark with distilled water.
- Invert the flask as many times as you think necessary to mix the solution of **FA 3** thoroughly.

- Fill the burette with **FA 2**.
- Pipette 25.0 cm^3 of the solution of **FA 3** into a conical flask.
- Add methyl orange indicator.
- Titrate the solution of **FA 3** with **FA 2**.
- 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 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 **FA 2** added in each accurate titration.

I	
II	
III	
IV	
V	
VI	
VII	

[7]

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(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 **FA 3** required ..... cm^3 of **FA 2** [1]

(c) Calculations

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

(i) Calculate how many moles of sodium carbonate were present in 25.0 cm^3 of the solution you pipetted for the titration.
[A_r: C, 12.0; O, 16.0; Na, 23.0]

moles of Na_2CO_3 = ... mol

(ii) The equation for the reaction between hydrochloric acid and sodium carbonate is shown below.

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

Use your answers to **(b)** and **(c)(i)** to calculate the concentration, in mol dm^{-3}, of the hydrochloric acid, **FA 2**.

concentration of HCl, **FA 2** = ... mol dm^{-3}

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(iii) **FA 2** is hydrochloric acid, HC*l*, made using 50.0 cm^3 of **FA 1** diluted to 1.00 dm^3 with distilled water.
Calculate the concentration, in mol dm^{-3}, of the hydrochloric acid, **FA 1**.

concentration of HC*l*, **FA 1** = ... mol dm^{-3}
[5]

[Total: 13]

For Examiner's Use

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) You are provided with solutions **FA 4**, **FA 5** and **FA 6** and solid **FA 7**. Each of these contain a transition metal ion.

(i) Carry out the following tests on **FA 4**.

test	*observations*
To 1 cm depth of **FA 4** in a test-tube, add an equal depth of concentrated hydrochloric acid **with care**.	
To 1 cm depth of **FA 4** in a test-tube, add aqueous ammonia.	
To 1 cm depth of **FA 4** in a test-tube, add aqueous silver nitrate.	
To 1 cm depth of **FA 4** in a test-tube, add an equal depth of aqueous potassium iodide then,	
add a few drops of starch solution.	

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(ii) From these tests identify **FA 4**.

.....

(iii) Suggest what happened to the potassium iodide in its reaction with **FA 4**. Use your practical results to explain your answer.

.....

.....

[6]

(b) **FA 5**, **FA 6** and **FA 7** each contain compounds of the same transition element.

(i) Complete the following table.

test	*observations*
To 1 cm depth of aqueous iron(II) sulfate in a test-tube, add a few drops of **FA 5**.	
To 1 cm depth of **FA 6** in a test-tube, add an equal depth of aqueous sodium hydroxide then,	
add 1 cm depth of hydrogen peroxide.	
To 1 cm depth of **FA 6** in a test-tube, add aqueous barium chloride or aqueous barium nitrate then,	
add an excess of either hydrochloric acid or nitric acid.	
To 1 cm depth of hydrogen peroxide in a **boiling tube**, add a small spatula measure of **FA 7**.	

(ii) From these tests identify **FA 6**. Explain how your observations support this conclusion.

identity .....

evidence for cation .....

.....

evidence for anion .....

.....

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(iii) It was suggested that Fe^{2+} was oxidised when iron(II) sulfate reacted with **FA 5**.

To 1 cm depth of aqueous iron(II) sulfate in a test-tube add **FA 5** dropwise until a **pale** permanent pink colour persists.

Devise and carry out a test to show that the Fe^{2+} ions in this solution have been oxidised.

Record the test used and the result obtained in the space below.

[9]

[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
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.]

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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 $\rightarrow$ (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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