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

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

6364028069

CHEMISTRY **9701/05**

Paper 5 Planning, analysis and evaluation **October/November 2007**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
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 are advised to show all working in calculations.
Use of Data Booklet is unnecessary.

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.

For Examiner's Use	
1	
2	
Total	

This document consists of **9** printed pages and **3** blank pages.

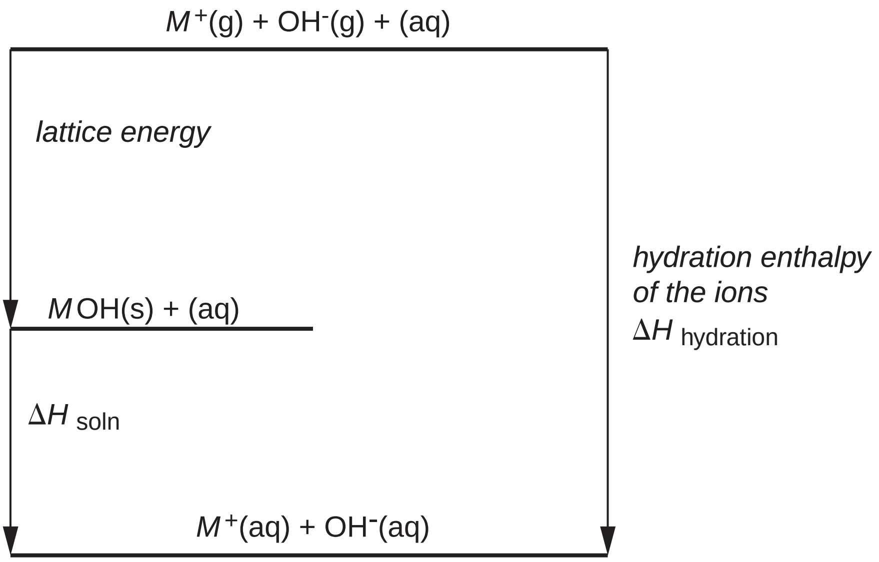
UNIVERSITY *of* CAMBRIDGE International Examinations

[Turn over

1 The hydroxides of Group I metals (LiOH, NaOH, KOH, RbOH, CsOH) are highly corrosive white solids which rapidly absorb water vapour on exposure to the atmosphere.
All of these solids dissolve exothermically in water.
The enthalpy change of solution, ΔH_{soln}, is the energy change associated with the following reaction. *M* represents the Group I metal.

$$MOH(s) + (aq) \longrightarrow M^{+}(aq) + OH^{-}(aq)$$

The following diagram represents theoretical stages in the formation of aqueous *M*OH.



Lattice energy and hydration enthalpy are both more exothermic when ions carry a higher charge and/or ions have a smaller radius.

When comparing Group I hydroxides, changes in $\Delta H_{hydration}$ are more significant than changes in lattice energy.

(a) By considering trends in the size and charge of the ions, predict the likely trend in ΔH_{soln} from LiOH to CsOH and sketch your prediction.

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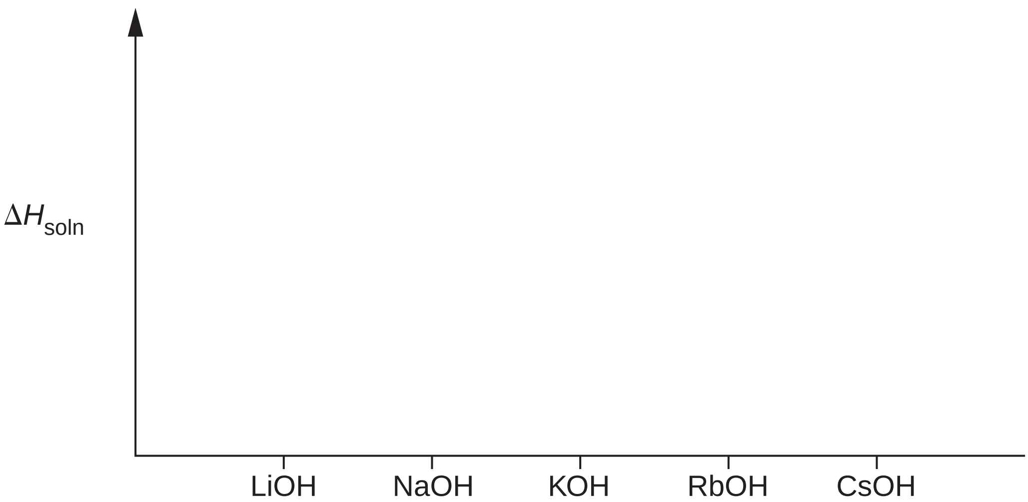

[2]

For Examiner's Use

(b) The enthalpy change of solution, ΔH_{soln}, for any Group I hydroxide can be measured experimentally in the laboratory.

In experiments to compare ΔH_{soln} for LiOH, NaOH, KOH, RbOH, CsOH state

the independent variable .... ,

the dependent variable .... ,

the other variable to be controlled ....

....
[3]

(c) Draw a labelled diagram to show the apparatus you would use to obtain data from which ΔH_{soln} could be determined.

From the information given on page 2 and the apparatus you plan to use, identify **two** possible sources of error in the experiment and state how you would minimise the effect of each.

error 1 ....

....

error 2 ....

....
[3]

(d) Identify a health and safety risk in the experiment and explain how you would minimise it when carrying out the experiment.

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.... [2]

(e) Describe the procedure you would carry out to find the enthalpy change of solution, ΔH_{soln}, for **one** of the Group I hydroxides.

Your plan should give a step-by-step description of the method, including

- how you would measure the independent variable,
- how you would measure the dependent variable,
- appropriate masses and volumes of reagents.

The following data may be of use in planning the detail of your experiment.

A_r: Li, 6.9; Na, 23.0; K, 39.1; Rb, 85.5; Cs, 133.0, O, 16.0; H, 1.0
4.3 J are required to raise the temperature of 1.0 cm^3 of any solution by 1°C.

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.... [4]

(f) The procedure is repeated for each of the Group I hydroxides.
Show how you would tabulate the results for **all** the experiments.

[1]

(g) Show how you would use the results of **one** experiment to calculate the enthalpy change of solution, ΔH_{soln}, for the reaction.

[1]

[Total: 16]

For Examiner's Use

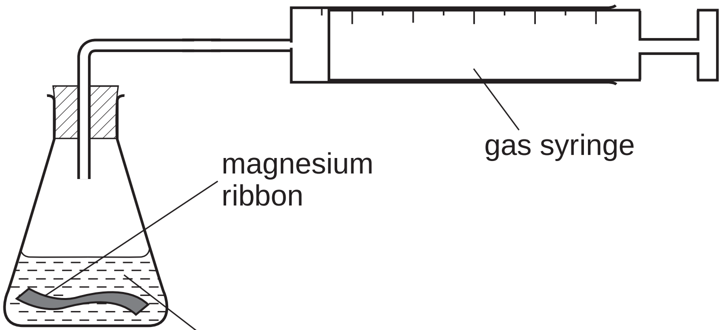
2 Students were asked to investigate how the rate of reaction between magnesium ribbon and hydrochloric acid varied with change in concentration of the acid.

$$2HCl(aq) + Mg(s) \rightarrow MgCl_2(aq) + H_2(g)$$

Student 1, looking at the equation, suggested the following.

rate of production of hydrogen gas = $k[HCl]^2$

This student used the following apparatus to investigate the rate of production of hydrogen gas, H_2.



The student used a 500 cm^3 measuring cylinder to measure 100 cm^3 of dilute acid into a conical flask.
A 1 cm length (0.01 g) of magnesium ribbon was dropped into the acid in the flask and the stopper quickly replaced in the flask.
The stop-clock was started and the volume of gas collected was measured at 0.5 minute intervals. The results of the experiment were recorded as shown in the table below.

time / min	volume of H_2 / cm^3
0.5	15.5
1.0	25.0
1.5	34.0
2.0	43.0
2.5	51.0
3.0	59.0
3.5	65.0
4.0	69.5
4.5	74.0
5.0	75.0

time / min	volume of H_2 / cm^3
5.5	80.0
6.0	82.5
6.5	85.0
7.0	87.0
7.5	87.5
8.0	91.0
8.5	92.5
9.0	93.5
9.5	94.5
10.0	95.0

(a) Plot a graph of volume of hydrogen produced against time.

[2]

(b) Identify clearly on your graph any anomalous readings and suggest a reason for these anomalous readings.

....

.... [1]

(c) On the graph you have plotted, construct a line from which you can calculate the initial rate of reaction.

Calculate the initial rate of reaction and show your working.

initial rate = ... $cm^3\,min^{-1}$ [2]

(d) By considering the experimental method described, explain why the plotted line does **not** pass through 0,0.

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.... [1]

(e) Identify a further source of error in the method described and suggest a change to the method to reduce this error.

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.... [1]

(f) Students 2-8 carried out similar experiments with different concentrations of acid.
The initial rate of reaction was calculated for each of their experiments and is shown in the table below.
Enter in the table the initial rate you have calculated for Student 1.

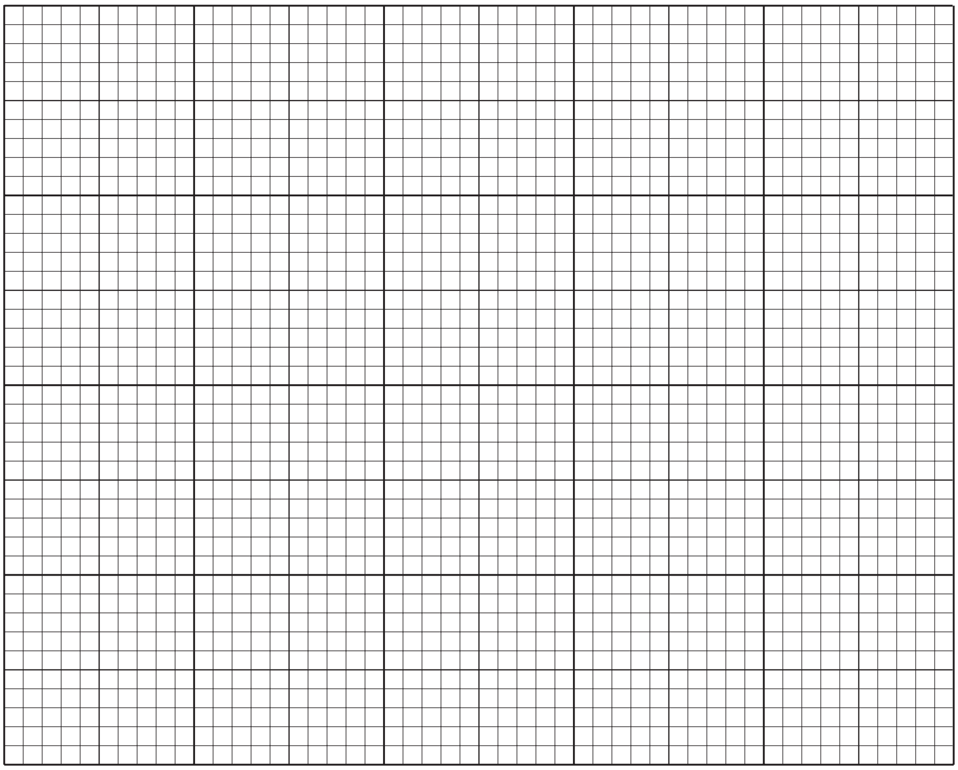
student	volume of acid used / cm^3	volume of water used / cm^3	mass of magnesium used / g	initial rate / cm^3 min^{-1}	relative concentration of acid
1	100	0	0.01		1.0
2	45	55	0.01	8.0	
3	90	10	0.01	16.4	
4	60	40	0.01	11.5	
5	100	100	0.01	9.3	
6	35	65	0.01	6.8	
7	80	20	0.01	15.2	
8	60	240	0.01	3.3	

Use the additional column of the table to record calculated values for the relative concentration of the hydrochloric acid.

$$\text{relative concentration of acid} = \frac{\text{volume of acid used}}{\text{total volume}}$$

[1]

(g) Plot the initial rate of reaction against the relative concentration of the acid.



[3]

(h) Is the prediction made by Student 1 consistent with your graph? Explain your answer.

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.... [2]

(i) Do any of the points you have plotted in **(g)** reduce your confidence in the conclusion that can be drawn? Justify your answer.

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.... [1]

[Total: 14]

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