UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0281936391

CHEMISTRY **9701/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2010**

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 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.

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.

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1	
2	
Total	

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

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1 At any temperature, equilibrium can be established between a liquid X and the vapour given off by that liquid.

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$$X\,(l) \rightleftharpoons X\,(g)$$

As the temperature of the system is raised, so the pressure exerted by the vapour increases. When the vapour pressure becomes equal to the surrounding (ambient) air pressure, the liquid boils.

When the liquid contains a dissolved solid (solute), the vapour pressure above the liquid is reduced.

You are to plan an experiment to investigate how the boiling point of an aqueous solution of potassium chloride depends on the concentration of the solution.

(a) (i) By considering how the vapour pressure changes as the concentration of the aqueous potassium chloride increases, predict and explain how the boiling point of the solution will be affected by the concentration of the solution.

Predict how the boiling point will change .....

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Explanation .....

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(ii) Display your prediction in the form of a sketch graph, labelling clearly the point representing the boiling point of pure water and its value.



[3]

(b) In the experiment you are about to plan, identify the following.

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(i) the independent variable .....

(ii) the dependent variable .....

[2]

(c) Draw a diagram of the apparatus you would use in the experiment. Your apparatus should use only standard items found in a school or college laboratory and should show clearly

(i) how the solution will be heated and over-heating of the solution prevented,

(ii) how the thermometer will be positioned. Remember you are investigating an equilibrium.

Label each piece of apparatus used, indicating its size or capacity and the temperature range that the thermometer should cover.

[3]

(d) When investigating how the boiling point of a solution changes with concentration, it is convenient to represent the concentrations of the solute as a ***molality***.

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> ***The molality of a solution is defined as the number of moles of a solute dissolved in one kilogram of water e.g. a one molal solution has one mole of solute dissolved in one kilogram of water.***

In addition to the standard apparatus present in a laboratory you are provided with the following materials.

100 g of distilled/deionised water (you should take particular note of this limited supply of water)
solid potassium chloride, KC*l*

Give a step-by-step description of how you would

(i) prepare a series of solutions of potassium chloride that can be used in the apparatus you have shown in **(c)** to give sufficient data to plot a graph as in **(a)(ii)**,

(ii) show how you would calculate the molality of one of these solutions.
[A_r: K, 39.1; C*l*, 35.5]

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(e) State a hazard that must be considered when planning the experiment.

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.....[1]

(f) State a limiting factor that must be taken into account when increasing the concentration of the aqueous potassium chloride.

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.....[1]

(g) Draw up a table with appropriate headings to show the data you would record when carrying out your experiments and the values you would calculate in order to construct a graph to support or reject your prediction in **(a)**. The headings should include the appropriate units.

[2]

[Total: 15]

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[Turn over

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2 When aqueous sodium hydroxide, NaOH, is added to aqueous copper(II) sulfate, $CuSO_4$, a precipitate of copper(II) hydroxide, $Cu(OH)_2$, is produced.
The stoichiometric equation for this reaction is

$$CuSO_4\,(aq) + 2NaOH\,(aq) \longrightarrow Cu(OH)_2\,(s) + Na_2SO_4\,(aq)$$

An experiment was carried out to investigate this stoichiometry.

- A weighed sample of copper(II) sulfate-5-water, $CuSO_4.5H_2O$, was completely dissolved in distilled water.
- An **excess** of aqueous sodium hydroxide was added.
- The resultant precipitate was filtered off.
- The precipitate was washed thoroughly and completely dried.
- The mass of the precipitate was recorded.

(a) Calculate the relative formular mass, M_r, of each of the following.
[A_r: Cu, 63.5; S, 32.1; O, 16.0; H, 1.0]

$CuSO_4.5H_2O$	$Cu(OH)_2$
M_r	M_r

[1]

(b) The results of the experiment are recorded below.

A	B	C	D	E
mass of $CuSO_4.5H_2O$ /g	mass of $Cu(OH)_2$ /g			
2.50	0.78			
6.24	1.95			
9.99	3.12			
14.98	4.20			
19.97	6.24			
24.96	7.80			
29.95	9.36			
34.94	11.81			
42.43	13.26			

Process the results in the table to calculate the number of moles of $CuSO_4.5H_2O$ used and the number of moles of $Cu(OH)_2$ produced, to enable you to plot a graph to show the relative number of moles of the $CuSO_4.5H_2O$ and $Cu(OH)_2$.
Record these values to **three** decimal places in the additional columns of the table. You may use some or all of the columns.
Label the columns you use.
For each column you use, include units where appropriate and an expression to show how your values are calculated.
You may use the column headings A to E in your expressions. [2]

(c) Why was it **not** necessary to know the concentration of the aqueous sodium hydroxide?

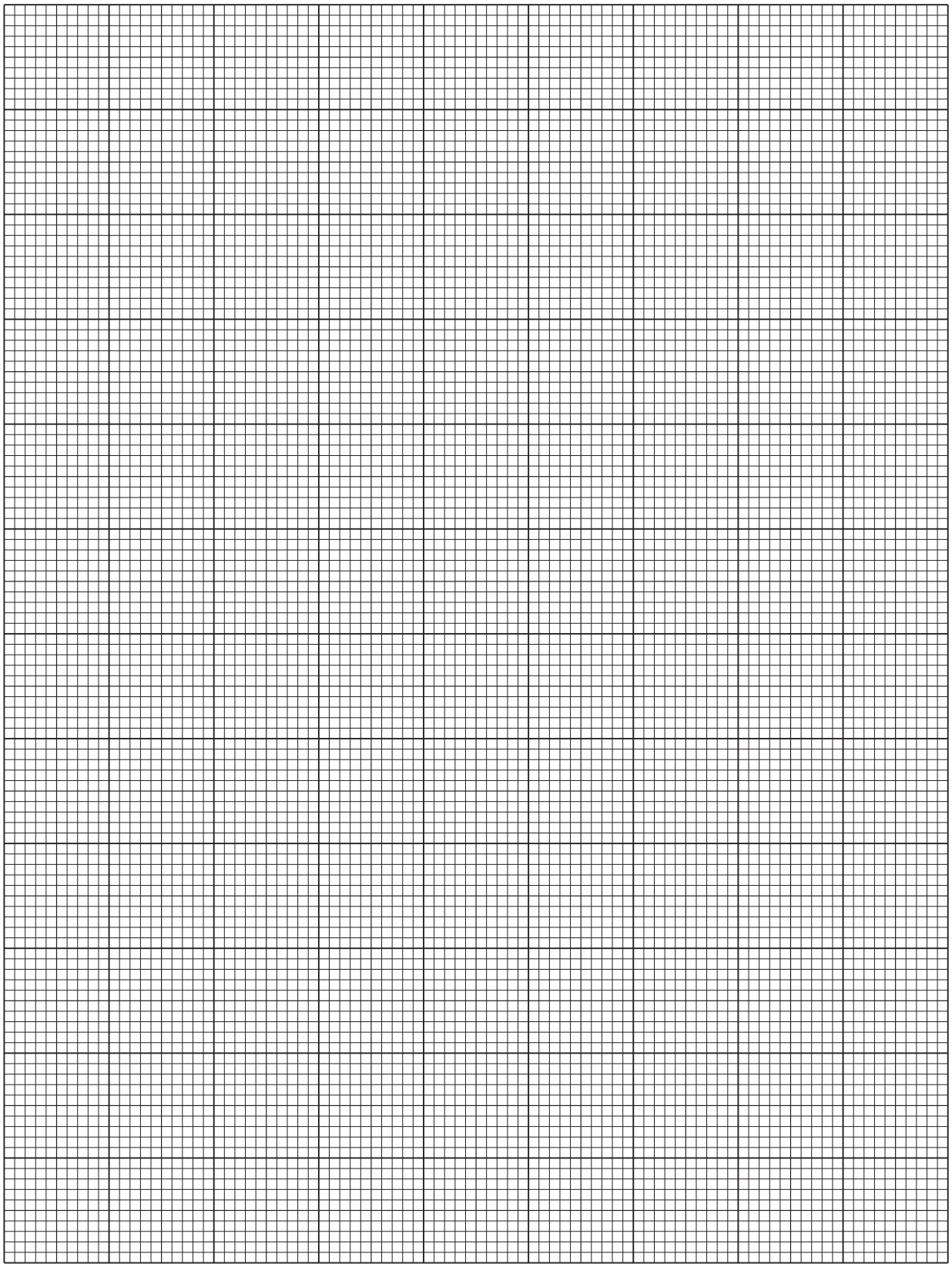
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.....[1]

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(d) Present the data calculated in **(b)** in graphical form. Draw the line of best fit.

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[3]

(e) Circle on the graph any point(s) you consider to be anomalous.
For any point circled on the graph suggest an error in the conduct of the experiment that might have led to an anomalous result.

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(f) Determine the slope of the graph. Mark clearly on the graph any construction lines and show clearly in your calculation how the intercepts were used in the calculation of the slope.

[3]

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(g) State whether the result in **(f)** confirms or not the stoichiometry of the equation for the reaction between aqueous copper(II) sulfate and aqueous sodium hydroxide.

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Comment on your conclusion.

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[2]

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