UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5752601311

CHEMISTRY **9701/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2011**

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 Reactions involving two aqueous solutions are dependent on collisions occurring between the particles of the two reagents.

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As the temperature of the system is raised, the average kinetic energy of the particles increases.

You are to plan an experiment to investigate how the rate of the reaction between hydrochloric acid and sodium thiosulfate, $Na_2S_2O_3$, depends on the temperature of the reaction. When these two reagents react, after a short period they slowly produce a white or yellow precipitate of sulfur. As more sulfur is produced, the reaction mixture becomes more cloudy until it cannot be seen through (i.e. it is opaque). The time taken for the mixture to become opaque can be dependent on the relative concentrations of the reagents or the temperature of the reaction mixture.

(a) (i) Predict how the rate of reaction will change if the temperature of the reagents is **increased**. Using the idea of how the kinetic energy of the particles changes as the temperature of the reagents **increases**, explain your prediction in terms of particle collisions.

prediction.....

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explanation.....

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(ii) Display your prediction in the form of a sketch graph, clearly labelling the axes.



[3]

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

(i) the independent variable .....

(ii) the dependent variable .....

[2]

(c) Draw a diagram of the apparatus and experimental set up you would use to carry out this experiment. Your apparatus should use only standard items found in a school or college laboratory and show clearly the following.

(i) the apparatus used as the reaction vessel and how the thermometer will be positioned in order to measure the temperature of the solution as accurately as possible

(ii) how the solution will be heated

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

[2]

(d) Using the apparatus shown in **(c)** design a laboratory experiment to test your prediction in **(a)**.

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

0.100 mol dm^{-3} aqueous sodium thiosulfate,
1.00 mol dm^{-3} hydrochloric acid,
A stop-watch/clock with second hand.

Give a step-by-step description of how you would carry out the experiment by stating

(i) the number of experiments you would do, and their temperature range (minimum and maximum temperatures),

(ii) what you would keep constant in all the experiments,

(iii) what temperature measurements you would make,

(iv) how you would use the cloudiness (opacity) of the reaction mixture to measure the time taken for each reaction.

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(e) State a hazard that must be considered when planning the experiment and describe precautions that should be taken to keep risks to a minimum.

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..... [1]

(f) Draw 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 section **(a)**. The headings **must** include the appropriate units.

[2]

[Total: 15]

2 The solubility of potassium chlorate(V) in water increases with temperature. The units of solubility are grams per one hundred grams of water (g / 100g water).

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An experiment is carried out to investigate this solubility.

- An empty boiling tube was weighed and the mass recorded.
- Some distilled water was added to the boiling tube and the new mass recorded.
- A small sample of potassium chlorate(V) was added and this new mass recorded.
- The boiling tube was carefully heated with stirring until all the solid had dissolved.
- The apparatus was allowed to cool slowly while constantly stirring and the temperature recorded when the first crystals appeared in the tube.

(a) The results of several such experiments are recorded below.

A	B	C	D	E	F	G
crystallising temperature / °C	mass of boiling tube /g	mass of boiling tube and water /g	mass of boiling tube, water and solid /g			
20.0	10.10	35.10	36.85			
25.0	10.20	35.20	37.45			
30.0	9.80	29.20	31.20			
40.0	9.95	32.95	36.55			
45.0	10.35	30.35	33.45			
50.0	9.90	34.90	39.40			
60.0	9.70	30.70	35.53			
65.0	9.95	33.95	40.07			
70.0	10.45	30.45	36.15			
75.0	10.35	35.35	42.75			
80.0	10.05	35.05	44.05			
90.0	10.10	40.10	53.90			

Process the results in the table to calculate the solubility in g / 100 g of the potassium chlorate(V) for each of the temperatures listed.

Record these values to **two decimal places** in the additional columns of the table. You may use some or all of the columns.

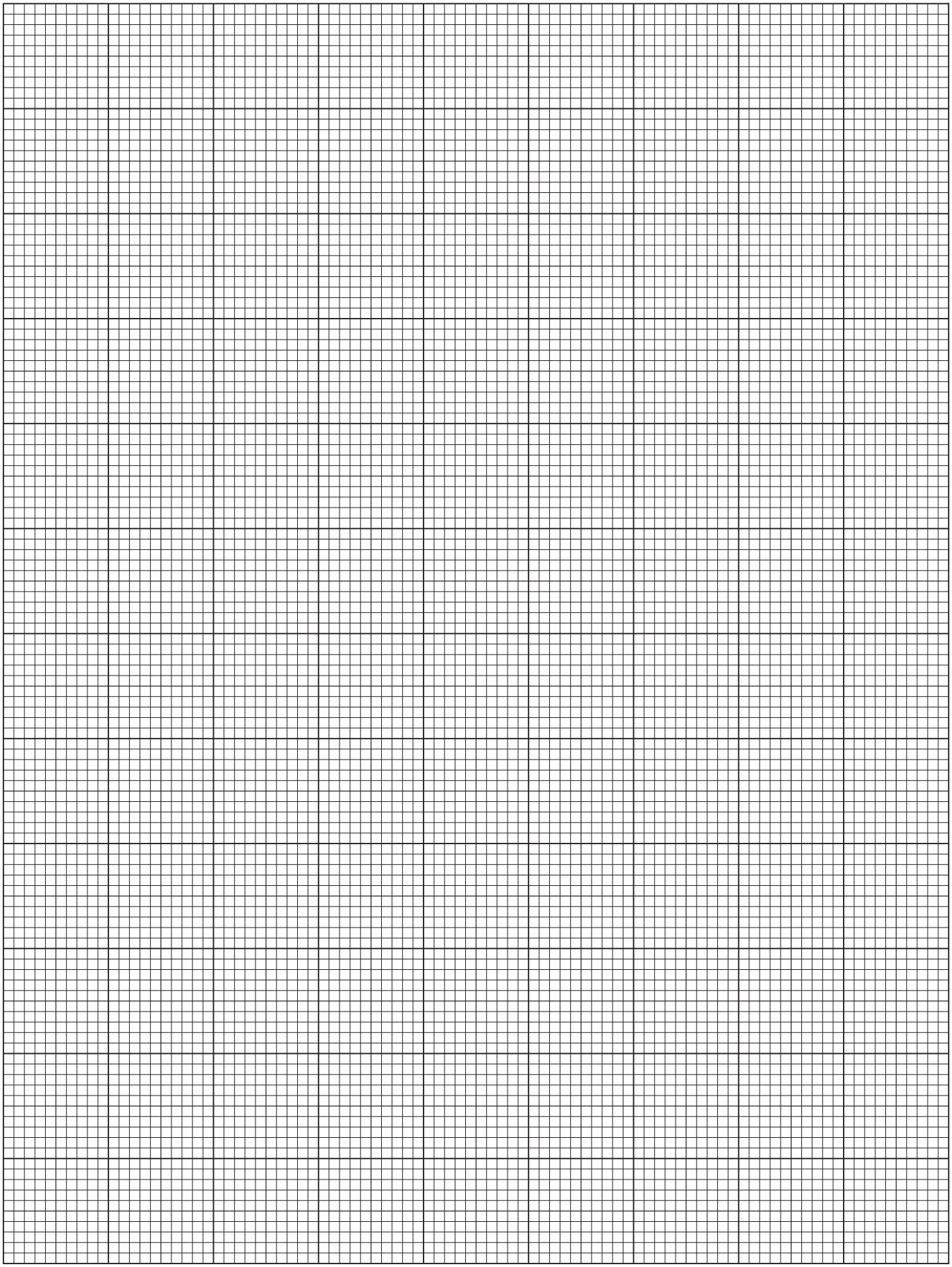
Label the columns you use.

For each column you use include units where appropriate and an expression to show how your values are calculated.

Use the column headings A to G for these expressions (e.g. A–B). [3]

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(b) Plot a graph to show the variation of solubility with temperature.
Draw the line of best fit.



[4]

(c) Circle and label on the graph any point(s) you consider anomalous.
For each anomalous point give a different reason why it is anomalous clearly indicating which point you are describing.

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(d) A solution of potassium chlorate(V) is made up using 50 g of water. This is found to be saturated at 85 °C. The solution is then cooled to 35 °C. Using your graph calculate the mass of solid deposited as a result of this temperature change.

[2]

(e) From the pattern of solubility demonstrated by your graph predict and explain whether the dissolving of potassium chlorate(V) in water is an exothermic or an endothermic reaction.

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prediction

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explanation

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[Total: 15]

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