UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6810082153

CHEMISTRY **9701/51**

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	

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1 The carbonates of group II in the periodic table decompose on heating forming an oxide and carbon dioxide.
X is any group II cation (e.g. Mg^{2+})

$$XCO_3 \rightarrow XO + CO_2$$

This decomposition occurs because the positively charged cations polarise (distort) the C—O bond in the carbonate ion causing the ion to break up. The charge density of the group II cations decreases down the group. This affects the decomposition rate.

> You are to plan an experiment to investigate how the rate of decomposition of a group II carbonate varies as the group is descended. The rate can be conveniently measured by finding the time taken to produce the same volume of carbon dioxide from each carbonate.

(a) (i) Predict how the rate of decomposition of the group II carbonates will change as the group is descended.

Explain this prediction in terms of the charge density of the cation as the group is descended.

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]

(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 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 to heat the carbonate

(ii) how the carbon dioxide will be collected

Label each piece of apparatus used, indicating its size or capacity.

[2]

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[Turn over

(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,

samples of the carbonates of magnesium, calcium, strontium and barium,
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 gas volume you would collect from each carbonate,

(ii) how you would calculate the mass of each carbonate to ensure that this volume of carbon dioxide is produced,

(iii) how you would control the factors in the heating so that different carbonates can be compared.

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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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.....[2]

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

[2]

(g) This simple experiment is likely to produce only approximate results.
Suggest an improvement to your apparatus or an alternative apparatus that may improve the reliability of the results.

[1]

[Total: 16]

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[Turn over

2 When sodium nitrate, $NaNO_3$, is heated, it decomposes into sodium nitrite, $NaNO_2$, and oxygen.
A suggested equation is:-

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$$2NaNO_3 \rightarrow 2NaNO_2 + O_2$$

An experiment was carried out to attempt to confirm this.

- An empty boiling tube was weighed and the mass recorded.
- A sample of sodium nitrate was added to the boiling tube and the new mass recorded.
- The boiling tube and sodium nitrate was heated strongly for five minutes and then allowed to cool back to room temperature.
- The boiling tube and contents was then reweighed and the mass recorded.

(a) Calculate the relative molecular masses (M_r) of $NaNO_3$ and $NaNO_2$.
[A_r: N, 14.0; O, 16.0; Na, 23.0]

[1]

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

A	B	C	D	E	F	G
mass of boiling tube / g	mass of boiling tube + $NaNO_3$ / g	mass of boiling tube + $NaNO_2$ / g				
9.90	13.10	12.50				
10.05	14.73	13.91				
10.25	14.20	13.46				
9.80	12.67	12.65				
9.60	14.56	13.63				
10.30	15.80	14.76				
11.05	17.18	15.50				
10.00	17.00	15.68				
9.75	17.65	16.16				
10.15	18.48	16.84				

Process the results in the table to calculate the number of moles of sodium nitrate and the number of moles of sodium nitrite.

Record these values in the additional columns of the table. You may use some or all of the columns.

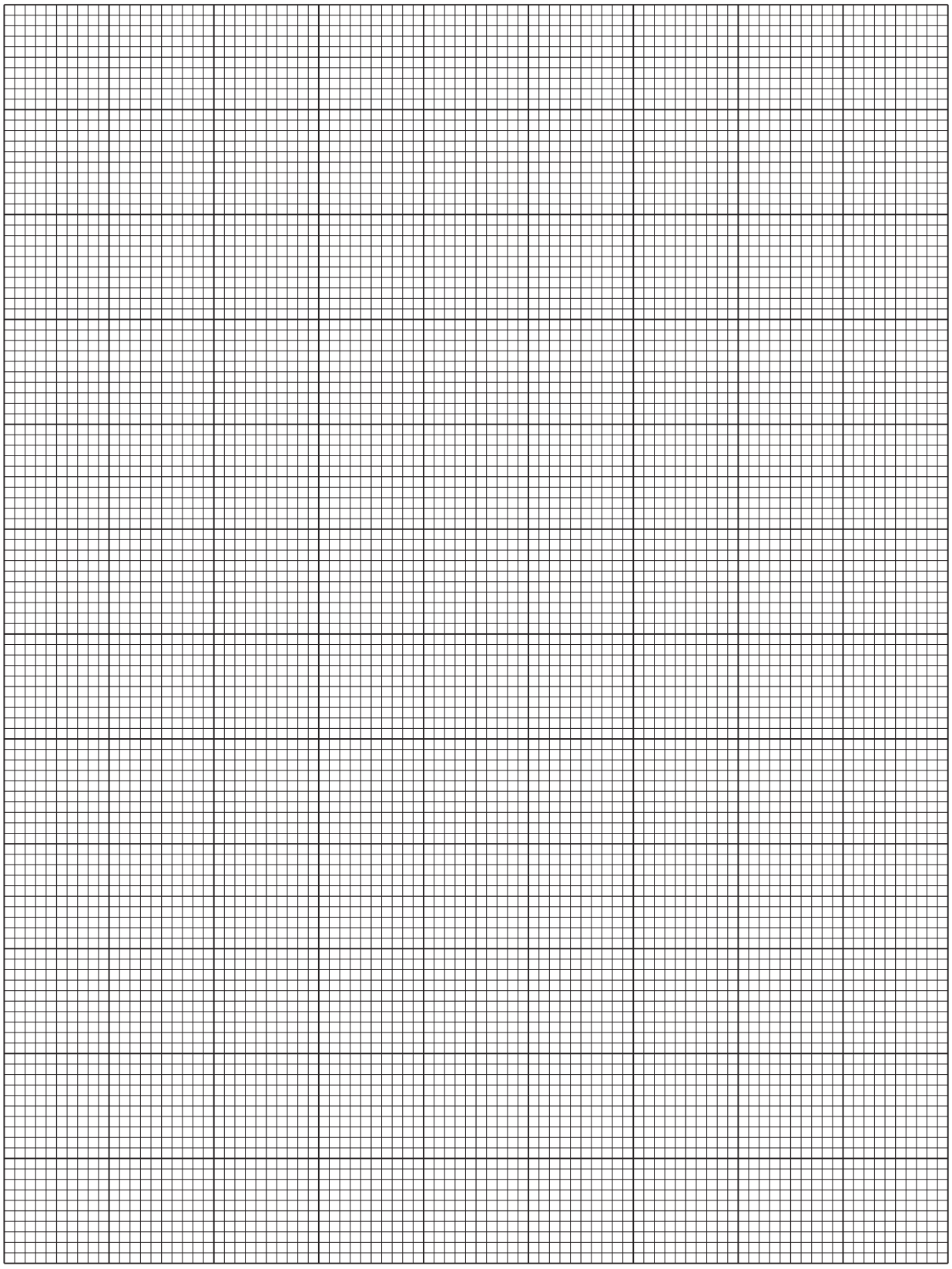
Masses should be recorded to **two decimal places**. Numbers of moles should be recorded to **two significant figures**.

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 G for these expressions (e.g. A–B). [2]

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(c) Plot a graph to show the relationship between the number of moles of sodium nitrate and the number of moles of sodium nitrite.
Draw the line of best fit.

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[3]

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

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.....[3]

(e) 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]

(f) **(i)** Does the value of the slope of your graph calculated in **(e)** confirm the equation given in **(a)** or not?

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(ii) Explain your answer in **(f)(i)** above.

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[2]

[Total: 14]

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