UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

4932589992

CHEMISTRY **9701/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2012**

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 There are three oxides of lead, PbO, PbO_2 and Pb_3O_4, all of which can be reduced to metallic lead by hydrogen.

The following information gives some of the hazards associated with these compounds.

Lead oxides
Lead(II) oxide (PbO) **Lead(IV) oxide** (PbO_2) **Dilead(II) lead(IV) oxide** (Pb_3O_4)
Toxic Dangerous for the environment
Harmful by inhalation and if swallowed. Danger of cumulative effects.

Hydrogen Extremely flammable. Readily forms an explosive mixture with air. Mixtures between 4 and 74 % by volume are explosive.

An unknown sample of an oxide of lead can be identified by investigating the molar ratio of oxygen atoms to lead atoms.

You are to plan an experiment to investigate the molar ratio of oxygen atoms to lead atoms in the oxide sample. Your plan should result in a correct identification of the oxide.

(a) Calculate the number of moles of oxygen atoms that combine with one mole of lead atoms in each of the three oxides.

[2]

(b) Draw a sketch graph to show how the number of moles of oxygen atoms varies with the number of moles of lead for lead(II) oxide, PbO. Draw two more sketch graphs to show this relationship for the other two oxides.
Label clearly each axis and each graph.



[2]

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

(i) the independent variable .....

(ii) the dependent variable .....

[1]

(d) Draw a diagram of the apparatus and experimental set up you would use to determine the chemical formula of the oxide. Your apparatus should use only standard items found in a school or college laboratory and should show clearly

(i) how the hydrogen gas needed for the reduction is prepared, naming the chemicals (reagents) to be used,

(ii) how the oxide of lead will be heated,

(iii) how any excess hydrogen is dealt with safely.

Label each piece of apparatus used.

[3]

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[Turn over

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(e) Using the apparatus shown in **(d)**, design a laboratory experiment which will enable you to determine the chemical formula of the oxide.

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

(i) stating a suitable mass of the oxide of lead,

(ii) stating how you would ensure that the decomposition is complete,

(iii) showing by calculation the minimum volume of hydrogen, measured at 25 °C, that would be needed to reduce the mass of oxide of lead stated in **(i)** above. For calculation purposes, you may assume that the oxide of lead is PbO,

(iv) stating how you would use your results to reach a conclusion.

[A_r: H, 1.0; O, 16.0; Pb, 207.0; the molar volume of a gas at 25 °C is 24.0 dm^3]

[4]

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(f) State one hazard that must be considered when planning the experiment and describe a precaution that should be taken to minimise the risk from this hazard.

.....

.....

.....

..... [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 determine graphically the formula of the oxide. The headings should include appropriate units.

[2]

[Total: 15]

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2 In aqueous solution, glucose can be slowly hydrolysed. The reaction appears to be first-order with respect to the glucose. As the hydrolysis proceeds, samples of the glucose solution can be analysed at regular intervals and the concentrations recorded.
If the reaction is first-order, the following equation can be used to verify this.

$$\log_{10} a - \log_{10}(a\text{-}x) = kt$$

where a is the initial concentration of glucose, x is the decrease in the concentration of the glucose, a-x is the glucose concentration at any time t and k is a constant.

A plot of $\log_{10}(a\text{-}x)$ against time will be linear for a first-order reaction and the slope will be equal to –k.

(a) The experimentally determined values of such a hydrolysis experiment carried out at 298 K are recorded below.

You should use a value of 1.000 mol dm^{-3} for a.

Process the results in the table to enable you to plot a graph of $\log_{10}(a\text{-}x)$ against time t.

Record these values to **three significant figures** in the additional columns of the table.

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

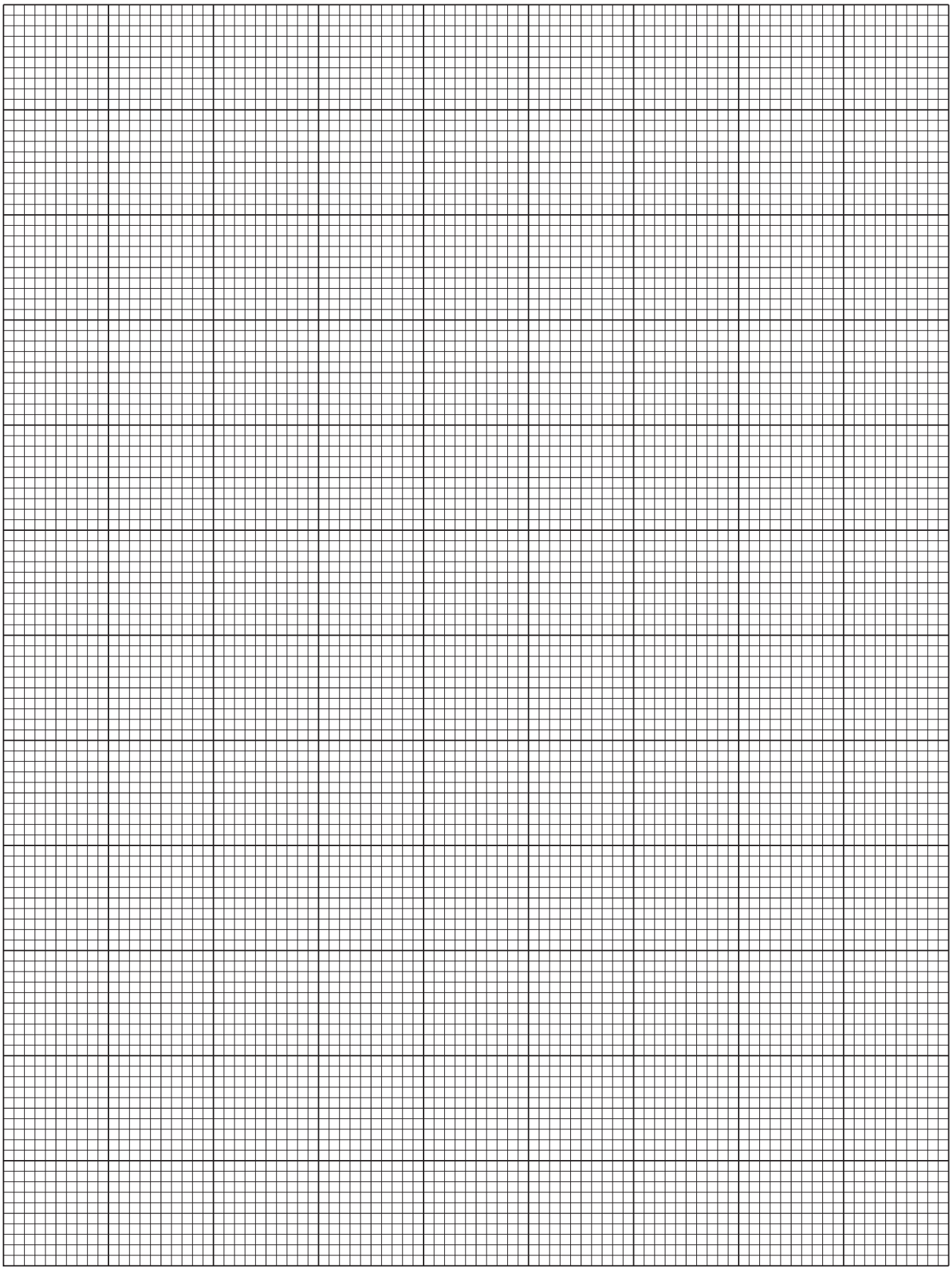
You may use the column headings A to D in these expressions (e.g. A-B).

A	B	C	D
time / min	decrease in the glucose concentration / mol dm^{-3}		
0	0.000		
30	0.101		
60	0.193		
100	0.259		
130	0.370		
180	0.469		
210	0.551		
240	0.573		
270	0.617		
300	0.655		

[2]

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(b) Present the data calculated in **(a)** in graphical form. Draw the line of best fit.
In plotting this graph, it is necessary to show an origin for both axes.
Remember that the values of $\log_{10}(a-x)$ are negative.



[3]

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

.....

.....

.....

..... [3]

(d) Comment on the reliability of the data provided in **(a)**.

.....

.....

..... [1]

(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.
Record the value of the slope to **three significant figures** with appropriate units.

[3]

(f) Do the results and your graph confirm the relationship $\log_{10} a - \log_{10} (a-x) = kt$?
Explain your answer.

[1]

(g) On your graph, draw another line to show how an increase in temperature would affect your results. [2]

[Total: 15]

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