UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

0337350796

CHEMISTRY **9701/53**

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	
3	
Total	

This document consists of **8** printed pages.

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UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

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1 The particles of a gas are considered to be in constant random motion. For a fixed mass of gas in a container, the particles collide with the container walls and it is these collisions that are responsible for the pressure exerted by the gas.

The more frequent the collisions, the greater the pressure. If the temperature is kept constant, the average kinetic energy of the gas remains constant. A temperature increase means an increase in this average kinetic energy.

(a) **(i)** Predict how the pressure of a fixed mass of gas held at a constant temperature varies as the volume of the gas decreases. Explain this prediction in terms of the frequency of the gas collisions with the container walls.

Predict how the pressure will change ....

....

Explanation ....

....

....

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

(iii) Sketch a second graph showing how your projected relationship will change if the temperature of the fixed mass of gas is increased. Label this second graph clearly. [3]

(b) If you were to carry out an experiment to investigate how the **pressure** of a fixed mass of gas varies as the **volume decreases**, name

(i) the independent variable ....

(ii) the dependent variable .... [2]

[Total: 5]

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2 Copper has two oxides, Cu_2O and CuO.
Copper(II) carbonate, $CuCO_3$, decomposes on heating to form one of these oxides. Separate equations can be written showing the two possible decompositions.

2.1 $2CuCO_3(s) \rightarrow Cu_2O(s) + 2CO_2(g) + \frac{1}{2}O_2(g)$

2.2 $CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$

The following information gives some of the hazards associated with copper(II) carbonate.

Copper(II) carbonate; Harmful if swallowed. Dispose of by reacting no more than 60 g in 1 dm^3 of warm 1 mol dm^{-3} ethanoic acid before pouring down a foul-water drain. This procedure should be kept to a minimum.

You are to plan an experiment to investigate the decomposition of copper(II) carbonate on heating and hence decide which of the two equations represents the actual decomposition. The volume of gas liberated per mole of copper(II) carbonate depends on which equation is correct and this should be used as the basis of the plan.

(a) Draw a diagram of the apparatus and experimental set up 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 copper(II) carbonate will be heated,

(ii) how the volume of the gas evolved will be collected and its volume measured.

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

[3]

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(b) Using the apparatus shown in **(a)**, design a laboratory experiment which will enable you to determine the way in which copper(II) carbonate decomposes on heating.

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

a sample of copper(II) carbonate

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

(i) calculating the volume of gas evolved by decomposing 1 mole of copper(II) carbonate according to equation **2.1**.

(ii) calculating the volume of gas evolved by decomposing 1 mole of copper(II) carbonate according to equation **2.2**.

(iii) using these results to calculate a mass of copper(II) carbonate that would give volumes of gas that could be collected using the apparatus proposed, under either decomposition.

(iv) stating how you would ensure that the decomposition is complete.

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

[A_r: C, 12.0; O, 16.0; Cu, 63.5; the molar gas volume at 25 °C is 24.0 dm^3]

[5]

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

....

....

....

....

.... [2]

[Total: 10]

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3 **(a)** The concentration of aqueous sulfuric acid can be determined by measuring the density of the solution.
In order to establish a calibration graph, various solutions of known percentage composition by mass were set up using very accurate apparatus.
The preparation of aqueous sulfuric acid is exothermic. Once each of the solutions had cooled, the actual density was determined using a hydrometer.
The table below shows some of the calculations involved, together with the measured densities.
To calculate the actual volumes of sulfuric acid and water mixed, the mass was used in conjunction with the appropriate density.
The density of pure water is 0.997 $g\,cm^{-3}$ and the density of pure sulfuric acid is 1.826 $g\,cm^{-3}$.
All measurements were carried out at 25 °C.

percentage by mass of sulfuric acid	mass of sulfuric acid / g	mass of water / g	volume of sulfuric acid / cm^3	volume of water / cm^3	total volume of 100 g of solution / cm^3	calculated density of the solution / $g\,cm^{-3}$	measured density of the solution / $g\,cm^{-3}$
0	0.000	100.000	0.000	100.301	100.301	0.997	0.997
10	10.000	90.000	5.476	90.271	95.747	1.044	1.064
20	20.000	80.000		80.241	91.194		1.137
30	30.000	70.000	16.429	70.211	86.640	1.154	1.215
40	40.000	60.000			82.087	1.218	1.299
50	50.000		27.382		77.532		1.391
60	60.000	40.000	32.859	40.120		1.370	1.494
70	70.000	30.000	38.335	30.090			1.606
80	80.000	20.000	43.812		63.872	1.566	1.722
90	90.000	10.000		10.030		1.686	1.809
100	100.000	0.000	54.765	0.000	54.765	1.826	1.826

Complete the table. You may use the space below for any working for your calculations.

[4]

(b) On the grid below, using appropriate scales and labelled axes, plot **two** curves to show the variation of **both** the calculated densities **and** the measured densities against the percentage of sulfuric acid. Label each curve.

[4]

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(c) (i) Using your curves, deduce the difference between the calculated and measured densities for the 45 % by mass of sulfuric acid mixture. State which of the two has the larger density.

(ii) By considering the molecular structures of the two liquids, suggest an explanation for the difference.

....

....

....

.... [3]

(d) You have 100.000 g of a 60 % by mass sulfuric acid mixture of a **calculated density** of 1.370 g cm^{-3}. Calculate the mass of water you would need to add to the 100.000 g in order to give a final **calculated density** of 1.154 g cm^{-3}.

[2]

(e) Attempting to determine the measured density of aqueous sulfuric acid in a school / college laboratory would involve using less accurate apparatus than in **(a)**.
Calculate the errors that could arise when measuring both the mass and volume of 100 g of sulfuric acid using a balance accurate to the nearest 0.01 g and a 100 cm^3 measuring cylinder accurate to the nearest 0.25 cm^3.

mass error

volume error

[2]

[Total: 15]