UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Subsidiary Level and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **9701/05**

Paper 5 Planning, analysis and evaluation **May/June 2007**

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.

Answer **all** questions.
You are advised to show all working in calculations.
Use of 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.

For Examiner's Use	
1	
2	
Total	

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

1 Hydrochloric acid and magnesium ribbon react to produce hydrogen gas.

$$2HCl(aq) + Mg(s) \rightarrow MgCl_2(aq) + H_2(g)$$

You are to plan the details of an experiment, based on the volume of gas produced in the reaction, to investigate how the rate of reaction depends on the concentration of the hydrochloric acid.

(a) Using scientific knowledge linking molecular or ionic collisions to rates of reaction, predict the relationship between

(i) the rate of formation of hydrogen gas and the concentration of the hydrochloric acid,

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(ii) the rate of formation of hydrogen gas and the temperature of the reaction.

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[2]

(b) In an experiment to determine the rate of reaction with respect to HCl identify the independent variable.

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(c) Identify **one** variable, other than temperature, that must be controlled in the experiment.

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For Examiner's Use

(d) Design a laboratory experiment that you would use to investigate your prediction in **(a)(i)**.

You are provided with the following.

magnesium ribbon
2 mol dm^{-3} hydrochloric acid

Your plan should give a step-by-step description of the method, including

(i) a list of the apparatus you would use,
(ii) how you would measure the independent variable and how you would ensure that its value has been measured accurately,
(iii) how you would mix the reactants without loss of gas from the apparatus,
(iv) how you would measure the dependent variable,
(v) how you would control the other variables,
(vi) appropriate quantities (volumes, relative concentrations) to use in the experiment.

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(i)	
(ii)	
(iii)	
(iv)	
(v)	
(vi)	
(vii)	

For Examiner's Use

[7]

(e) Prepare a table that you could use to record all of the data from the experiment. Include columns for processing the data recorded.
Explain how you would use the data to confirm or reject your prediction in **(a)(i)**.

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(f) Describe how you would alter the method to investigate how the rate of reaction varies with changing temperature.

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[Total: 15]

[Turn over

2 A chloride of mercury has the formula $HgCl_x$.

The formula of the chloride can be determined experimentally. A solution of the chloride in water is reduced to mercury metal by the addition of hypophosphorous acid, H_3PO_2.

Method

- A 100 cm^3 beaker is weighed empty and then with $HgCl_x$.
- The solid is dissolved in distilled water.
- The resulting solution is heated in a water bath.
- 10 cm^3 of hypophosphorous acid is added from a measuring cylinder.
- The mixture is stirred and heated for a further 5 minutes.
- The aqueous solution remaining after the reaction is poured off to leave droplets of mercury in the bottom of the beaker.
- The mercury is washed several times with distilled water, discarding the wash water each time.
- The beaker and mercury are dried by rinsing several times with propanone which dissolves any remaining water drops.
- The remaining propanone is evaporated by warming the beaker.
- The beaker and mercury are weighed.
- The experiment is repeated using different masses of $HgCl_x$.

Observations

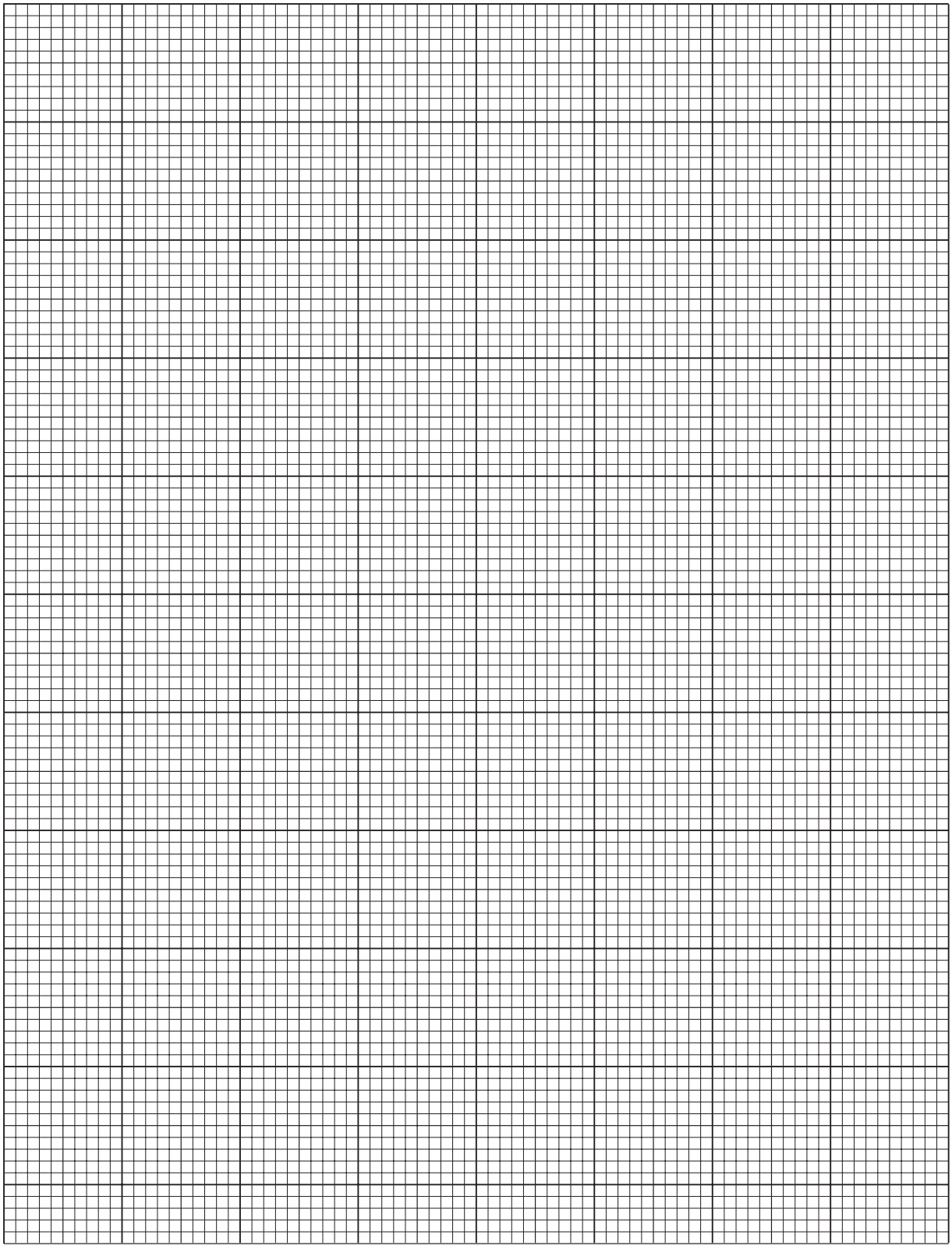
- $HgCl_x$ dissolves in water to form a colourless solution.
- On adding H_3PO_2 a white suspension forms which rapidly turns to a grey suspension of droplets of metallic mercury.
- On further heating, the suspended droplets merge to form large drops of mercury at the bottom of the beaker.

Results

	A	B	C	D	E	F
experiment	mass of beaker /g	mass of beaker + mercury chloride /g	mass of beaker + mercury /g			
1	54.87	55.52	55.30			
2	54.64	55.88	55.59			
3	56.70	58.38	57.94			
4	51.03	53.34	52.53			
5	55.33	58.74	57.84			
6	53.05	57.20	56.10			
7	53.92	58.57	57.17			
8	55.26	61.09	59.57			

(a) Process the results in the table to produce data that will enable you to plot a graph from which the formula of $HgCl_x$ can be determined.
Record this data in the additional columns of the table. You may use some or all of the columns.
Label the columns you use. For each column, include the units and an equation to show how your values are calculated. You may use the column headings **A** to **F** in the equations e.g. **C** – **B**. [2]

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



[4]

(c) Indicate clearly any anomalous points on the graph that you did not use when drawing the line of best-fit. By reference to the instructions for the experiment suggest an explanation for these anomalies.

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(d) Explain why the mass of $HgCl_x$ used in experiment 8 is more appropriate than that used in experiment 1.

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(e) Draw construction lines on the graph to derive values to enable you to calculate the value of **x** in $HgCl_x$.
[A_r: Hg, 201.0; Cl, 35.5]

Experimental value of **x** is …… Formula of $HgCl_x$ is ……

[2]

(f) By considering the data you have processed and the graph you have drawn, explain whether the experimental procedure described is suitable for the determination of the formula of $HgCl_x$.

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(g) The mass of chlorine in $HgCl_x$ can also be determined by precipitation of an insoluble chloride. Use your knowledge of halogen chemistry to suggest a suitable reagent for this reaction.

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[Total: 15]

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