Cambridge International A Level

**Cambridge International Examinations**
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*3961515302*

**CHEMISTRY** **9701/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2015**

**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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
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.

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


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**1** It is possible to determine the relative molecular mass, $M_r$, of a small sample of a volatile liquid by measuring its mass and then heating to vaporise it to obtain its volume as a gas.

**(a)** Explain how the relative molecular mass can be determined in this way.

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..... [2]

**(b) (i)** The volume of the vaporised sample depends on its temperature and pressure.

In an experiment, a sample of volatile liquid of known mass was vaporised and its volume recorded. The pressure was correctly recorded as 101 kPa but the temperature was incorrectly recorded as 50 °C. The correct temperature was 60 °C.

By considering the effect of these different temperatures on the gas volume, explain how the value of the calculated $M_r$ would be affected.

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..... [3]

**(ii)** The temperature was maintained at 60 °C but the pressure was increased to 110 kPa. Would this have given an answer that was nearer to the true value of the relative molecular mass? Explain your answer.

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..... [1]

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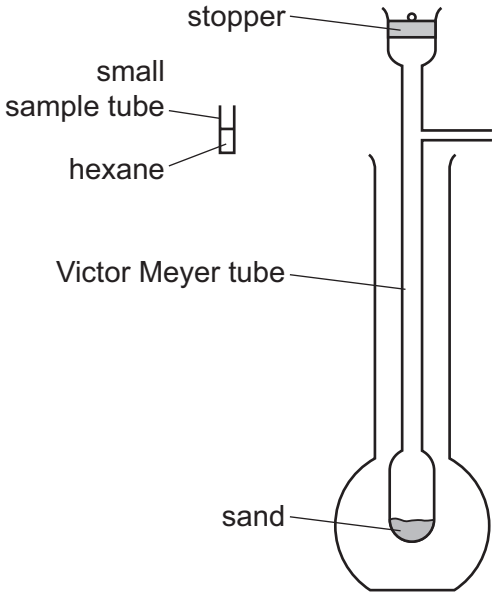
In an experiment to determine the relative molecular mass of hexane, boiling point 69 °C, a specialist piece of apparatus called a Victor Meyer tube can be used. This consists of a long tube with a bulb at the base in which a sample can be vaporised. The tube has a side arm to allow the escape of gas from within the tube. The tube is surrounded by another which can be used to heat the contents of the first tube.

A diagram of the apparatus is shown below.




A small sample tube containing the hexane is inserted at the top of the Victor Meyer tube. The sample tube is small enough to fit inside the Victor Meyer tube and falls freely onto the hot sand below. The sand will cushion its fall so that the sample tube does not break. The stopper is then quickly replaced at the top of the Victor Meyer tube. The hot sand causes the hexane to vaporise and expel air contained in the Victor Meyer tube.

**(c)** Complete the diagram above to show:

- how the apparatus should be heated,
- a connection to further apparatus which would allow the air expelled from the Victor Meyer tube when the sample of hexane is vaporised to be collected and measured.

[2]

**(d)** Suggest **one** hazard associated with the use of hexane.

.....

..... [1]



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**(e)** **(i)** With the gas collection apparatus connected to the heated Victor Meyer tube, expelled air will be collected before the hexane is introduced. Explain why.

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..... [2]

**(ii)** At which stage of the experimental procedure should the sample tube be dropped into the Victor Meyer tube?

.....

..... [1]

**(f)** State what measurements you would need to make in order to determine the relative molecular mass of hexane.

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..... [3]

[Total: 15]

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**QUESTION 2 STARTS ON THE NEXT PAGE.**



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**2** In an experiment, various masses of solid barium hydroxide are added to 60.0 $cm^3$ of a solution of hydrochloric acid contained in a polystyrene cup.

In each experiment a fresh sample of the acid is taken and its initial temperature is measured. After the barium hydroxide has been added, the acid is stirred and the maximum temperature reached is noted.

The results of each experiment are recorded in the table below.

**(a)** Complete the table below to give the temperature rise obtained from each experiment to **one decimal place** and the amount of barium hydroxide used in mol to **three significant figures** in each case.
The mass of 1 mol of barium hydroxide is 171 g.

| initial temperature of HC*l* / °C | mass of barium hydroxide added /g | maximum temperature reached / °C | temperature rise / °C | barium hydroxide added / mol |
|---|---|---|---|---|
| 21.0 | 0.500 | 22.2 | | |
| 20.6 | 1.00 | 23.0 | | |
| 21.2 | 1.50 | 24.9 | | |
| 21.8 | 2.00 | 26.5 | | |
| 20.5 | 3.00 | 27.8 | | |
| 21.4 | 4.00 | 31.1 | | |
| 21.2 | 5.00 | 31.6 | | |
| 21.0 | 6.00 | 31.4 | | |
| 20.8 | 8.00 | 31.2 | | |

[2]

**(b)** **(i)** Using the grid on page 7, plot a graph to show how the temperature rise varies with the moles of barium hydroxide added. [1]

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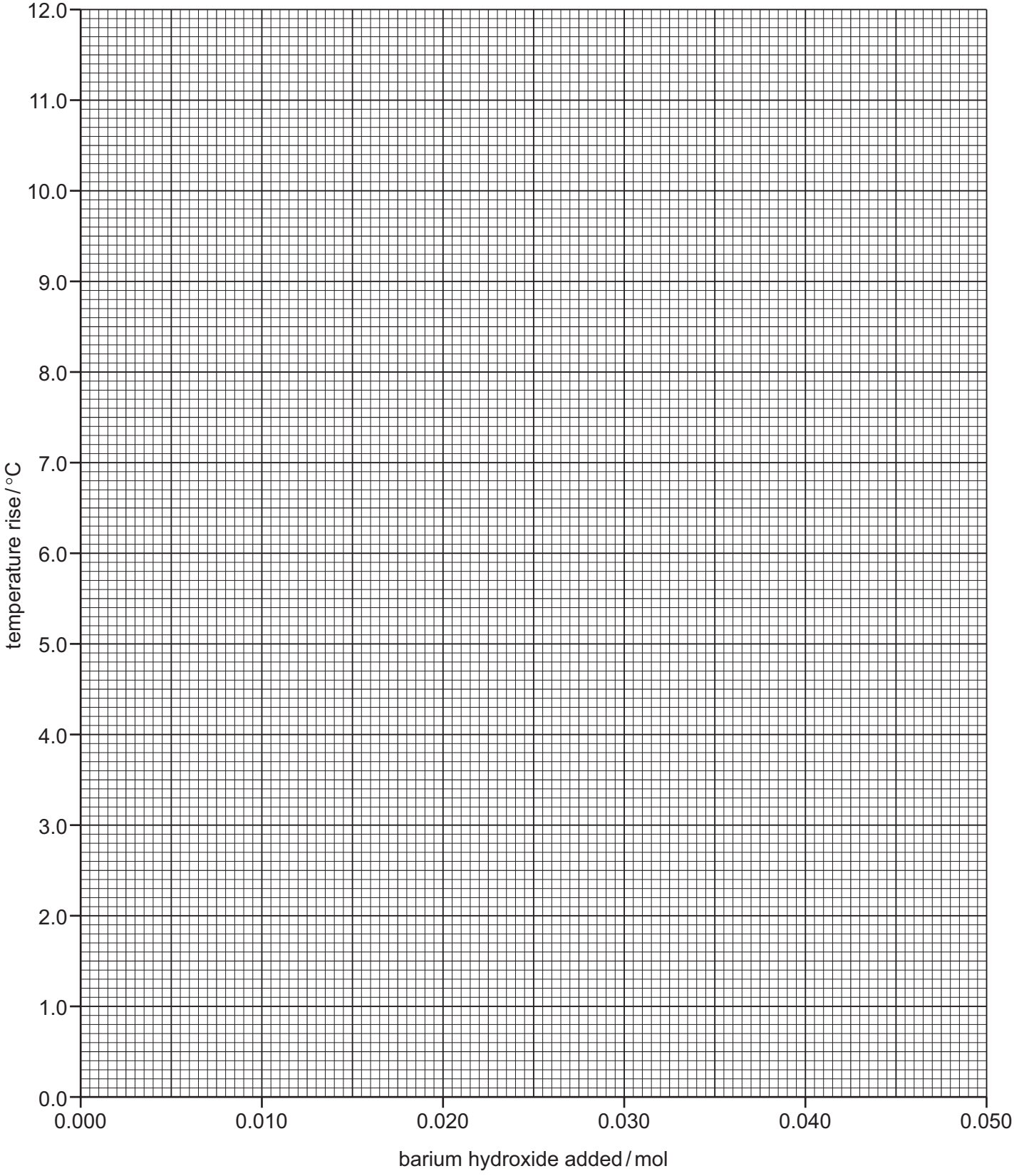


**(ii)** Draw **two** lines of best fit on your graph and state the value on the *x*-axis at the point of intersection of the two lines.

value on the *x*-axis at the point of intersection is ..... [2]



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**(c)** Use the value on the *x*-axis at the point of intersection to calculate the concentration of the hydrochloric acid in mol $dm^{-3}$.

[2]

**(d)** Explain the variation in temperature that takes place when barium hydroxide is added to the hydrochloric acid.

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..... [2]

**(e)** **(i)** When the experiment is done in the way described, the results are not very accurate.

Apart from limitations due to the accuracy of the measuring equipment, suggest why:

- all the temperature rises measured are less than theoretically should be expected,

.....

.....

- the temperature rises are more inaccurate as they approach their maximum value.

.....

.....
[2]

**(ii)** What improvement would you make to achieve greater accuracy?

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..... [1]

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**(f)** In another experiment, 60.0 $cm^3$ of ethanoic acid is used instead of the 60.0 $cm^3$ of hydrochloric acid.

If the ethanoic acid has the same concentration as the hydrochloric acid, draw on your graph another pair of lines to show the results you would expect to obtain.

Explain your answer.

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..... [3]

[Total: 15]

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