Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3984008780

CHEMISTRY

9701/52

Paper 5 Planning, Analysis and Evaluation

May/June 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 **8** printed pages.

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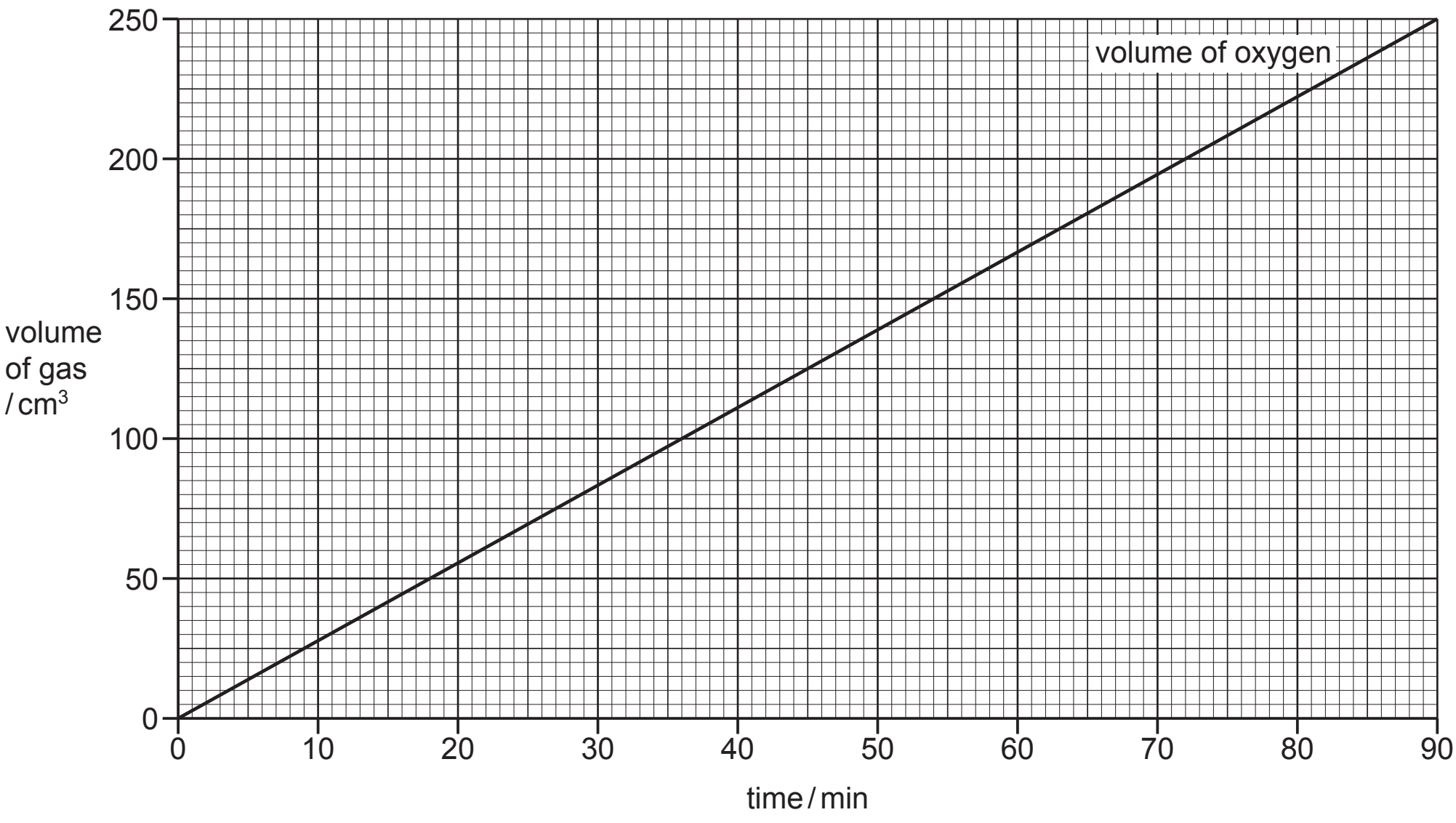
1 This question concerns electrolysis of different compounds.

(a) During the electrolysis of dilute sulfuric acid using a current of 0.75A for 90 minutes, the volume of oxygen gas collected was recorded and is shown in the graph below.



(i) Give equations for the reactions that occur at each electrode in the electrolysis of sulfuric acid.

.....

.....

..... [2]

(ii) On the graph above, use a ruler to draw and label a line (hydrogen) to predict the volume of hydrogen that would be given off during the same experiment. [1]

(iii) On the graph above, use a ruler to draw and label a line (oxygen) to predict the volume of oxygen that would be produced if a current of 0.45A was used instead of the 0.75A used in the original experiment. [1]

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(b) During the electrolysis of potassium butanedioate, the following reaction occurs.

$$2H_2O + \begin{matrix} CH_2COO^-K^+ \\ | \\ CH_2COO^-K^+ \end{matrix} \rightarrow C_2H_4 + 2CO_2 + H_2 + 2K^+OH^-$$

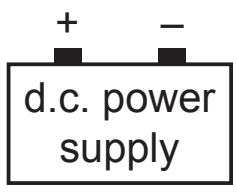
potassium butanedioate

An experiment can be carried out to confirm the above equation. In order to do this, the amounts of hydrogen, ethene and carbon dioxide produced need to be measured.

Hydrogen is produced at one electrode, ethene and carbon dioxide are produced at the other. The carbon dioxide can be separated from the ethene by absorbing it in an alkali before the volume of ethene is measured.

(i) Using the power supply drawn below, draw a fully labelled circuit diagram and apparatus which shows how:

- the current could be measured,
- the hydrogen produced could be collected and its volume measured,
- the carbon dioxide could be removed using a named alkali,
- the volume of ethene could be measured.



[5]

(ii) State what measurements should be taken when carrying out the experiment.

.....

.....

.....

..... [2]

(iii) **C** coulombs of electricity resulted in **V** cm^3 of hydrogen gas being produced during the electrolysis.

In terms of **C** and **V**, state the number of coulombs, **N**, that would be required to produce 24 dm^3 of hydrogen.

[1]

(iv) In terms of **N**, state the number of faradays of electricity that would be required to produce 1 mol of hydrogen at room temperature and pressure.
(1 faraday of electricity = 96 500 coulombs)

[1]

(v) Give the equation for the reaction that takes place when the carbon dioxide is absorbed by the alkali.
Include state symbols.

..... [1]

(vi) Predict the organic product that would be obtained at the anode when a solution of potassium *hexanedioate* is electrolysed.

[1]

[Total: 15]

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2 In order to identify a monoprotic (monobasic) hydroxycarboxylic acid, HX, the following experiments are carried out.

25.0 cm^3 of an aqueous solution of HX is titrated against 0.0500 mol dm^{-3} aqueous sodium carbonate. The end-point of the titration is reached when 25.0 cm^3 of the aqueous sodium carbonate has been added.

(a) (i) Write the equation for the complete neutralisation of HX with sodium carbonate.

..... [1]

(ii) How does the equation show that the concentration of HX is 0.100 mol dm^{-3}?

.....

..... [1]

(b) (i) State the acid dissociation constant, K_a, for the above reaction **in terms of H^+ and HX only**.

K_a =

[1]

(ii) The pH of the aqueous solution of HX is 2.43.

Use the pH and the concentration of HX to show that the pK_a of the acid is 3.86. **All your working must be shown**.

[2]

(c) In an experiment various masses of the sodium salt of the acid, NaX, are added to separate portions of 100 cm^3 of HX with stirring. After each addition the pH of the solution obtained is measured. The results of the experiment are recorded in the table below.

mass of NaX added / g	pH
0.00	2.43
0.10	2.81
0.20	3.11
0.30	3.19
0.40	3.41
0.60	3.59
0.80	3.71
1.00	3.81
1.20	3.89
1.50	3.99
2.00	4.11

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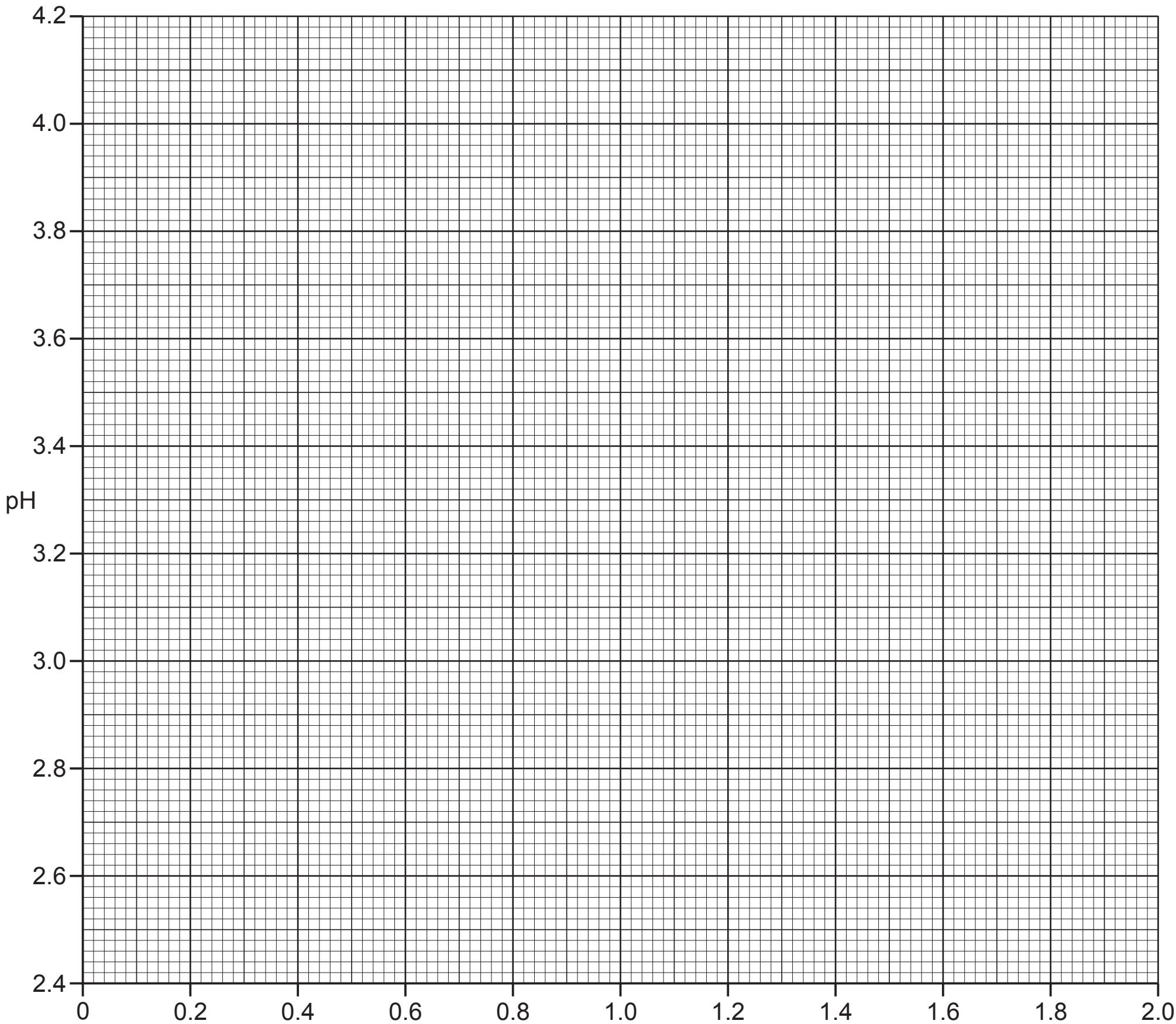
(i) Plot a graph to show how the pH of the solution varies with the mass of NaX added. Draw the curve of best fit.



[2]

(ii) Circle **one** anomalous point on your graph and give a reason for how this could have occurred using the experimental procedure described.

.....

.....

.....

..... [2]

(d) **(i)** The graph shows that a pH of 3.86 is obtained when 1.12 g of NaX is added to 100 cm^3 of HX.
Remember that pK_a of HX is also 3.86.
Use this information to calculate the relative molecular mass, M_r, of HX.
Show your working.
[A_r: H, 1.0; C, 12.0; O, 16.0; Na, 23.0]

[3]

(ii) The calculated M_r is subject to small experimental error. Suggest a structure for the organic hydroxycarboxylic acid, HX, that best fits your M_r data.

If you have not calculated a value for the M_r, use the value of 104. This is not the correct value.

[1]

(e) Another method for determining the concentration of the acid HX could be to evaporate a sample of the solution and weigh the solid that remains.

Suggest **two** reasons why this might not be a very good method of finding the mass of solid HX in a sample of the solution.

.....

.....

.....

..... [2]

[Total: 15]

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