TAYLOR'S COLLEGE

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Class	Student Number	Name

CAMBRIDGE A LEVEL PROGRAMME

A2 TRIAL EXAMINATION MARCH/APRIL 2011

(January & March 2010 Intakes)

Thursday **31 March 2011** **8.30 am – 9.45 am**

CHEMISTRY 9701/52

PAPER 5 Planning, analysis and evaluation 1 hour 15 minutes

Candidates answer on the Question Paper

READ THESE INSTRUCTIONS FIRST

Write your name, class and student number in the spaces at the top of this page.
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 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.

For Examiner's Use	
1	
2	
Total	

This document consists of **9** printed pages

[Turn over

1

Lithium is an alkali metal – one of a group of very reactive metals which are stored under oil to prevent contact with air and water vapour.

The reaction of lithium with water can be represented by the equation below.

$$2Li(s) + 2H_2O\ (l) \rightarrow 2LiOH(aq) + H_2(g)$$

(a) In the space below, draw a diagram that clearly shows the apparatus you could use to:

- React a weighed amount of lithium metal with water,
- Collect the hydrogen gas produced,
- Measure the volume of gas produced.

[3]

(b) What would you have to do before weighing lithium?

.....

.....[1]

(c) Tabulate all the measurements in a single table.

[3]

(d) Suggest and give a reason for **one** safety measure, related to the chemicals used or produced, that you would have to employ in conducting this experiment.

.....

.....[1]

(e) If 0.0583g of lithium produces 100 cm^3 of hydrogen gas at room temperature and pressure, show that the relative atomic mass, A_r of lithium is approximately 7.

[$V_m = 24dm^3mol^{-1}$ under room conditions]

[3]

(f) Give **two** reasons why the value of A_r calculated in **(e)** is approximate.

.....

.....

.....[2]

(g) Using the aqueous lithium hydroxide remaining after the reaction, it is possible to obtain an 'accurate' value of A_r for lithium. What practical technique could be used to obtain this value?

.....[1]

(h) Explain why the method you have used in **(g)** will give you a more accurate result.

.....

.....

.....[1]

[Total: 15]

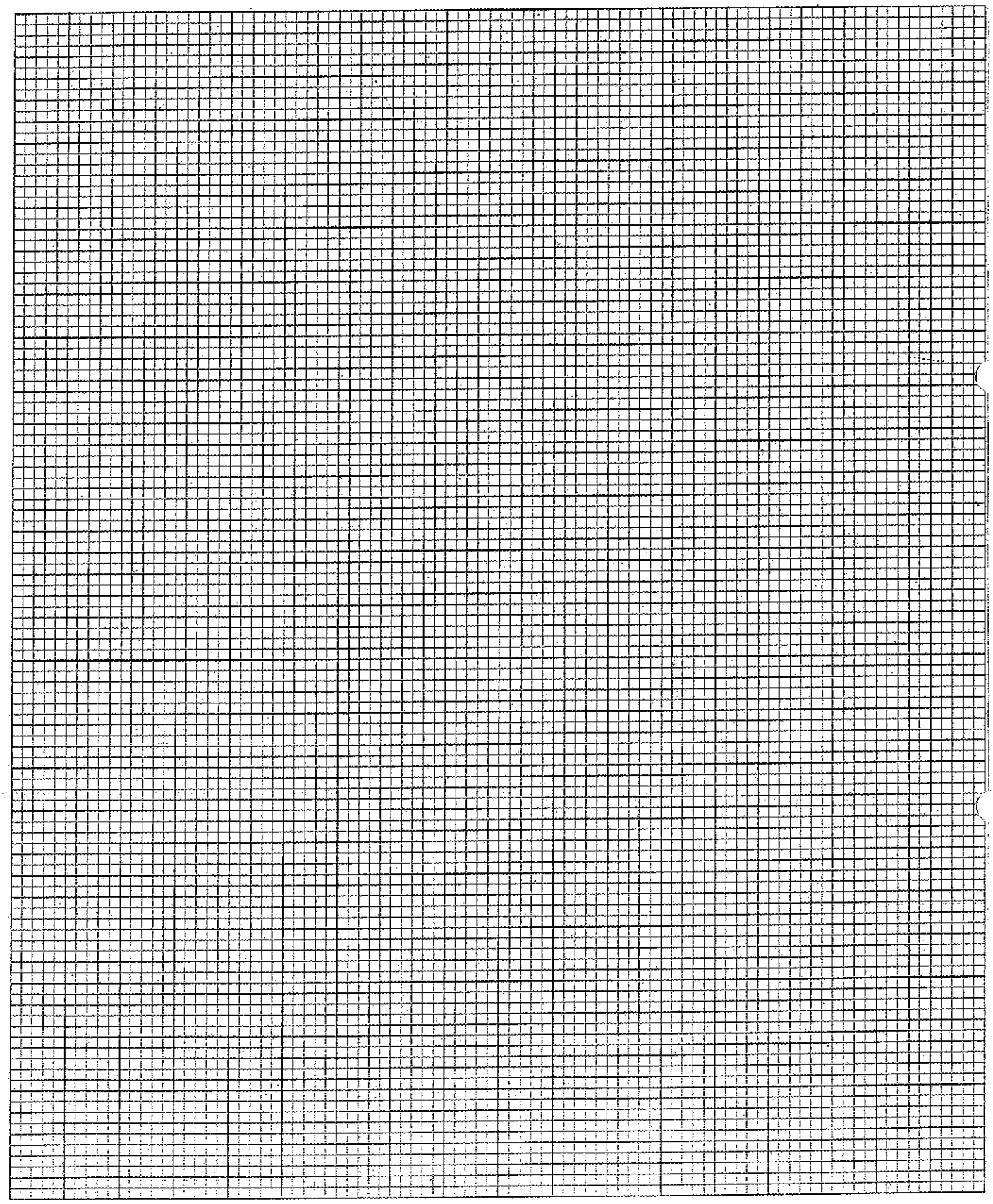
2 The pK_a value of a weak monoprotic acid can be determined by using the pH curve obtained when the acid is titrated against sodium hydroxide. The pH of the solution formed when exactly **half** of the acid has been neutralised is equal to the pK_a value of the acid.

A chemist used a pH curve to determine a pK_a value of an unknown weak monoprotic acid. The chemist transferred 25.0 cm^3 of a solution of the acid into a conical flask using a pipette, and measured the pH of the acid solution using a pH meter which can be read to one decimal place. A solution of sodium hydroxide of concentration of 0.100 mol dm^{-3} was added from a burette in small portions. The pH of the mixture was recorded after each addition of the sodium hydroxide solution. The chemist's results are given in the table below.

Volume of sodium hydroxide added / cm^3	pH	Volume of sodium hydroxide added / cm^3	pH
0.00	2.9	21.50	5.0
2.00	3.4	22.00	5.4
4.00	3.6	22.50	11.7
8.00	3.8	23.00	12.0
12.00	4.0	24.00	12.2
16.00	4.3	25.00	12.3
20.00	4.2	28.00	12.4
21.00	4.8	30.00	12.4

Analysis full marks can only be scored in calculations if you show all your working.

(a) Use the results given in the table in **page 5** to plot a graph of pH (y-axis) against volume of sodium hydroxide solution added. Use the points to draw the **pH curve.**



[4]

(b) Use your graph to determine

(i) the volume of sodium hydroxide solution at the end-point of the titration

.....

(ii) the volume of sodium hydroxide solution needed to neutralise half of the acid

.....

(iii) the pH of the half-neutralised mixture

..... [3]

(c) Use the pH of the half-neutralised mixture from part **b(iii)** to calculate the value of the acid dissociation constant, K_a, of the weak acid.

[1]

(d) The weak acid is known to be one of the following.

Acid	K_a / mol dm^{-3}
Trichloroethanoic acid	2.3×10^{-1}
Dichloroethanoic acid	5.0×10^{-2}
Chloroethanoic acid	1.3×10^{-3}
Methanoic acid	1.6×10^{-4}
Ethanoic acid	1.7×10^{-5}

Use your answer from part **(c)** and the data above to identify the unknown acid.

..... [1]

(e) For the pipette and the burette, the maximum total errors are shown below.

These errors take into account multiple measurements.
pipette ± 0.05 cm^3
burette total error ± 0.15 cm^3

Estimate the maximum percentage error in using these pieces of apparatus and, hence, estimate their combined error.
You should use the volume of sodium hydroxide at the end-point to estimate the percentage error in using the burette.

[3]

(f) The overall percentage apparatus error for this experiment, including the errors in using the pH meter, was found to be 25%. Explain and state **one** reason on the magnitude of the difference between the K_a value obtained from the graph and the K_a value of the acid you identified in the table as the unknown acid.

.....

..... [1]

(g) Suggest **one** way in which this experiment could be improved and the reason for it.

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.....

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.....

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..... [2]

[Total:15]