TAYLOR'S COLLEGE

Wisdom • Integrity • Excellence
since 1969

Class	Student Number	Name

CAMBRIDGE A LEVEL PROGRAMME

A2 TRIAL EXAMINATION AUGUST 2011

(June 2010 Intake)

Monday **22 August 2011** **8.30 am – 9.45 am**

CHEMISTRY 9701/53

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 The relative molecular mass, M_r, of a metal carbonate can be estimated by adding a weighed sample of the carbonate to an excess of hydrochloric acid.

You are to devise an experimental method to determine the M_r of a given sample of solid carbonate X_2CO_3.
You are provided with 10.00 g of X_2CO_3 and 100 cm^3 of 2.0 mol dm^{-3} hydrochloric acid.
You have to measure between 5.50 g and 6.00 g of X_2CO_3 to react with 100 cm^3 of acid.
The normal apparatus to be found in a school laboratory is available.

(a) Give a step by step description of

- The apparatus you will use (you may include it in the method)
- The detailed practical method which gives full instructions about how to obtain accurate results
- At least one source of error and the action you will take to minimize it
- Specimen results recorded in an appropriate form
- A specimen calculation to show how you will calculate the M_r of X_2CO_3
  [A_r: C, 12.0 ; O, 16.0 .]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[10]

[Turn Over

(b) Carbon dioxide is soluble in aqueous solutions and some of the carbon dioxide given off in the reaction remains dissolved in the acid solution.

Suggest a method to reduce or eliminate this error.

.....

.....

[1]

(c) The M_r of X_2CO_3 may also be found by carrying out the thermal decomposition of X_2CO_3.

Write an equation for this thermal decomposition.

.....

[1]

(d) Outline the key measurements to be made in order to find the M_r of X_2CO_3 by using the thermal decomposition method.

.....

.....

.....

.....

.....

.....

[2]

[Total : 14]

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.

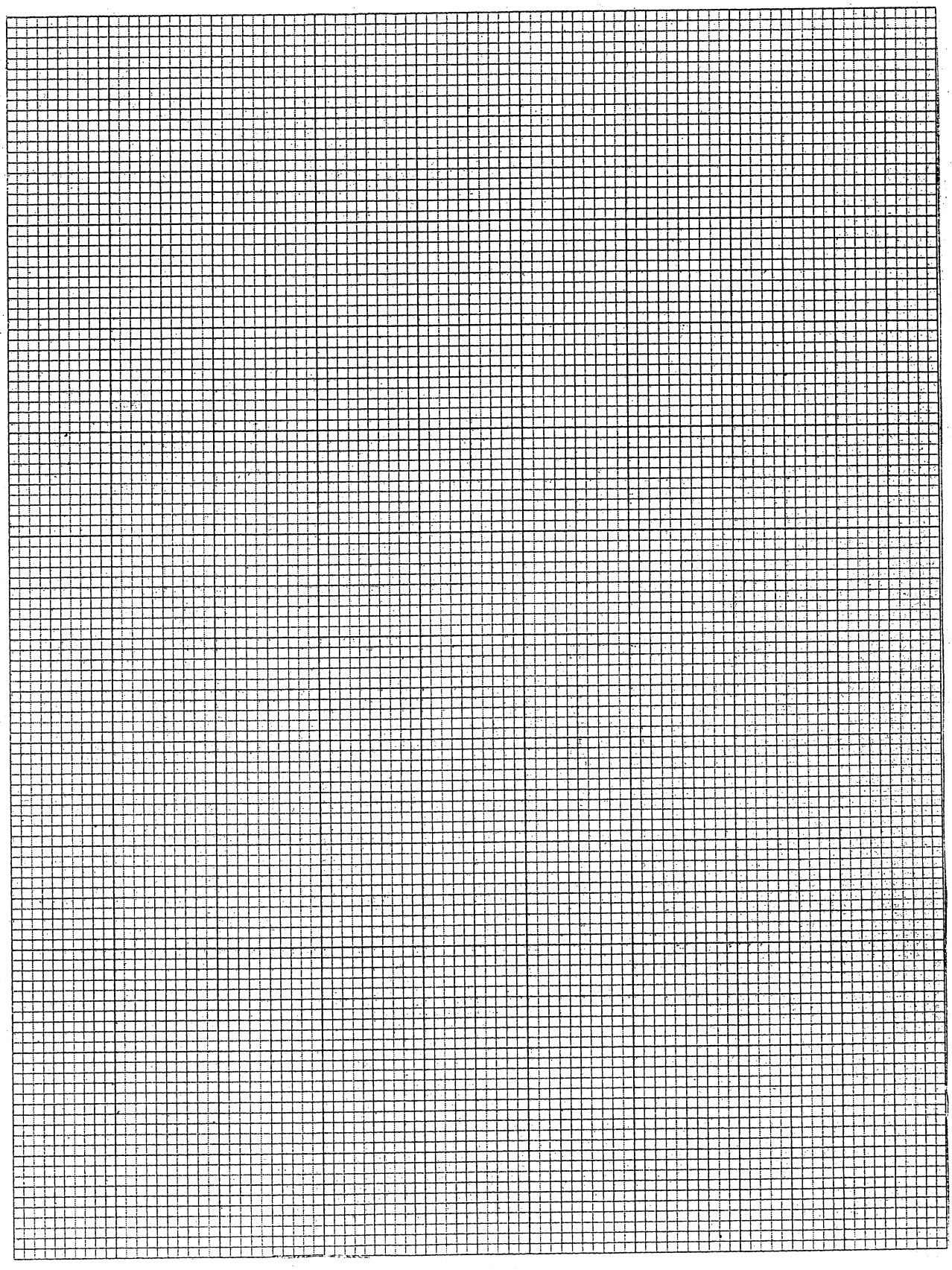
In an experiment to determine the **pKa** value of an unknown weak monoprotic acid, a pH curve was used. The procedure is as follows.

- 25.0 cm^3 of a solution of acid was transferred into a conical flask using a pipette.
- pH of the solution was measured 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 results are given in **Table 1** below.

Volume of sodium hydroxide solution added/ cm^3	pH	Volume of sodium hydroxide solution added/ cm^3	pH
0.0	2.9	21.5	5.0
2.0	3.4	22.0	5.4
4.0	3.6	22.5	11.7
8.0	3.8	23.0	12.0
12.0	4.0	24.0	12.2
16.0	4.3	25.0	12.3
20.0	4.2	28.0	12.4
21.0	4.8	30.0	12.4

Table 1

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



(ii) Use your graph (part (i)) 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.

.....

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

.....

.....

.....

(iv) The weak acid is known to be one of the following given in **Table 2**.

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}

Table 2

Use your answer from part (iii) and the data in **Table 2** to identify the unknown acid.

.....

[8]

(b) The maximum total errors for the pipette and the burette are shown below. These errors take into account multiple measurements.

Pipette	$\pm$ 0.05 cm^3
Burette	$\pm$ 0.15 cm^3

Estimate the maximum percentage error in using these pieces of apparatus and calculate the maximum overall percentage error in this experiment.

.....

.....

.....

.....

[2]

(c) (i) Calculate the difference between the K_a value obtained from the graph and the K_a value of the acid you identified in **Table 2** as the unknown acid. Express this difference as a percentage of the value given in **Table 2**.

.....

.....

.....

(ii) The overall percentage error of this experiment, including the errors in using the pH meter, was found to be 25%. Comment on the magnitude of the difference between the K_a value obtained from graph and the K_a value of the acid you identified in **Table 2**.

.....

.....

.....

.....

[4]

(d) State two ways in which the accuracy of the pH readings could be improved.

.....

.....

.....

.....

.....

[2]

[Total: 16]