CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

CHEMISTRY

UNIT 2 – PAPER 03/2

2 hours

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of THREE questions. Answer ALL questions.

2. Write your answers in the spaces provided in this booklet.

3. ALL working MUST be shown.

4. The use of non-programmable calculators is permitted.

5. A data booklet is provided.

Answer ALL questions.

1. You are provided with a sample, A, of the hydrated salt $Na_2CO_3 \cdot nH_2O$. You are required to determine the value of n and hence the formula of the hydrated salt.

    (a) Weigh the empty crucible. Add between 4.50 g and 5.00 g of A and reweigh the crucible. Record your data in Table 1.

    ### TABLE 1

Mass of empty crucible (g)	
Mass of crucible and A (g)	
Mass of A (g)	

    [3 marks]

    (b) Warm the crystals carefully to get rid of most of the water of crystallisation. Prevent loss of solid by gradually increasing the heat to a maximum, and then heat strongly for about 8 minutes.

    Allow the crucible to cool.

    Describe the appearance of the heated solid in the crucible.

    _____

    [2 marks]

    (c) Reweigh the crucible and its contents. Enter your results in Table 2.

    Repeat steps (b) and (c) as many times so as to achieve constant mass. (At this point all the water of crystallisation would have been removed.)

    ### TABLE 2

	1st weighing	2nd weighing	3rd weighing	
Mass of crucible and A after heating (g)				
Mass of A after heating (g)				

    [2 marks]

GO ON TO THE NEXT PAGE

(d) Calculate the mass of water of crystallisation driven off during heating. Show all your working.

_____

_____

[1 mark]

(e) Calculate the mass of anhydrous salt, A, in the sample.

_____

[1 mark]

(f) Calculate the number of moles of water driven off.

_____

_____

_____

[2 marks]

(g) Calculate the number of moles of anhydrous salt, A.

_____

_____

[2 marks]

(h) Calculate the number of moles of water which combines with one mole of anhydrous salt, A.

_____

[1 mark]

Deduce the value of n.

_____

[1 mark]

(i) Write the equation to describe the heating of Salt A.

_____

[2 marks]

Total 17 marks

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2. A student is given the task of determining the concentration of a solution of oxalic acid (ethane-1,2,-dioic acid), $H_2C_2O_4$, by titrating 25 cm³ portions of the acid with a standard solution of potassium manganate(VII) containing 0.02 mol dm⁻³. Figure 1 shows the readings on the burette before and after each titration.

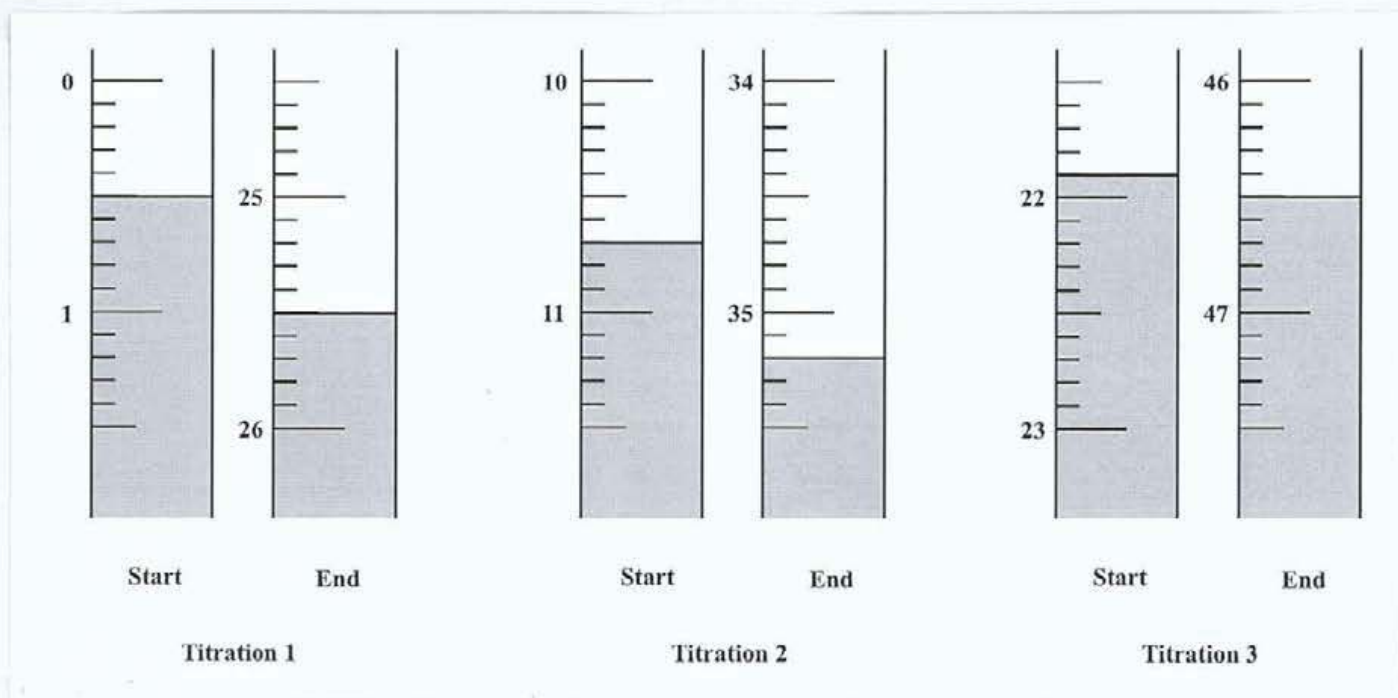| Start	End	Start	End	Start	End
Titration 1		Titration 2		Titration 3	

Figure 1. Burette reading

(a) (i) What substance in the titration is performing the role of the indicator?

_____

[1 mark]

(ii) What colour change would be expected at the end of the reaction?
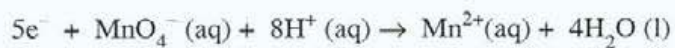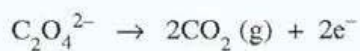
_____

[1 mark]

(iii)   In the space below, construct Table 3 to record the titration results. Include the initial and final burette readings, and the volume of $KMnO_4$ used.

[**5 marks**]

(iv)   State the volume of $KMnO_4$ (aq) to be used in the calculation.

_____

[**1 mark**]

The redox nature of the reaction occurring in the titration can be represented by the two half-equations below.

$$C_2O_4^{2-} \rightarrow 2CO_2 \text{ (g)} + 2e^-$$

$$5e^- + MnO_4^- \text{ (aq)} + 8H^+ \text{ (aq)} \rightarrow Mn^{2+} \text{(aq)} + 4H_2O \text{ (l)}$$

(v)   Write the ionic equation for the reaction occurring in the titration.

_____

_____

[**2 marks**]

(vi) Calculate the concentration of the oxalic acid solution in mol dm^{-3}.

_____

_____

_____

_____

_____

_____

_____

_____

[4 marks]

(b) Outline the steps to be taken by the student in performing the titration.

_____

_____

_____

_____

_____

_____

_____

_____

[4 marks]

(c) In taking readings of liquids, the bottom of the meniscus is usually read. However, in the case of $KMnO_4$(aq), this procedure is not followed.

Give ONE reason for this deviation from the normal.

_____

_____

[1 mark]

Total 19 marks

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3. Two students were overheard discussing the alcoholic content of two brands of beer. One student was adamant in his claim that Brand A contained a greater percentage of alcohol than Brand B.

    Plan and design an experiment to test the truth of his claim.

    Your answer should include the following:

    (a) Hypothesis

    _____

    _____

    [1 mark]

    (b) Aim

    _____

    _____

    [1 mark]

    (c) Apparatus and materials

    _____

    _____

    [2 marks]

    (d) Procedure

    _____

    _____

    _____

    _____

    _____

    _____

    [3 marks]

(e)   Variables

    (i)   Manipulated _____

    (ii)   Responding _____

                                            [2 marks]

(f)   Data to be collected

_____

_____

                                          [1 mark]

(g)   Discussion of expected results

_____

_____

                                          [1 mark]

(h)   ONE possible assumption or source of error.

_____

                                          [1 mark]

                                      Total 12 marks

END OF TEST