4.5.3 Chemistry Paper 3 (233/3)

1. (a) You are provided with the following:

- **Solution A** – Indicator solution
- **Solution B** – 0.05 M compound B
- **Solution C1** – Hydrochloric acid to be used in Questions 1(a) and 1(b)

You are required to determine the concentration in moles per litre of hydrochloric acid in solution C1.

PROCEDURE I (a)

(i) Place two test tubes in a test tube rack. To the first test tube, place about 2 cm^3 of solution B. To the second test tube, place about 2 cm^3 of solution C1.

(ii) Add 2 drops of indicator solution A to each of the test tubes, shake and note the colour of each solution. Record the colours in **Table 1**.

Table 1

Solution	Colour
Solution B + indicator solution A	
Solution C1 + indicator solution A	

(1 mark)

Complete the following statement:

In the titration of solution B (in a conical flask) with hydrochloric acid using indicator solution A, the colour change at the end point is from ..... to .....

(1 mark)

PROCEDURE II (a)

(i) Using a pipette and pipette filler, pipette 25.0 cm^3 of **solution C1** into a 250 ml volumetric flask. Add distilled water to the mark. Label this as **solution C2**.

(ii) Fill a burette with **solution C2**.

(iii) Using a clean pipette and pipette filler, place 25.0 cm^3 of **solution B** in a 250 ml conical flask.

(iv) Titrate **solution B** with **solution C2** using 3 drops of indicator **solution A**. Record the results in **Table 2**.

Table 2

	I	II	III
Final burette reading			
Initial burette reading			
Volume of solution **C2** used, cm^3			

(4 marks)

Calculate the:

(i) average volume of **solution C2** used. (1 mark)

(ii) number of moles of **compound B** used. (1 mark)

(iii) number of moles of hydrochloric acid used (1 mole of compound B reacts with 2 moles of hydrochloric acid). (1 mark)

(iv) concentration in moles per litre, of hydrochloric acid in **solution C2**. (1 mark)

(v) concentration in moles per litre, of hydrochloric acid in **solution C1**. (1 mark)

(b) You are provided with **two** portions of **solid D**, sodium hydrogen carbonate each weighing **2.5 g**.

You are required to determine the heat of reaction of hydrochloric acid with aqueous sodium hydrogen carbonate.

PROCEDURE I (b)

(i) Using a 100 ml measuring cylinder, measure 30 cm^3 of distilled water and place it in a 100 ml plastic beaker.

(ii) Measure the temperature of the distilled water and record in **Table 3**.

(iii) Add one of the portions of **solid D** to the water. Stir with the thermometer and measure the minimum temperature reached. Record the reading in **Table 3**.

Table 3

Final temperature of the solution, °C	
Initial temperature of water, °C	
Temperature change, °C	

(1½ marks)

Calculate the:

(i) heat change of the solution (assume specific heat capacity of solution = $4.2\,Jg^{-1}$ per degree, density of solution = $1.00\,g\,cm^{-3}$) (1 mark)

(ii) number of moles of sodium hydrogen carbonate, **solid D** used (relative formula mass = 84) (1 mark)

(iii) heat change, ΔH_1 in $kJmol^{-1}$ of sodium hydrogen carbonate (1 mark)

PROCEDURE II (b)

(i) Clean the 100 ml plastic beaker.

(ii) Repeat **procedure I (b)** using the second portion of **solid D** and 30 cm^3 of **solution C1** instead of 30 cm^3 of distilled water.

(iii) Record the results in **Table 4**.

Table 4

Final temperature of solution °C	
Initial temperature of solution C1, °C	
Temperature change, °C	

(1½ marks)

Calculate the:

(i) heat change of the solution (assume specific heat capacity of solution = $4.2\,Jg^{-1}$ per degree, density of solution = $1.00\,g\,cm^{-3}$) (1 mark)

(ii) heat change, ΔH_2 in $kJmol^{-1}$ of sodium hydrogen carbonate (1 mark)

(iii) heat change, $\Delta H_3 = \Delta H_2 - \Delta H_1$ for the reaction of hydrochloric acid and one mole of aqueous sodium hydrogen carbonate (1 mark)

2. You are provided with an organic compound, **solid M**.

Carry out the following tests and record the observations and inferences in the spaces provided.

(a) Place about one-fifth of **solid M** on a metallic spatula and burn it using a Bunsen burner flame.

Observations	Inferences

(1 mark) (1 mark)

(b) Place the remaining amount of **solid M** in a boiling tube. Add about 15 cm^3 of distilled water and shake to dissolve. Use about 2 cm^3 portions of the solution, in a test tube, for each of the following tests.

(i) To the first portion, add 3 drops of acidified potassium dichromate(VI). Warm the mixture.

Observations	Inferences

(1 mark) (1 mark)

(ii) To the second portion, add 3 drops of bromine water.

Observations	Inferences

(1 mark) (1 mark)

(iii) To the third portion, add **all** the solid sodium carbonate provided. Test any gases produced with a burning splint.

Observations	Inferences

(1 mark) (1 mark)

3. You are provided with **solution N**. Carry out the following tests and record the observations and inferences in the spaces provided. Use about 2 cm^3 portions, in a test tube, for each of the tests.

(a) To the first portion, add aqueous sodium hydroxide dropwise until in excess.

Observations	Inferences

(1 mark) (1 mark)

(b) Warm the second portion and then add aqueous ammonia dropwise until in excess.

Observations	Inferences

(1 mark) (1 mark)

(c) To the third portion, add 3 drops of aqueous barium nitrate. Shake and then add about 1 cm^3 dilute nitric(V) acid.

Observations	Inferences

(2 marks) (1 mark)

(d) Place about 1 cm^3 of aqueous sodium hydroxide in a test tube, then add the fourth portion of **solution N**.

(i) Heat the mixture and test any gases produced with red litmus paper.

Observations	Inferences

(1 mark) (1 mark)

(ii) Rewarm the mixture obtained in (d)(i) above, then add the piece of folded aluminium foil provided. Test any gases produced with red litmus paper.

Observations	Inferences

(1 mark) (1 mark)

Identify a cation and two anions in **solution N**.

Cation: (½ mark)

Anions: (½ mark)