EXPERIMENT NO. 5

Quantitative Analysis

Read through the whole method before starting any practical work. Where appropriate, prepare a table for your results in the space provided.

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

1 In this experiment you will determine the percentage by mass of an impure sample of sodium hydrogencarbonate, $NaHCO_3$.
You will do this by titration with hydrochloric acid, HC*l*. The impurity in the sample is **X**. **X** is a sodium compound which does not react with HC*l*.

FB 1 is a mixture containing sodium hydrogencarbonate and **X**.
You are supplied with approximately 4.0 g of **FB 1**.
FB 2 is 0.105 mol dm^{-3} hydrochloric acid, HC*l*.
methyl orange indicator

(a) Method

Preparing a solution of FB 1

- Weigh the 100 cm^3 beaker. Record the mass.
- Add between 2.8 g and 3.0 g of **FB 1** to the beaker.
- Reweigh the beaker with **FB 1**. Record the mass.
- Calculate and record the mass of **FB 1** used.
- Add approximately 50 cm^3 of distilled water to **FB 1** in the beaker.
- Stir the mixture with a glass rod until all the **FB 1** has dissolved.
- Transfer this solution into the 250 cm^3 volumetric flask.
- Wash the beaker with distilled water and transfer the washings to the volumetric flask.
- Add distilled water to the volumetric flask up to the mark.
- Shake the flask thoroughly.
- This solution of impure sodium hydrogencarbonate is **FB 3**. Label the flask **FB 3**.

mass of beaker /g	45.26
mass of beaker + FB1 /g	48.16
mass of FB1 used/g	2.90

Titration of FB 3

- Fill the burette with **FB 2**.
- Pipette 25.0 cm^3 of **FB 3** into a conical flask.
- Add approximately 5 drops of methyl orange indicator.
- Carry out a rough titration.
- Record your burette readings and the rough titre in the space below.

final burette reading/cm^3	26.90
initial burette reading/cm^3	0.40
titre /cm^3	26.50

The rough titre is ..... 26.50 ..... cm^3.

- Carry out as many accurate titrations as you think necessary to obtain consistent results.
- Make sure any recorded results show the precision of your practical work.
- Record in a suitable form below all of your burette readings and the volume of **FB 2** added in each accurate titration.

Final burette reading/cm³	29.30	34.70	37.30
Initial burette reading/cm³	3.20	8.40	10.10
Titre/cm³	26.10	26.30	26.20
Best Titres	✓		✓

I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

(b) From your accurate titration results, obtain a suitable value for the volume of **FB 2** to be used in your calculations.
Show clearly how you obtained this value.

$$\frac{26.10 + 26.20}{2}$$

25.0 cm^3 of **FB 3** required ....26.15..... cm^3 of **FB 2**. [1]

(c) Calculations

(i) Give your answers to **(ii)**, **(iii)**, **(iv)** and **(v)** to the appropriate number of significant figures. [1]

(ii) Calculate the number of moles of hydrochloric acid, HC*l*, in the volume of **FB 2** calculated in **(b)**.

$c = 0.105\ mol\ dm^{-3}$

$V = 26.15\ cm^3$

$n = CV$

$= 0.105 \times \frac{26.15}{1000}$

moles of HC*l* = 2.746×10^{-3} mol [1]

(iii) Complete and balance the equation for the reaction of sodium hydrogencarbonate with hydrochloric acid. Include state symbols.

$NaHCO_{3(aq/s)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + CO_{2(g/aq)} + H_2O_{(l)}$

Deduce the number of moles of sodium hydrogencarbonate that reacted with the number of moles of HC*l* calculated in **(ii)**.

ratio 1 : 1

moles of $NaHCO_3$ = 2.746×10^{-3} mol [1]

(iv) Use your answer to **(iii)** to calculate the number of moles of sodium hydrogencarbonate in the **FB 1** that you weighed out.

$25.0\ cm^3$ —— $2.746 \times 10^{-3}\ mol$

$\therefore$ $250.0\ cm^3$ —— x

moles of $NaHCO_3$ in **FB 1** used = 2.746×10^{-2} mol [1]

(v) Calculate the percentage by mass of $NaHCO_3$ in **FB 1**.

Mass of $NaHCO_3$

$m = n \times M_r$

$= 2.746 \times 10^{-2} \times 84$

$2.307\ g$

Percentage of $NaHCO_3$

$= \frac{2.307}{2.90} \times 100$

percentage by mass of $NaHCO_3$ in **FB 1** = 79.55 % [1]

[Total: 14]