

# 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,  $\text{NaHCO}_3$ . You will do this by titration with hydrochloric acid,  $\text{HCl}$ . The impurity in the sample is **X**. **X** is a sodium compound which does not react with  $\text{HCl}$ .

**FB 1** is a mixture containing sodium hydrogencarbonate and **X**.

You are supplied with approximately 4.0 g of **FB 1**.

**FB 2** is  $0.105 \text{ mol dm}^{-3}$  hydrochloric acid,  $\text{HCl}$ .

methyl orange indicator

### (a) Method

#### Preparing a solution of **FB 1**

- Weigh the  $100 \text{ cm}^3$  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  $50 \text{ cm}^3$  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  $250 \text{ cm}^3$  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  $25.0 \text{ cm}^3$  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 / $\text{cm}^3$	26.90
initial burette reading / $\text{cm}^3$	0.40
titre / $\text{cm}^3$	26.50

The rough titre is ..... 26.50 .....  $\text{cm}^3$ .

- 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/cm <sup>3</sup>	29.30	34.70	37.30
Initial burette reading/cm <sup>3</sup>	3.20	8.40	10.10
Titre/cm <sup>3</sup>	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<sup>3</sup> of **FB 3** required ..... 26.15 ..... cm<sup>3</sup> of **FB 2**. [1]

(c) Calculations

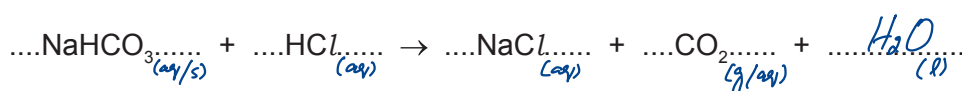
(i) Give your answers to (ii), (iii), (iv) and (v) to the appropriate number of significant figures. [1]

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

$$c = 0.105 \text{ mol dm}^{-3} \quad n = CV$$
$$v = 26.15 \text{ cm}^3 \quad = 0.105 \times \frac{26.15}{1000}$$

moles of HCl =  $2.746 \times 10^{-3}$  mol [1]

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



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

ratio                      1 : 1

moles of NaHCO<sub>3</sub> =  $2.746 \times 10^{-3}$  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.

$$\frac{25.0 \text{ cm}^3}{250.0 \text{ cm}^3} = \frac{2.746 \times 10^{-3} \text{ mol}}{x}$$

moles of NaHCO<sub>3</sub> in **FB 1** used =  $2.746 \times 10^{-2}$  mol [1]

(v) Calculate the percentage by mass of NaHCO<sub>3</sub> in **FB 1**.

<p><u>Mass of NaHCO<sub>3</sub></u></p> $m = n \times M_r$ $= 2.746 \times 10^{-2} \times 84$ <div style="border: 1px solid black; display: inline-block; padding: 2px;">2.307 g</div>	<p><u>Percentage of NaHCO<sub>3</sub></u></p> $= \frac{2.307}{2.90} \times 100$
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percentage by mass of NaHCO<sub>3</sub> in **FB 1** = 79.55 % [1]