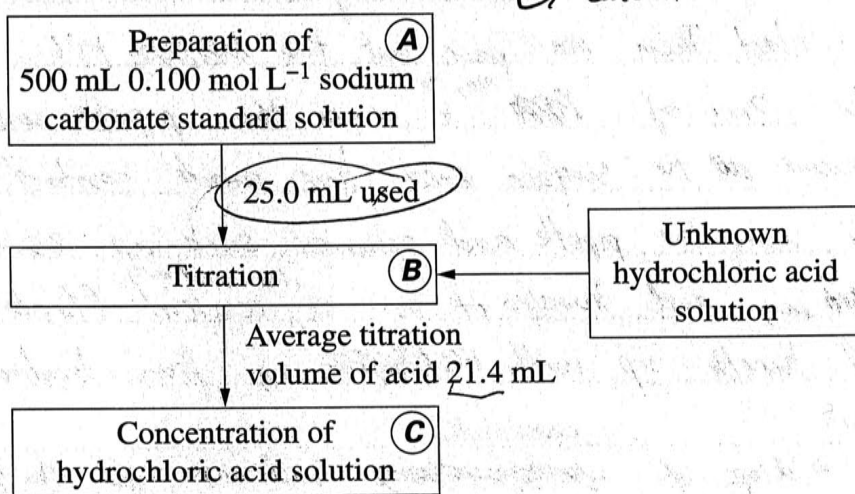


**Question 28** (8 marks)

The flowchart shown outlines the sequence of steps used to determine the concentration of an unknown hydrochloric acid solution.

8



Describe steps **A**, **B** and **C** including correct techniques, equipment and appropriate calculations. Determine the concentration of the hydrochloric acid.

Step **A**, requires the preparation of a standard solution.

$$\begin{aligned} \text{Moles of } (\text{Na}_2\text{CO}_3) &= 0.5 \times 0.1 \\ &= 0.05 \text{ moles} = 5.2995 \text{ g} \end{aligned}$$

- 1) Using an electronic balance, weigh out 5.2995g of  $\text{Na}_2\text{CO}_3$  solid on a watch glass.
- 2) Now using a funnel, transfer the solid into a 500ml volumetric flask, use distilled water washer bottle to rinse all remaining particles from the funnel and watch glass into the volumetric flask.
- 3) Now tightly swirl the volumetric flask until the solid dissolves completely.

Question 28 continues on page 18

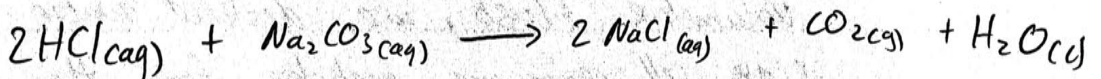
- 4) Fill the volumetric flask up to the 500ml mark with distilled water. Ensure that the bottom meniscus ~~touches~~ touches the line.
- 5) Place a stopper on the top of the flask.

Question 28 (continued)

Step (B)

- 1). Transfer 100 mL of the  $\text{Na}_2\text{CO}_3$  standard into a dry and clean beaker, label it.
  - 2). Do this for the unknown  $\text{HCl(aq)}$  into another clean and dry beaker, label it.
  - 3). Using 10 mL of  ~~$\text{Na}_2\text{CO}_3$~~   <sup>$\text{HCl}$</sup>  from the beaker, rinse the burette ensuring all the surface area has made contact. Then ~~can~~ pour out the  ~~$\text{Na}_2\text{CO}_3$~~   $\text{HCl}$ .
  - 4). Use 10 mL of  ~~$\text{HCl}$~~   <sup>$\text{Na}_2\text{CO}_3$</sup>  to rinse the pipette and ensure all the surface area has made contact. Then pour out.
  - 5). Now using the pipette and splunder, suck up 2.5 mL of  ~~$\text{Na}_2\text{CO}_3$~~  <sup>clean and dry</sup> and transfer it to a conical flask.
  - 6). Fill burette up with  ~~$\text{Na}_2\text{CO}_3$~~   $\text{HCl(aq)}$  from beaker up to 0 mL mark.
  - 7). Add 5 drops of ~~metaphosphoric~~ <sup>phenolphthalein</sup> indicator to the conical flask.
  - 8). ~~Titrate~~ slowly add drops of  ~~$\text{Na}_2\text{CO}_3$~~   <sup>$\text{HCl}$</sup>  to the <sup>conical flask</sup> until you observe a colour change, then you have reached your equivalence point.
- End of Question 28**
- 9). Record the mL used of  ~~$\text{Na}_2\text{CO}_3$~~   <sup>$\text{HCl}$</sup>  into a table. The first run, is your rough, remember to omit from average taken.
  - 10). ~~Repeat the titration~~ clean and dry the conical flask before repeating experiment 5 times.
  - 11). Average your results, omitting outliers and first rough titration.
  - 12). Calculate the concentration of unknown, using average.

Step (C)



Average titration ( $\text{HCl}$ ) = 21.4 mL

Moles of ( $\text{Na}_2\text{CO}_3$ ) =  $0.025 \times 0.1$   
= 0.0025 moles

Since  $\text{HCl} : \text{Na}_2\text{CO}_3 \Rightarrow 2:1$

$\therefore$  moles of  $\text{HCl}$  = 0.005 moles

Thus,

$$\begin{aligned} \text{Conc. HCl} &= \frac{0.005 \text{ moles}}{0.0214} \\ &= 0.2336448598 \text{ mol L}^{-1} \\ &\approx 0.234 \text{ mol L}^{-1} \text{ (3sf)} \end{aligned}$$