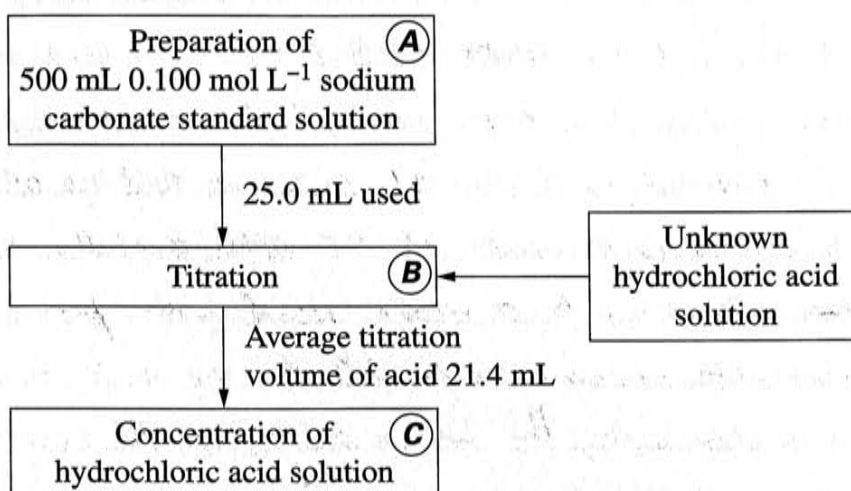


## Question 28 (8 marks)

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 is the process of preparing a standard solution. Step B is the process of titrating the HCl against the  $\text{Na}_2\text{CO}_3$  and Step C was the calculation of the HCl concentration.

Step A involves the process of preparing a standard solution. A standard solution is a solution created with known volume, concentration, and ~~chemical structure~~ <sup>low reactivity with air</sup>. The standard solution in this case is the sodium carbonate solution. Initially, one must weigh an amount of  $\text{Na}_2\text{CO}_3$  by using an accurately calibrated electronic balance. This predefined mass of  $\text{Na}_2\text{CO}_3$  is then dissolved in a specific, accurately measured volume of water, and ~~is then kept until~~ by adding the solid powder, ~~and~~ stoppering, and shaking to ensure complete dissolution. In this experiment, the mass of the standard can be calculated

Question 28 continues on page 18

... (next page)



## Question 28 (continued)

$$n = cV \quad \therefore n(\text{Na}_2\text{CO}_3) = 0.1 \times 0.5 = 0.05 \text{ moles}$$

$$\text{and } n = \frac{m}{M}$$

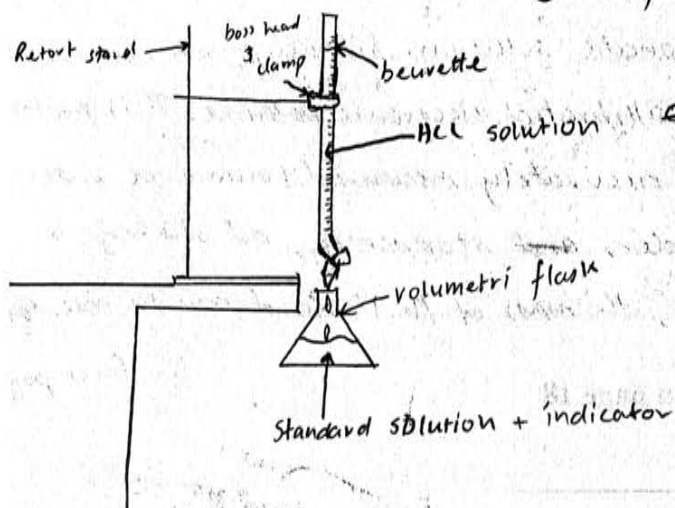
$\therefore M(\text{Na}_2\text{CO}_3) \times n = m \quad \therefore m = 5.2995 \text{ g of Na}_2\text{CO}_3(\text{s})$  used in preparation of the standard.

Step B: ~~the~~ involves titrating an unknown concentration of HCl, against the

standard, with an appropriate indicator such as ~~the~~ bromothymol blue, until a point where complete neutralisation is achieved. The standard is ~~pipetted~~ pipetted from its beaker into volumetric flask (25 ml), and then ~~distilled~~ distilled H<sub>2</sub>O is added to fill up to the ticked line. Once this is ready it is kept aside and the titrant is prepared.

The titrating ~~pipette~~ burette is cleaned with the HCl to ensure that no other chemicals could be present which may contaminate the HCl. After carefully rinsing and emptying, it is set up by ~~attaching~~ attaching to a retort stand with ~~boss head~~ boss head and clamps with the centre measurement at eye level. With the tap in the closed position and the volumetric flask underneath, the HCl is added to the burette to a point below the zero mark, so accurate readings can be made. Once the apparatus is set up as shown in diagram, the titration process can begin by slowly releasing

the tap, whilst swirling the volumetric flask to ensure mixing. When the colour of the solution begins to change, the rate of flow of the HCl should be minimised to ensure prevention of overshooting the mark. Once the titration is complete, a series of five to 10 repetitions should be undertaken to ensure reliability of results, whilst eliminating any extreme outliers.



Step C: ~~The concentration to determine concentration can be determined~~ Mathematically, the concentration of HCl titrated can be determined:



$$\therefore n(\text{HCl}) = 2 \times 0.05 = 0.1 \text{ mol}$$

$$c = \frac{n}{V} = \frac{0.1}{0.0214} = 4.67 \text{ mol L}^{-1}$$