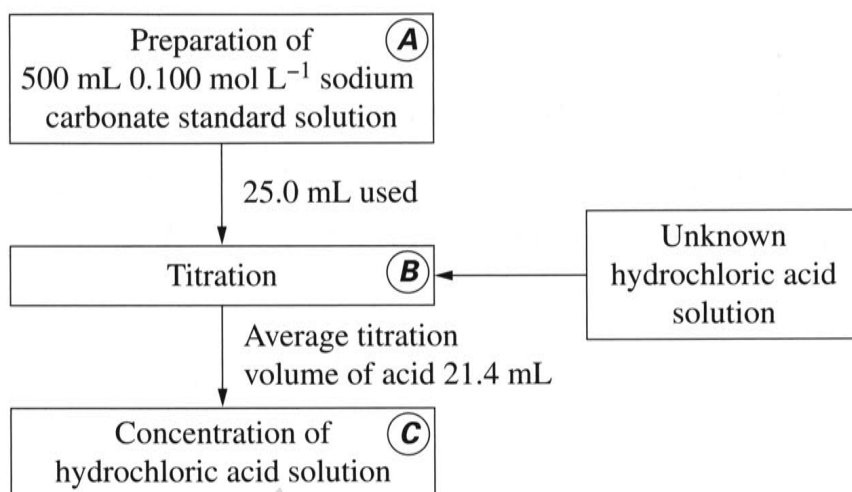**Question 28** (8 marks)

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

8

```
┌─────────────────────────────┐
│  Preparation of        (A)  │
│ 500 mL 0.100 mol L⁻¹ sodium │
│  carbonate standard solution│
└─────────────────────────────┘
              │
              │ 25.0 mL used
              ▼
┌─────────────────────────────┐        ┌──────────────────┐
│                        (B)  │        │     Unknown      │
│        Titration            │◄───────│ hydrochloric acid│
│                             │        │     solution     │
└─────────────────────────────┘        └──────────────────┘
              │  Average titration
              │  volume of acid 21.4 mL
              ▼
┌─────────────────────────────┐
│   Concentration of     (C)  │
│  hydrochloric acid solution │
└─────────────────────────────┘
```

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

<u>Step A</u>: weigh out accurately 5.3g of sodium carbonate
(Na_2CO_3). Add 20mL of distilled water and stir with a
stirring rod, ~~Re~~ Repeat 5-6 times or until all the Na_2CO_3 is
dissolved. Transfer the solution to a pre-rinsed conical flask,
~~ou~~ ensuring the beaker is washed with a wash bottle several
times to ensure all the Na_2CO_3 (aq) has been transferred.
Add distilled water until the bottom of the meniscus hits
the 500mL mark. Now calculate the concentration of the
sodium carbonate standard solution. moles = $\frac{5.3g}{22.99 \times 2 + 12.9 + 3 \times 16}$ = 0.05000

∴ 0.05000 moles / 500mL = 0.1000 moles/L = 0.100 mol /L

Question 28 continues on page 18

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Question 28 (continued)

Step B - ~~Place 25mL of the standard solution and~~ Rinse four conical Flasks with distilled water ~~a fe~~ . Do the same with the pipette, ~~i~~ except rinse with $Na_2CO_3(aq)$
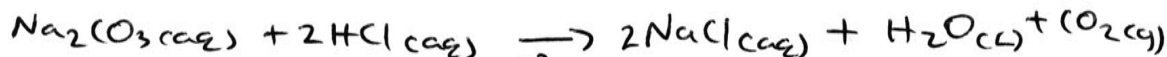
Then draw out 25mL of $Na_2CO_3(aq)$ using the pipette and place in each conical flask. Wash the burrette with distilled water and then hydrochloric acid (HCl). Then fill it up with HCl upto the etched $0mL$ marke. The apparatus should look like the diagram below. Place a suitable indicator in the conical Flask and titrate. ~~The so~~ The first reading should be a rough guide, but ~~the~~ be carefull and release ~~drop~~ the HCl drop by drop to ensure a more accurate reading for the next three and ~~a~~ ensure there ~~these~~ are no outliers in those three values before averaging them.

Titration apparatus:

burrette with HCl
retort stand
conical Flask with 25mL of Na_2CO_3
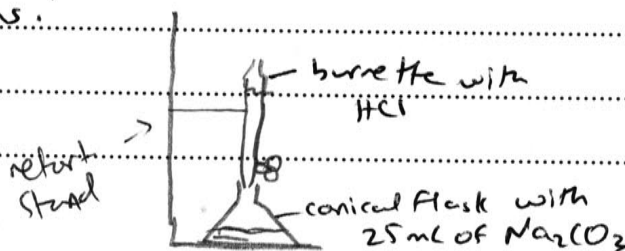
End of Question 28

Step 3C - when the two react it does so accordingly

$$Na_2CO_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

∴ moles of Na_2CO_3 = $0.100 \times$ ~~0.5~~ 25×10^{-3} = ~~0.0500~~ 2.5×10^{-3}

∴ moles of HCl = $2 \times$ moles Na_2CO_3 = $2 \times$ ~~0.0500~~ 2.5×10^{-3} = ~~0.100~~ 5×10^{-3}

∴ ~~0.100 moles / 21.4×10^{-3}~~

∵ 5×10^{-3} moles / 21.4×10^{-3} L

∴ 0.23364 mol/L = 0.234 mol/L