**Question 28** (8 marks)

The flowchart shown outlines the sequence of steps used to determine the   **8**
concentration of an unknown hydrochloric acid solution.

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┌─────────────────────────┐
│   Preparation of    (A) │      N̶a̶t̶(̶a̶q̶)̶.  Na₂ CO₃ .
│ 500 mL 0.100 mol L⁻¹ sodium │
│  carbonate standard solution │
└─────────────────────────┘
             │
        25.0 mL used
             │
             ▼
┌─────────────────────────┐        ┌──────────────────┐
│    Titration       (B) ◄┼────────┤    Unknown       │
└─────────────────────────┘        │ hydrochloric acid│
             │                     │    solution      │
   Average titration               └──────────────────┘
   volume of acid 21.4 mL
             │
             ▼
┌─────────────────────────┐
│   Concentration of  (C) │
│ hydrochloric acid solution │
└─────────────────────────┘
```
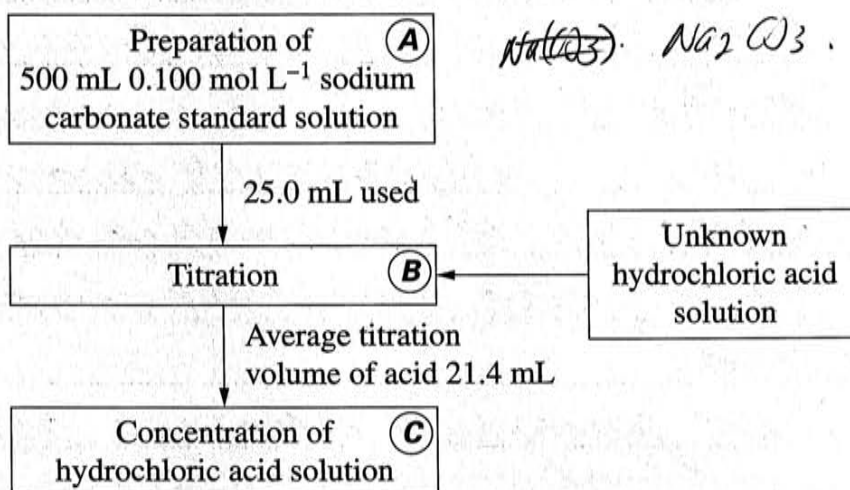
Describe steps **A**, **B** and **C** including correct techniques, equipment and appropriate
calculations. Determine the concentration of the hydrochloric acid.

Step A Preparation of A standard solution.

① measure out exactly 0.1 mol of sodium carbonate solid
using an gravimetric electronic balance (10.599 gram)

② place sodium carbonate into a 500mL volumetric
flask.

③ fill 80 100mL of distilled water into volumetric
flask.

④ Place a stopper in volumetric flask and swivel
the flask until all of the Na₂CO₃ is dissolved.
Invert 3 times to ensure it is dissolved

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Question 28 (continued)

⑤ fill up the volumetric flask with distilled water
till the etched mark (this should be the bottom of the
meniscus.

Step B ① rinse pipette with Na_2CO_3 solution from standard
solution.

② rinse out burette with unknown HCl solution.

③ Rinse out conical flask ~~with~~ with water

④ pipette exactly 25mL of standard solution into
a conical flask, tapping gently on side to ensure
all drops of Na_2CO_3 are transferred into conical flask.

⑤ fill up burette with HCl solution till the zero.

⑥ open the top of burette and let HCl solution
into conical flask.

⑦ Swirl flask gently until observable colour
change.

⑧ Record the amount of HCl used.

⑨ Repeat steps 1-8

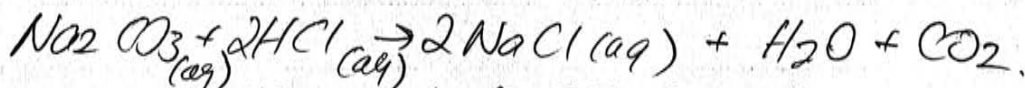⑩ Calculate the average amount of HCl used,
ignoring the outlying titration value.

End of Question 28

Step C: calculations

$\triangle$mcl: average ~~titrable~~ volume of HCl used = 21.4mL

$\triangle$mcl: volume of Na_2CO_3 = 25mL

$\triangle$mcl: mol of Na_2CO_3 = $0.5 \times \frac{25}{1000}$ = $\frac{0.5 mol}{20}$ = $0.025 mol$.

$$Na_2CO_{3(aq)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O + CO_2.$$

hence $\triangle$mcl: mol of HCl used = $0.025 \times 2 = 0.05$.

hence final: concentration of HCl = ~~mol/Vol~~ $\frac{m}{V} = \frac{0.05}{\frac{21.4}{1000}}$

              = $2.336448...$

              = $2.3 mol\ L^{-1}$