Question 28 (8 marks)

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

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

**Step 1.** Requires the preparation of a standard solution.

**Moles of** \( \text{Na}_2\text{CO}_3 \) = \( 0.5 \times 0.1 \) = 0.05 moles = 5.79959

1. **Using an electronic balance,** weigh out 5.29959 g of \( \text{Na}_2\text{CO}_3 \) solid on a watch glass.

2. **Now, using a funnel,** transfer the solid into a 50 mL volumetric flask. Use distilled water, rinse bottle to rinse all remaining particles into the funnel and watch glass into the volumetric flask.

3. **Now, lightly swirl the** volumetric flask until the solid dissolve completely.

4. **Fill the volumetric flask up to the 50 mL mark with distilled water. Ensure that the bottom miniscus touches the line.**

5. **Place a stopper on the top of the flask.**

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Step B

1. Transfer 100 ml of the Na₂CO₃ standard into a dry and clean beaker, and label it.

2. Do this for the unknown HCl (aq) into another clean and dry beaker, and label it.

3. Using 10 ml of HCl, rinse the burette, ensuring all the surface area has made contact. Then pour out the HCl.

4. Use 10 ml of Na₂CO₃ to rinse the burette and ensure all the surface area has made contact. Then pour out.

5. Now using the burette and splinter, suck up 5 ml of clean and dry Na₂CO₃ (aq), and transfer it to a clean conical flask.

6. Fill burette up with HCl (aq) from burette up to one mark.

7. Add 5 drops of methyl orange indicator to the conical flask.

8. Titrate slowly and drop by drop of HCl to the conical flask until you observe a colour change, then you have reached your equivalence point.

9. Record the ml used of HCl into a table. The first run is your rough, remember to omit from average later.

10. Repeat the titration clean and dry the conical flask before repeating experiment 5 times.

11. Average your results, omitting outliers and last rough titration.

12. Calculate the concentration of unknown, using average.

Step C

\[ \text{2HCl(aq)} + \text{Na₂CO₃(aq)} \rightarrow \text{2NaCl(aq)} + \text{CO₂(g)} + \text{H₂O(l)} \]

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

Moles of \( \text{Na₂CO₃} \) = \( \frac{0.05 \times 0.1}{0.0025 \text{ moles}} \)

Since \( \text{HCl : Na₂CO₃} \) = 2:1

\( \therefore \) moles of HCl = 0.005 moles

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<th>Thus,</th>
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<tr>
<td>Conc. HCl = ( \frac{0.005 \text{ moles}}{0.0214} )</td>
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<tr>
<td>= ( 0.2336 \text{ mol L}^{-1} ) (3 sf)</td>
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