

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 $\text{CO}_3^{2-} + 2\text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O}$; $\text{HCO}_3^- + \text{H}^+ \rightarrow \text{CO}_2 + \text{H}_2\text{O}$. Pass gas into limewater: it becomes milky. Both anions release CO_2 , and other reactions can bubble, so this observation does not distinguish the two.

2.2 NH_4^+ is supported; carbonate or hydrogencarbonate is supported, not a unique choice. $\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$; $\text{NH}_3 + \text{HCl} \rightarrow \text{NH}_4\text{Cl}$. Both candidate anions give CO_2 with acid.

2.3 Methyl orange: yellow to the specified orange endpoint, becoming red with excess acid. Phenolphthalein: pink to just colourless. Flask water does not change the amount of NaOH already delivered; pipette water would dilute the solution before measuring/delivering it, reducing the alkali amount in the nominal aliquot.

3.1 $\text{H}_2\text{A} + 2\text{NaOH} \rightarrow \text{Na}_2\text{A} + 2\text{H}_2\text{O}$. $n(\text{acid}) = m/M = 1.575/126.0 = 0.01250 \text{ mol}$; $c = 0.01250/0.2500 = 0.05000 \text{ mol dm}^{-3}$. The aliquot has $0.05000 \times 0.02500 = 0.001250 \text{ mol}$ acid, requiring 0.002500 mol NaOH. $c(\text{NaOH}) = 0.002500/0.02380 = 0.1050 \text{ mol dm}^{-3}$. Dissolve fully before transfer and rinse all transferring vessels/funnel into the flask.

3.2 Mass contribution $100(0.002/1.575) = 0.127\%$; flask $100(0.12/250.0) = 0.048\%$; pipette $100(0.06/25.00) = 0.240\%$. Titre contribution $100(0.10/23.80) = 0.420\%$. Sum = 0.835% , about 0.84% . Burette/titre is largest. Use suitable more precise volume measurement, or a safely larger titre with appropriate concentrations and apparatus capacity. Repetition addresses random endpoint variation, not a calibration bias.

3.3 HCl introduces Cl^- and can itself cause AgCl, so the conclusion is invalid. On a fresh aliquot use dilute HNO_3 , then aqueous AgNO_3 . AgCl is white and dissolves in dilute NH_3 ; AgBr is cream, remains in dilute but dissolves in concentrated NH_3 ; AgI is yellow and remains in both. $\text{Ag}^+(\text{aq}) + \text{X}^-(\text{aq}) \rightarrow \text{AgX}(\text{s})$.