

Solutions

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



2.2 $[\text{H}^+] = 2.00 \times 10^{-5}(0.100/0.200) = 1.00 \times 10^{-5} \text{ mol dm}^{-3}$; $\text{pH} = 5.00$.

2.3 Y; its transition lies within the steep region so a small titrant addition produces the endpoint colour change.

3.1 After reaction $\text{HA} = 0.0150 \text{ mol}$ and $\text{A}^- = 0.00500 \text{ mol}$. $[\text{H}^+] = 10^{-5}(0.0150/0.00500) = 3.00 \times 10^{-5} \text{ mol dm}^{-3}$; $\text{pH} = 4.52$. OH^- has consumed HA and formed A^- , so initial acid moles are no longer the buffer numerator.

3.2 Acid 0.00250 mol , OH^- added 0.00300 mol ; excess 0.000500 mol . $[\text{OH}^-] = 0.000500/0.0550 = 0.00909 \text{ mol dm}^{-3}$. $\text{pOH} = 2.04$, $\text{pH} = 11.96$. HA is exhausted; an HA/ A^- buffer no longer exists.

3.3 $[\text{H}^+] = 10^{-5.00} = 1.00 \times 10^{-5} \text{ mol dm}^{-3}$. $[\text{A}^-]/[\text{HA}] = K_a/[\text{H}^+] = 1.80$. Equal stock concentrations make this the volume ratio; common final volume cancels. $V_{\text{HA}} + V_{\text{A}^-} = 100.0$ and $V_{\text{A}^-} = 1.80V_{\text{HA}}$ give $V_{\text{HA}} = 35.7 \text{ cm}^3$ and $V_{\text{A}^-} = 64.3 \text{ cm}^3$.