

5(a)(i)	$\text{Co}^{2+} = [\text{Ar}] 3d^7$ AND $\text{Co}^{3+} = [\text{Ar}] 3d^6$
5(a)(ii)	has vacant d orbitals that are energetically accessible
5(a)(iii)	- pink - blue - aqueous Any two [1], all three [2]
5(a)(iv)	$[\text{Co}(\text{H}_2\text{O})_6]^{2+} + 4\text{HCl} \rightarrow [\text{CoCl}_4]^{2-} + 6\text{H}_2\text{O} + 4\text{H}^+$ OR $[\text{Co}(\text{H}_2\text{O})_6]^{2+} + 4\text{Cl}^- \rightarrow [\text{CoCl}_4]^{2-} + 6\text{H}_2\text{O}$
5(a)(v)	ligand exchange
5(a)(vi)	$[\text{Co}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow \text{Co}(\text{OH})_2(\text{H}_2\text{O})_4 + 2\text{H}_2\text{O}$ OR $[\text{Co}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow \text{Co}(\text{OH})_2 + 6\text{H}_2\text{O}$
5(b)(i)	M1: Nemst equation $E = E^\ominus + (0.059 / z) \times \log\left(\frac{[\text{oxidised}]}{[\text{reduced}]}\right)$ M2: $E = -0.28 + (0.059 / 2) \times \log(0.02)$
5(b)(ii)	1.66 V
5(b)(iii)	$3\text{Co} + \text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ \rightarrow 3\text{Co}^{2+} + 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$
5(b)(iv)	$\text{Co}^{2+} / \text{Co}$, $\text{Co}^{2+} / \text{Co}$, $\text{Cr}_2\text{O}_7^{2-} / \text{Cr}^{3+}$
5(c)	M1: moles of cobalt = $0.547 / 58.9 = 0.00929$ M2: coulombs required = $0.00929 \times 96500 \times 2 = 1792$ M3: time required = $1792 / 0.50 = 3584.8 \text{ s} = 59.7 \text{ minutes}$ 3sf