Question	Marking Guidance	Mark	Comments
7(a)	Orange dichromate	1	Allow max 2 for three correct colours not identified to species but in correct order
	Changes to purple / green / ruby / red-violet / violet Chromium(III)	1	
	(Note green complex can be $[Cr(H_2O)_5Cl]^{2+}$ etc)		Do not allow green with another colour
	That changes further to blue Chromium(II)	1	Allow max 1 for two correct colours not identified but in correct order
	$[Cr_2O_7]^{2-} + 14H^+ + 3Zn \rightarrow 2Cr^{3+} + 3Zn^{2+} + 7H_2O$	1	Ignore any further reduction of Cr^{2+}
	$2Cr^{3+} + Zn \rightarrow 2Cr^{2+} + Zn^{2+}$ /	1	Ignore additional steps e.g. formation of CrO_4^{2-}
	$[Cr_2O_7]^{2-} + 14H^+ + 4Zn \rightarrow 2Cr^{2+} + 4Zn^{2+} + 7H_2O$		
7(b)	Green precipitate	1	
	(Dissolves to form a) green solution	1	Solution can be implied if 'dissolves' stated
	$[Cr(H_2O)_6]^{3+} + 3OH^- \rightarrow Cr(H_2O)_3(OH)_3 + 3H_2O$	1	Penalise $Cr(OH)_3$ once only
	$Cr(H_2O)_3(OH)_3 + 3OH^- \rightarrow [Cr(OH)_6]^{3-} + 3H_2O$	1	Allow $[Cr(H_2O)_6]^{3+} + 6OH^- \rightarrow [Cr(OH)_6]^{3-} + 6H_2O$
			Allow formation of $[Cr(H_2O)_2(OH)_4]^-$ and $[Cr(H_2O)(OH)_5]^{2-}$ in balanced equations
			Ignore state symbols, mark independently

7(c)	(ligand) substitution / replacement / exchange	1	Allow nucleophilic substitution
	The energy levels/gaps of the <u>d</u> electrons are <u>different</u> (for each complex)	1	
	So a <u>different</u> wavelength/frequency/colour/energy of light is absorbed (when d electrons are excited)	1	Ignore any reference to emission of light
	OR light is absorbed and a different wavelength/frequency/colour/energy (of light) is transmitted/reflected		

7(d)	$E\ O_2$ (/ H_2O) > $E\ Cr^{3+}$ (/ Cr^{2+}) / e.m.f = 1.67 V	1	Allow E(cell) = 1.67
	So Cr^{2+} ions are oxidised by oxygen/air	1	Allow any equation of the form: $Cr^{2+} + O_2 \rightarrow Cr^{3+}$
	With $[Cr(H_2O)_6]^{2+}$ get $CrCO_3$	1	If named must be chromium(II) carbonate
	with $[Cr(H_2O)_6]^{3+}$ get $Cr(H_2O)_3(OH)_3$ / $Cr(OH)_3$	1	Allow 0 to 3 waters in the complex
	and CO_2	1	Can score M3, M4, M5 in equations even if unbalanced
	Cr(III) differs from Cr(II) because it is acidic / forms H^+ ions	1	
	because Cr^{3+} ion polarises <u>water</u>	1	Ignore charge/size ratio and mass/charge