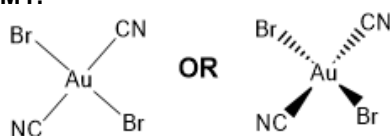
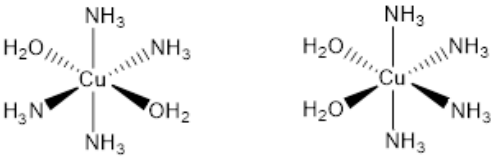


5(a)	<table><tr><th rowspan="2">species</th><th colspan="2">number of unpaired electrons</th></tr><tr><th>3d</th><th>4s</th></tr><tr><td>Cu</td><td>0</td><td>1</td></tr><tr><td>Cu²⁺</td><td>1</td><td>0</td></tr></table>	species	number of unpaired electrons		3d	4s	Cu	0	1	Cu ²⁺	1	0	
species	number of unpaired electrons												
	3d	4s											
Cu	0	1											
Cu ²⁺	1	0											
5(b)	• five 3d orbitals (lines, boxes) in the isolated Cu²⁺ ion of the same energy • splitting: three higher and two lower d orbitals • energy of all five d orbitals in complex higher than all d orbitals in isolated ion any two [1], all three [2]												
5(c)	M1: more than one (stable) oxidation state / exist in variable oxidation states M2: vacant / empty (d) orbitals are energetically accessible OR vacant / empty (d) orbitals can form dative bonds with ligands												
5(d)	<table><tr><th>metal ion</th><th>coordination number</th><th>formula of complex ion</th><th>charge of complex ion</th></tr><tr><td>Ag⁺</td><td>2</td><td><u>Ag(CN)₂</u></td><td>1–</td></tr><tr><td>Fe²⁺</td><td>6</td><td><u>Fe(CN)₆</u></td><td>4–</td></tr></table> each row [1]	metal ion	coordination number	formula of complex ion	charge of complex ion	Ag ⁺	2	<u>Ag(CN)₂</u>	1–	Fe ²⁺	6	<u>Fe(CN)₆</u>	4–
metal ion	coordination number	formula of complex ion	charge of complex ion										
Ag ⁺	2	<u>Ag(CN)₂</u>	1–										
Fe ²⁺	6	<u>Fe(CN)₆</u>	4–										
5(e)	M1:  M2: (shape) square planar AND (bond angle) 180°												
5(f)(i)	M1: moles MnO₄[–] = 0.075 × 0.0225 = 1.6875 × 10^{–3} M2: moles V²⁺ = 5 / 3 × 1.6875 × 10^{–3} = 2.8125 × 10^{–3} M3: mass V = 50.9 × 2.8125 × 10^{–3} = 0.143 g % of V = 0.143 / 0.250 × 100 = 57.3 min 2sf												
5(f)(ii)	2VO₃[–] + 3Zn + 12H⁺ → 2V²⁺ + 3Zn²⁺ + 6H₂O M1: 2 : 3 ratio on both sides M2: rest of the equation correct												

6(a)(i)	Ni(CO) ₄
6(a)(ii)	- ethanedioate given as C₂O₄ - formula shows one Ni and three ligands - charge = 4- any two [1], all three [2] Ni(C₂O₄)₃⁴⁻ scores [2]
6(a)(iii)	F AND optical
6(b)(i)	N atom can donate one lone pair of electrons
6(b)(ii)	[Cd(en) ₂] ²⁺ AND has a larger K _{stab} / is more stable
6(b)(iii)	$\frac{[\text{Cd}(\text{CH}_3\text{NH}_2)_4]^{2+}}{[\text{Cd}^{2+}][\text{CH}_3\text{NH}_2]^4}$

1(a)	forms (one or more) stable ions / compounds / oxidation states with incomplete / partially filled (3)d orbital(s) / d shell / d sub-shell
1(b)(i)	(orbitals) are at the same energy
1(b)(ii)	$(1s^2) 2s^2 2p^6 3s^2 3p^6 3d^9$
1(c)(i)	$[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}(\text{aq})$ deep / dark / royal blue AND $[\text{CuCl}_4]^{2-}(\text{aq})$ yellow
1(c)(ii)	M1: d orbital(s) of different energy / d-d splitting occurs / d sub-shell splits M2: electron(s) promoted / excited M3: light / wavelength / frequency / photon absorbed AND complementary colour seen
1(d)(i)	M1: ligand exchange / replacement / substitution / displacement M2: $[\text{CuCl}_4]^{2-} + 4\text{NH}_3 + 2\text{H}_2\text{O} \rightarrow [\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+} + 4\text{Cl}^-$
1(d)(ii)	M1: one correct 3D structure of $[\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+}$ M2: correct 3D stereoisomer structure of isomer 1 
1(d)(iii)	cis isomer AND dipoles do not cancel
1(e)(i)	(two) oxygen and (one) nitrogen (can donate) three lone pair(s) of electrons (to the metal ion)
1(e)(ii)	$[\text{Co}(\text{C}_4\text{H}_5\text{NO}_4)_2]^-$
1(f)(i)	equilibrium constant for the formation of the complex (ion) in a solvent / water / solution OR from its constituent ions or molecules
1(f)(ii)	$[\text{Ag}(\text{CN})_2]^- (\text{aq})$ AND largest (value of) K_{stab}
1(g)	M1 M2: any two [1], all four [2] - moles $\text{MnO}_4^- = 0.015 \times 18.70 / 1000 = 2.805 \times 10^{-4}$ - moles $\text{SO}_3^{2-} = 2.805 \times 10^{-4} \times 5/2 = 7.0125 \times 10^{-4}$ (in 10 cm³) - moles $\text{SO}_3^{2-} = 1.753 \times 10^{-2}$ (in 250 cm³) - mass $\text{Na}_2\text{SO}_3 = 1.753 \times 10^{-2} \times 126.1 = 2.21$ g M3: % purity = $100 \times 2.21 / 3.75 = 58.9 - 59.0$ % min 2sf