Question	Expected Answers	Marks
1 (a) (i)	6	1
(ii)	Species with (lone) pair of electrons	1
	Capable of being donated / forms a dative covalent bond / co-ordinate bond to a metal ion. (allow suitable diagram)	1
(b) (i)	$[Co(H_2O)_6]^{2+}$ is octahedral	
	$[CoCl_4]^{2-}$ is tetrahedral (both needed for 1 mark)	1
(ii)	pink to blue	1
(iii)	Ligand substitution / exchange/displacement	1
(c) (i)	1 mark for correct 3-D diagram of cis isomer	1
	1 mark for correct 3-D diagram of trans isomer	1
	(see additional sheet for diagrams. Allow planar diagrams if two appropriate 90° angles are shown)	
(ii)	Geometric / cis - trans	1
(d)	1 mark for using cis isomer	1
	1 mark for correct 3-D diagrams which are mirror images of each other.	1
	(see additional sheet for diagrams. If all diagrams are drawn as non-3d do not penalise in (d))	
		Total: 11

Question	Expected Answers	Marks
2 (a)	Correctly drawn lower energy d-orbital (see additional sheet for diagrams)	1
	Correctly drawn high energy d-orbital (see additional sheets for diagrams) Allow one mark if transposed.	1
(b)	Need at least 1 electron in lower energy d-orbitals and a space in the higher energy d-orbitals. (allow d-orbitals are partially filled)	1
	Promotion of an electron absorbs visible light	1
	Colour absorbed depends upon energy gap / energy gap matches energy from visible light / idea that only part of visible light absorbed / $\Delta E = hf$	1
	Remaining light transmitted to give colour / transmitted light is no longer white (Accept appropriate diagrams for the marks)	1
(c)	Isomer is $[Cr(H_2O)_6]Cl_3$	1
	Yellow /green light is absorbed	1
	Purple light transmitted / violet and red transmitted (to give purple colour).	1
		Total: 9

Question	Expected Answers	Marks
3. (a)	Stainless steel + corrosion resistant / Alloys / making tools + very hard Chrome plating + prevents rusting / corrosion	1
(b) (i)	All oxidation number worked out to show that none have changed (Cr = +6, H = +1, O = -2)	1
(ii)	Yellow to orange	1
(iii)	NaOH or another suitable alkali /OH^- (not H_2O)	1
(c) (i)	Brown solution/brown precipitate/black solid Add starch to get blue / black colour	1
(ii)	Titration / volumetric analysis using sodium thiosulphate(with starch indicator) (allow from equation)	1 1
	$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$	1
	1 mol $Cr_2O_7^{2-}$ = 6 mols $S_2O_3^{2-}$	1
		Total: 9

Question	Expected Answers	Marks
4. (a)	A = Platinum(electrode) B = H^+(aq) / HCl(aq) / other suitable acid C = Voltmeter / galvanometer D = Cl_2(g) State symbols needed for B and D All correct = 2, 3 correct =1	2
(b) (i)	Arrow marked on or close to wire via voltmeter pointing from hydrogen half cell to chlorine half cell	1
	Electrons flow to half cell with more +ve standard electrode potential	1
(ii)	Pressure = 1 Atm / 100 kPa Temp = 298 K / 25^0C Concentration = 1 mol dm^{-3} All 3 correct = 2 marks 2 correct = 1 mark	2
(c)	The standard electrode potential for ClO_3^- / ½Cl_2 is more positive than that of ½ Cl_2 / Cl^-	1
	ClO_3^- has a greater tendency to gain electrons than Cl_2 / ClO_3^- is a better oxidising agent than Cl_2	1
	Alternative: Because $E^{\ominus}$ is positive, the reaction will go from left to right therefore ClO_3^- is reduced so it must be a better oxidising agent than chlorine.	
		Total: 8

Question	Expected Answers	Marks
5.	Blue solution / it goes blue	1
	Correct oxidation number for Cu in Cu_2O (+1), $CuSO_4$ (+2), and Cu (0)	1
	Cu^+ / Cu_2O is oxidised to Cu^{2+}/$CuSO_4$ and Cu^+ / Cu_2O is reduced to Cu	1
	This is disproportionation	1
	Cu(I) stable as a solid / unstable in aqueous solution	
	Cu(II) stable in aqueous solution / stable as solid	1
	Cu(0) stable as the element/solid	1
		1
	QWC 1 mark to be awarded for an answer that includes two complete sentences with good use of basic grammar.	1
		Total: 8

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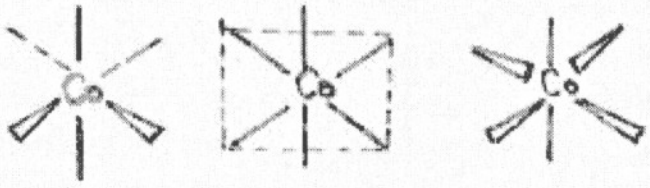
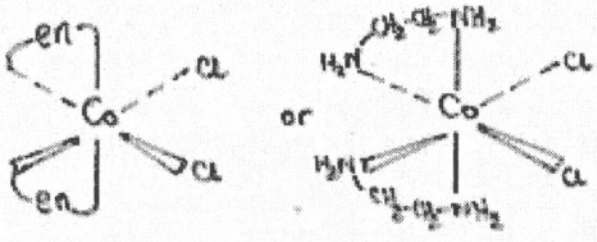
Additional sheet

1. (c) (i) Allow any suitable 3-D diagrams. Possibilities to include:

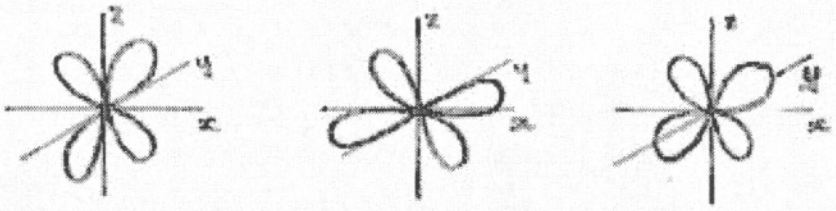


(d) Allow any suitable 3-D diagrams such as:



2. (a)

Correct lower energy d-orbitals include:



Correct higher energy d-orbitals include: