

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit () = words which are not essential to gain credit — = (underlining) key words which <u>must</u> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument																
Question	Expected Answers	Marks															
1 (a)	Vanadium used in alloys for strength Vanadium(V) oxide used as a catalyst (Don't accept just the word catalyst)	1															
(b)	Diagram to show: V/V ²⁺ system Hydrogen electrode (Pt, H ₂ and H ⁺ must be labelled) Salt bridge + voltmeter + complete circuit Temp 298K, concentration 1 mol.dm ⁻³ , pressure 1 atm All 3 = 2 marks; any 2 = 1 mark	1 1 1 2															
(c) (i)																	
(ii)	<table border="1" data-bbox="416 972 1209 1256"> <thead> <tr> <th></th> <th>V²⁺</th> <th>VO₂⁺</th> <th>VO²⁺</th> <th>V³⁺</th> </tr> </thead> <tbody> <tr> <td>Oxidation Number</td> <td>+2</td> <td>+5</td> <td>+4</td> <td>+3</td> </tr> <tr> <td>Colour</td> <td>lilac</td> <td>yellow</td> <td>blue</td> <td>Green</td> </tr> </tbody> </table>		V ²⁺	VO ₂ ⁺	VO ²⁺	V ³⁺	Oxidation Number	+2	+5	+4	+3	Colour	lilac	yellow	blue	Green	4
	V ²⁺	VO ₂ ⁺	VO ²⁺	V ³⁺													
Oxidation Number	+2	+5	+4	+3													
Colour	lilac	yellow	blue	Green													
	Correct calculation of cell potential as -0.44 V Because it is -ve, reaction not feasible	1 1															
	Alternative: V better reducing agent than Zn Because the E ^o for V/V ²⁺ is more -ve	Total: 12															

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Question	Expected Answers	Marks
2 (a) (i) (ii) (b) (c)	Central ion surrounded by molecules/ions/ligands Molecule/ion with a lone pair of electrons Able to form a dative covalent or co-ordinate bond / which can be donated Two lone pairs/ able to form two dative covalent / co-ordinate bonds Stereoisomerism – same atoms with same order of bonds but a different spatial arrangement / same structure but different arrangement of atoms Both isomers drawn for cis / trans Both isomers drawn for optical (must be mirror images) (all diagrams to show 3-D arrangement) Enantiomers/non superimposable mirror images Rotate plane polarised light in opposite direction by same number of degrees (any two for 1 mark)	1 1 1 1 2 2 1 1 Total: 11

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Question	Expected Answers	Marks
3 (a) (i)	Two orbital boxes higher and 3 orbital boxes lower	1
	Correct arrangement of electrons	1
	(see additional sheet)	
(ii)	One lower energy and one higher energy d-orbital shown	2
	(see additional sheet)	
(b)	Electrons promoted from low to high energy d-orbitals	1
	Energy involved lies in visible region of spectrum /	1
	needs visible light	1
	Some of the visible light is transmitted / absorbed	1
	Idea that colour depends upon the actual wavelengths	1
	transmitted / energy gap	1
	Need at least one unpaired d-orbital or	1
	$\text{Cu}^+ 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$	1
	Only Cu^{2+} has an unpaired electron or	1
	$\text{Cu}^{2+} 1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$	1
	QWC: communicates by using at least 3 terms from the following list	
	d-orbitals, visible, spectrum, transmitted, wavelength,	
	energy gap, unpaired electron, high or low energy,	
	absorbed, d-sub shell	1
(c)	Compound absorbs green/yellow	1
	Blue and red transmitted (to give purple)	1
	(allow all colours absorbed except violet/blue and red for 1 mark)	
		Total: 13

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Question	Expected Answers	Marks
4 (a) (i)	$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{I}^- \rightleftharpoons 2\text{Cr}^{3+} + 3\text{I}_2 + 7\text{H}_2\text{O}$ All species correct (ignore electrons for this mark) Equation balanced (penalise if electrons not cancelled out)	1 1
(ii)	Brown colour disappears $\text{S}_2\text{O}_3^{2-}$ reacts with I_2 (to form colourless I^-) Green colour remains due to Cr^{3+} (must say what gives green colour)	1 1 1
(b) (i)	Oxidation Number of Cr on both sides = +6 Oxidation Number does not change therefore not redox	1 1
(ii)	Orange to yellow (both needed for 1 mark)	1
(iii)	Any suitable named acid or correct formula eg H_2SO_4	1
		Total: 9