Transition Metals

Mark Scheme 2

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Chemistry Lab Skills 2
Sub Topic	Transition Metals
Booklet	Mark Scheme 2

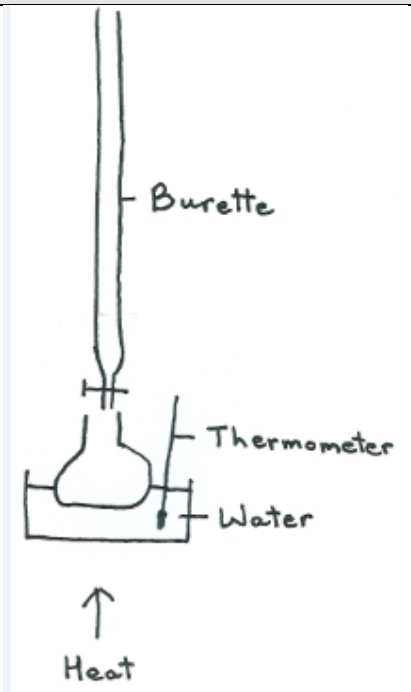
Time Allowed: **46 minutes**

Score: **/38**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question Number	Acceptable Answers	Reject	Mark
1(a)(i)	 Burette and (conical) flask / beaker **and** **Either** Heated water bath / direct heat Can be shown by heat/arrow **(1)** Thermometer in flask / water **(1)** **OR** Heating mantle / hot plate **(1)** With thermostatic control **(1)** ALLOW 1 mark for heating separate from the titration		2

Question Number	Acceptable Answers	Reject	Mark
1(a)(ii)	(The excess / unreacted) **zinc** / **Zn((s))** (is removed) Allow Insoluble zinc Insoluble reactant Zinc Zinc solid / left over	Insoluble impurities Insoluble reactant alone	1

Question Number	Acceptable Answers	Reject	Mark
1(a)(iii)	To prevent it / **T** being oxidized by air / oxygen ALLOW To prevent oxidation OR The vanadium(II) is easily oxidized by air / oxygen OR (As a) large volume / volume greater than 50 cm^3 of potassium manganate(VII) is required		1

Question Number	Acceptable Answers	Reject	Mark
1(a)(iv)	**EITHER** Because the potassium manganate(VII) is self-indicating ALLOW Reaction is self-indicating ALLOW Potassium manganate (VII) changes colour during the reaction/ at the end point. **OR** at the end point a pink / purple solution forms (from a blue/yellow/green solution) ALLOW Modified pink e.g. yellow pink because of the yellow vanadate(V)	Just obvious / clear colour change without potassium manganate(VII)	1

Question Number	Acceptable Answers	Reject	Mark
1(b)(i)	$\frac{25 \times 0.10}{1000} = 2.5 \times 10^{-3}/0.0025$ (mol)		1

Question Number	Acceptable Answers	Reject	Mark
1(b)(ii)	Total volume of 0.02 mol dm^{-3} solution of potassium manganate(VII) = 25 + 50 = 75 cm^3 **(1)** $\frac{(75) \times 0.02}{1000}$ = 1.5×10^{-3}/0.0015 (mol) **(1)** ALLOW for 1 mark $\frac{25 \times 0.02}{1000}$ = 5×10^{-4}/0.0005 (mol) **OR** $\frac{50 \times 0.02}{1000}$ = 1×10^{-3}/0.001 (mol) ALLOW Internal TE for incorrect volume in first calculation for second mark.		2

Question Number	Acceptable Answers	Reject	Mark
1(b)(iii)	$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$		1

Question Number	Acceptable Answers	Reject	Mark
1(b)(iv)	**METHOD 1** 2.5×10^{-3} mol of vanadium ions lose $5 \times 1.5 \times 10^{-3} = 7.5 \times 10^{-3}$ mol electrons **(1)** Therefore 1 mol of vanadium ions lose 3 mol of electrons **(1)** As final oxidation state is +5 the oxidation state of vanadium in the purple solution is +2 **(1)** **METHOD 2** Ratio of Mn:V = 0.0015:0.0025 = 3:5 **(1)** Oxidation number of Mn changes by 5 so oxidation number of vanadium must change by 3 **(1)** As final oxidation state is +5 the oxidation state of vanadium in the purple solution is +2 **(1)** **METHOD 3** **First Mark** +2 (with no working) **Second Mark** Working backwards from this: Any mention of transfer of 3 electrons OR $V^{5+} + 3e^{(-)} \rightarrow V^{2+}$ OR $V^{2+} - 3e^{(-)} \rightarrow V^{5+}$ IGNORE $Mn(VII) + 3e^{(-)} \rightarrow Mn(II)$ **Third Mark** 7.5×10^{-3} mols of electrons / change in oxidation number removed from 2.5×10^{-3} V^{3+} OR 7.5×10^{-3} mols of manganate(VII) ion react with 2.5×10^{-3} mols V^{3+} ALLOW TE from (b)(ii) and (iii)		3

Question Number	Acceptable Answers	Reject	Mark
1(c)	$VO_3^- + 2H^+ \longrightarrow VO_2^+ + H_2O$		1

Question Number	Acceptable Answers	Reject	Mark
1(d)	**First Mark** V^{3+} / V(III) / (V)+3 **(1)** **Second Mark** Any of the following calculations : V(IV)/VO^{2+} to V(III)/ V^{3+} = +0.48 (V) OR V(III)/V^{3+} to V(II)/ V^{2+} =-0.12 (V) OR ALLOW V(V)/VO_2^+ to V(IV)/VO^{2+} =+0.66 (V) OR Sn^{2+}(aq)|Sn(s) has a more negative electrode potential than the last two vanadium potentials (so vanadium reduced to V^{3+}) Accept reverse argument OR By the anticlockwise rule if shown with appropriate arrows **(1)**		2

Total for Question 1 = 15 marks

Question Number	Acceptable Answers	Reject	Mark
2(a)	Green OR Green (Cr^{3+}) IGNORE additional information unless another wrong colour. ALLOW Shades of green like: pale green light green dark green ALLOW Violet / purple / red-violet / red-purple / mauve / ruby-violet / green-violet	Blue Blue-green Grey-green Blue-violet	**1**

Question Number	Acceptable Answers	Reject	Mark
2(b)	Green / grey-green / grey-blue **precipitate / ppt / ppte** (of $Cr(OH)_3$ / $[Cr(H_2O)_3(OH)_3]$) ALLOW recognisable spelling of state eg percipitate **(1)** **Second mark depends on first mark** (or near miss such as incorrect formula of precipitate / incorrect colour of ppt) Dissolves (to give green solution) OR Green solution forms (of $[Cr(OH)_6]^{3-}$) **(1)** IGNORE shades of colour: Light / dark etc	Other wrong descriptions like effervescence Incorrect formula for example $Cr(H_2O)_2(OH)_4]^-$ Dissolves to give a yellow / blue solution Incorrect formula for example CrO_4^{2-}	**2**

Question Number	Acceptable Answers	Reject	Mark
2(c)	CrO_4^{2-} **OR** CrO_4^{-2} **(1)** **Check the charge is correct** IGNORE brackets eg $[CrO_4]^{2-}$ Oxidation / redox (reaction) Ignore references to Cr^{3+}, Cr^{6+}, loss/gain and loss of electrons, deprotonation **(1)** **Mark each part independently.**	CrO_4^{-} $Cr_2O_7^{2-}$ Reduction Reduction / redox Redox / reduction References to Cr^{2+} 'Gain of electrons' alone	**2**

Total for Question 2 = 5 marks

Question Number	Correct Answer	Reject	Mark
3(a)	Any **two** from: Fe^{2+} / $Fe(H_2O)_6^{2+}$ Ni^{2+} / $Ni(H_2O)_6^{2+}$ Cr^{3+} / $Cr(H_2O)_6^{3+}$ Allow Cu^{2+} Ignore names As usual: 1 correct and 1 incorrect scores 1 2 correct and 1 incorrect scores 1 3 correct and 1 incorrect scores 2	Cr^{2+} $Cu(H_2O)_6^{2+}$ $Cu(H_2O)_4^{2+}$	**2**

Question Number	Correct Answer	Reject	Mark
3(b)(i)	Fe^{2+} / $Fe(H_2O)_6^{2+}$ Ignore names		**1**

Question Number	Acceptable Answers	Reject	Mark
3(b)(ii)	$Fe(OH)_2$/ $Fe(H_2O)_4(OH)_2$ / $Fe(OH)_2(H_2O)_4$ Ignore names TE if Ni^{2+} in (b)(i) then $Ni(OH)_2$/ $Ni(H_2O)_4(OH)_2$ / $Ni(OH)_2(H_2O)_4$ score 1. No TE for Cr^{3+}		**1**

Question Number	Acceptable Answers	Reject	Mark
3(b)(iii)	$Fe(OH)_3$/ $Fe(H_2O)_3(OH)_3$ / $Fe(OH)_3(H_2O)_3$ Ignore names No TE from (b)(i) ALLOW: Fe_2O_3 with or without water		**1**

Question Number	Acceptable Answers	Reject	Mark
3(b)(iv)	Oxidation / redox (reaction) Additional information may be given and can be ignored, e.g. 'green precipitate undergoes oxidation'. ALLOW: Oxidation and reduction	Just 'reduction'	**1**

Question Number	Acceptable Answers	Reject	Mark
3(c)	Purple to colourless/pale yellow/brown Both required OR Purple (solution) decolourised Allow Pink for purple OR Green to yellow/brown	Colourless to purple Green to purple	**1**

Question Number	Acceptable Answers	Reject	Mark
3(d)(i)	Cl^-(ion) Ignore names: e.g. Chlor**ide** (ion) Iron(II) chloride	Cl $FeCl_2$ Chlor**ine** ion	**1**

Question Number	Acceptable Answers	Reject	Mark
3(d)(ii)	Ammonia reacts with the iron ions to form a precipitate OR A precipitate forms **(1)** **Second mark** (A precipitate of) Iron(II) hydroxide/ Iron(III) hydroxide/ $Fe(OH)_2$/ $Fe(H_2O)_4(OH)_2$/ $Fe(OH)_3$/ $Fe(H_2O)_3(OH)_3$ (forms) OR Obscures the dissolving of the white precipitate (OWTTE e.g. masks precipitate) **(1)** **ALLOW** Precipitate should dissolve but here ammonia is neutralised by nitric acid **(1 max)**		**2**

(Total for Question 3 = 10 marks)

Question Number	Acceptable Answers	Reject	Mark
4(a)	$CuCl_4^{2-}$/$[CuCl_4]^{2-}$ /$(CuCl_4)^{2-}$/$[Cu(Cl)_4]^{2-}$	$CuCl_4$ Correct formula with added H_20	**1**

Question Number	Acceptable Answers	Reject	Mark
4(b)	(pale) blue **precipitate** **(1)** Ignore gelatinous in front of precipitate but not in front of solution in next part. precipitate dissolves (in excess ammonia)/ precipitate disappears/soluble/solution forms **(1)** deep/dark(er)/royal blue(solution) **(1)** deep blue solution forms scores 2nd and 3rd marks Marks stand alone Ignore formulae even if incorrect	Just "blue"	**3**

Question Number	Acceptable Answers	Reject	Mark
4(c)(i)	($2S_2O_3^{2-} + I_2 \rightarrow$) $S_4O_6^{2-} + 2I^-$ Ignore state symbols even if incorrect		**1**

Question Number	Acceptable Answers	Reject	Mark
4(c)(ii)	mol $S_2O_3^{2-}$ = 17.85 x 0.120/1000 **(1)** = 2.142 x 10^{-3}/0.002142 mol Cu^{2+} = 2.142 x 10^{-3} in 25 cm^3 total mol Cu^{2+} = 2.142 x 10^{-3} x 250/25 **(1)** **=** 2.142 x 10^{-2}/0.02142 [$CuSO_4$] = 2.142 x 10^{-2} x 1000/20.0 = 1.07(1) (mol dm^{-3}) **(1)** Ignore sf except 1 sf Correct answer with no working **(3)** 0.107 (mol dm^{-3}) **2 max** Check unfinished calculation not finished on next page 2nd and 3rd marks can be transferred errors	1 sf 1.0/1	**3**

(Total for Question 4 = 8 marks)