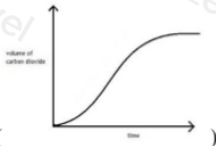


Question Number	Answer	Mark
14	 <p>The only correct answer is D ()</p> <p><i>A is incorrect because there is an initial slow rate before speeding up</i></p> <p><i>B is incorrect because there is an initial slow rate before speeding up</i></p> <p><i>C is incorrect because the rate slows as the reactant concentration decreases</i></p>	(1)

Question Number	Answer	Mark
14	<p>The only correct answer is C (+5 → +4 → +5)</p> <p><i>A is not correct because the oxidation state in V₂O₅ is +5 not +2</i></p> <p><i>B is not correct because the oxidation state in V₂O₅ is +5 not +2</i></p> <p><i>D is not correct because the vanadium cannot be oxidised from +5 to +6</i></p>	(1) Computer

Question Number	Answer	Mark
10	<p>The only correct answer is B ([Co(H₂O)₆]²⁺)</p> <p><i>A is not correct because VO²⁺ is blue</i></p> <p><i>C is not correct because [Cr(H₂O)₆]²⁺ is blue</i></p> <p><i>D is not correct because [Cu(H₂O)₆]²⁺ is blue</i></p>	(1) Computer

Question Number	Answer	Mark
5(a)	<p>The only correct answer is D ($[\text{Ar}] 3d^{10} 4s^1$ $[\text{Ar}] 3d^{10}$ / $[\text{Ar}] 3d^9$)</p> <p><i>A is incorrect because the copper atom has the structure $[\text{Ar}]3d^{10}4s^1$ and Cu^+ is $[\text{Ar}]3d^{10}$</i></p> <p><i>B is incorrect because the copper atom has the structure $[\text{Ar}]3d^{10}4s^1$ and Cu^+ is $[\text{Ar}]3d^{10}$ and Cu^{2+} is $[\text{Ar}]3d^9$</i></p> <p><i>C is incorrect because Cu^+ has the structure $[\text{Ar}]3d^{10}$ and Cu^{2+} is $[\text{Ar}]3d^9$</i></p>	(1)

Question Number	Answer	Mark
5(b)	<p>The only correct answer is C (T S P)</p> <p><i>A is incorrect because T is the only Cu(0) present in the scheme</i></p> <p><i>B is incorrect because T is the only Cu(0) present in the scheme</i></p> <p><i>D is incorrect because S is the only Cu(I) in the scheme other than Cu(I) in copper(I) iodide</i></p>	(1)

Question Number	Answer	Mark
5(c)	<p>The only correct answer is D (NH_3)</p> <p><i>A is incorrect because aqueous ammonia is needed to convert $\text{Cu}(\text{OH})_2$ to $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$</i></p> <p><i>B is incorrect because aqueous ammonia is needed to convert $\text{Cu}(\text{OH})_2$ to $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$</i></p> <p><i>C is incorrect because aqueous ammonia is needed to convert $\text{Cu}(\text{OH})_2$ to $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$</i></p>	(1)

Question number	Answer	Mark
4	<p>The only correct answer is D ($\text{Zn}(\text{OH})_2$)</p> <p><i>A is incorrect because $\text{Cu}(\text{OH})_2$ is only soluble in excess aqueous ammonia</i></p> <p><i>B is incorrect because $\text{Fe}(\text{OH})_2$ is insoluble in both excess aqueous ammonia and excess aqueous sodium hydroxide</i></p> <p><i>C is incorrect because $\text{Ni}(\text{OH})_2$ is only soluble in excess aqueous ammonia</i></p>	(1)

Question number	Answer	Mark
6	<p>The only correct answer is B (Mn^{2+} acts as a catalyst; concentration of reactants decreases)</p> <p><i>A is incorrect because the kinetic energies of the particles do not change</i></p> <p><i>C is incorrect because MnO_4^- is not a catalyst and the kinetic energies of the particles do not change</i></p> <p><i>D is incorrect because MnO_4^- is not a catalyst</i></p>	(1)

Question number	Answer	Mark
4	<p>The only correct answer is C (Ni^{2+})</p> <p><i>A is incorrect because Cu^{2+} gives a blue precipitate with aqueous sodium hydroxide and with aqueous ammonia</i></p> <p><i>B is incorrect because the precipitate formed with Fe^{2+} and aqueous ammonia is insoluble in excess ammonia</i></p> <p><i>D is incorrect because V^{2+} is a purple solution</i></p>	(1)

Question number	Answer	Mark
2	<p>The only correct answer is C ($\text{SO}_2 \rightarrow \text{SO}_3$, $+5 \rightarrow +4 \rightarrow +5$)</p> <p><i>A is incorrect because this is not the step catalysed</i></p> <p><i>B is incorrect because the vanadium is reduced</i></p> <p><i>D is incorrect because this is not the step catalysed and the vanadium is reduced</i></p>	(1)

Question Number	Answer	Mark
5	<p>The only correct answer is D (strong acid and strong alkali)</p> <p><i>A is incorrect because chromium(III) hydroxide is insoluble in water</i></p> <p><i>B is incorrect because chromium(III) hydroxide also dissolves in strong alkalis</i></p> <p><i>C is incorrect because chromium(III) hydroxide also dissolves in strong acids</i></p>	(1)

Question number	Answer	Mark
3	<p>The only correct answer is A ($[\text{Al}(\text{H}_2\text{O})_6]^{3+}$)</p> <p><i>B is incorrect because $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ gives a blue solution</i></p> <p><i>C is incorrect because $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ gives an orange / brown solution</i></p> <p><i>D is incorrect because $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ gives a green solution</i></p>	(1)

Question number	Answer	Mark
9	<p>The only correct answer is A ($\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$)</p> <p><i>B is incorrect because H^+ ions cannot be produced in an alkaline solution</i></p> <p><i>C is incorrect because H^+ ions cannot be produced in an alkaline solution</i></p> <p><i>D is incorrect because H^+ ions cannot be produced in an alkaline solution</i></p>	(1)

Question Number	Answer	Mark
8	<p>The only correct answer is A ($[\text{Fe}(\text{CN})_6]^{4-}$)</p> <p><i>B is not correct because $\text{C}_2\text{O}_4^{2-}$ is a bidentate ligand</i></p> <p><i>C is not correct because EDTA^{4-} is a hexadentate ligand</i></p> <p><i>D is not correct because $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ is a bidentate ligand</i></p>	(1) Computer

Question number	Answer	Mark
5	<p>The only correct answer is C (24.4%)</p> <p><i>A is incorrect because 6.10 % is the value when only 1 mol of water is considered</i></p> <p><i>B is incorrect because 8.06 % is the value when only 1 mol of water is considered and no water has been included in the molar mass of the salt</i></p> <p><i>D is incorrect because 32.2 % is the value when no water has been included in the molar mass of the salt</i></p>	(1)

Question number	Answer	Mark
1	<p>The only correct answer is D (zinc)</p> <p><i>A is incorrect because cobalt forms a stable Co^{2+} ion with incompletely-filled d-orbitals</i></p> <p><i>B is incorrect because copper forms a stable Cu^{2+} ion with incompletely-filled d-orbitals</i></p> <p><i>C is incorrect because nickel forms a stable Ni^{2+} ion with incompletely-filled d-orbitals</i></p>	(1)

Question number	Answer	Mark
10	<p>The only correct answer is B (negative; positive)</p> <p><i>A is incorrect because $E_{\text{cell}}^{\circ} = E_{\text{rhs}} - E_{\text{lhs}}$ so $0.17 - (-0.40) = +0.57 \text{ V}$ or $0.40 - (-0.17) = +0.57 \text{ V}$</i></p> <p><i>C is incorrect because $E_{\text{cell}}^{\circ} = E_{\text{rhs}} - E_{\text{lhs}}$ so $0.17 - (-0.40) = +0.57 \text{ V}$ or $0.40 - (-0.17) = +0.57 \text{ V}$</i></p> <p><i>D is incorrect because $E_{\text{cell}}^{\circ} = E_{\text{rhs}} - E_{\text{lhs}}$ so $0.17 - (-0.40) = +0.57 \text{ V}$ or $0.40 - (-0.17) = +0.57 \text{ V}$</i></p>	(1)

Question Number	Answer	Mark
7	<p>The only correct answer is C (six)</p> <p><i>A is not correct because it only takes into account water ligands</i></p> <p><i>B is not correct because it only takes into account ethanoate ions</i></p> <p><i>D is not correct because the coordination numbers of the two chromiums have been added together</i></p>	(1) Computer

Question number	Answer	Mark
8	<p>The only correct answer is A (standard reduction potential; most negative to most positive)</p> <p><i>B is incorrect because the electrochemical series has the most negative standard electrode potential first</i></p> <p><i>C is incorrect because standard cell potentials are determined from two standard electrode potentials</i></p> <p><i>D is incorrect because standard cell potentials are determined from two standard electrode potentials and the electrochemical series has the most negative standard electrode potential first</i></p>	(1)

Question Number	Answer	Mark
6	<p>The only correct answer is A (all can act as bidentate ligands)</p> <p><i>B is incorrect because this is true for H_2O, OH^- and NH_3</i></p> <p><i>C is incorrect because this is true for H_2O, OH^- and NH_3</i></p> <p><i>D is incorrect because this is true for H_2O, OH^- and NH_3</i></p>	(1)

← C is in     Tt  +   >  

D is in

Question Number	Answer
7	<p>The only correct answer is C (tetrahedral and square planar)</p> <p><i>A is incorrect because $[\text{CuCl}_4]^{2-}$ is tetrahedral</i></p> <p><i>B is incorrect because $[\text{CuCl}_4]^{2-}$ is tetrahedral and $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$ is square planar</i></p> <p><i>D is incorrect because $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$ is square planar</i></p>

Question Number	Answer	Mark
2(a)	<p>The only correct answer is C ($\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$)</p> <p><i>A is incorrect because water is the product, not a reactant</i></p> <p><i>B is incorrect because oxygen is a reactant, not a product</i></p> <p><i>D is incorrect because this is the reverse equation</i></p>	(1)

Question Number	Answer	Mark
2(b)	<p>The only correct answer is D (+1.23V)</p> <p><i>A is incorrect because the sign is incorrect</i></p> <p><i>B is incorrect because this is the sum of the two electrode potentials and the first value must be positive not negative</i></p> <p><i>C is incorrect because this is the changing of both signs for the electrode potentials and then subtracting</i></p>	(1)

Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	An answer that makes reference to the following points: suitable metal <ul style="list-style-type: none"> Mg / V / Zn / Fe / Ni / Cu correct E^\ominus cell <ul style="list-style-type: none"> Mg = (+) 3.7 (V), V = (+) 2.51(V), Zn = (+) 2.09(V), Fe = (+)1.77(V), Ni = (+) 1.58 (V), Cu = (+) 0.99 (V) 	(1) No other metals will score and no TE on other metals (1)	(2)

Question Number	Answer	Additional Guidance	Mark
20(a)(iii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> $[\text{Cr}(\text{NH}_3)_6]^{3+}$ ligand exchange 	(1) Ignore omission of square brackets Ignore (aq) (1) Allow ligand substitution / replacement	(2)

Question Number	Answer	Additional Guidance	Mark
20(a)(iv)	An answer that makes reference to the following points: <ul style="list-style-type: none"> not redox because the oxidation number of chromium has not changed oxidation number is 6/+6/6+/VI in both $\text{Cr}_2\text{O}_7^{2-}$ and CrO_4^{2-} 	(1) Allow just 'no as the oxidation number of chromium has not changed' (1)	(2)

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> $\text{KCr}(\text{SO}_4)_2$ 	Allow ions in any order Ignore correct charges on some/all of the ions	(1)

Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	<ul style="list-style-type: none"> M1 calculation of molar mass of $\text{KCr}(\text{SO}_4)_2$ M2 moles of $\text{KCr}(\text{SO}_4)_2$ 	Example of calculation (1) $39.1 + 52 + (32.1 \times 2) + (16 \times 8) = 283.3 \text{ (g mol}^{-3}\text{)}$ Allow TE from formula in (b)(i) (1) $56.74 \div 283.3 = 0.200 \text{ (mol)}$ Allow TE from M1	(4)

Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	An answer that makes reference to the following points: suitable metal <ul style="list-style-type: none"> Mg / V / Zn / Fe / Ni / Cu correct E^\ominus cell <ul style="list-style-type: none"> Mg = (+) 3.7 (V), V = (+) 2.51(V), Zn = (+) 2.09(V), Fe = (+)1.77(V), Ni = (+) 1.58 (V), Cu = (+) 0.99 (V) 	(1) No other metals will score and no TE on other metals (1)	(2)

Question Number	Answer	Additional Guidance	Mark
20(a)(iii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> $[\text{Cr}(\text{NH}_3)_6]^{3+}$ ligand exchange 	(1) Ignore omission of square brackets Ignore (aq) (1) Allow ligand substitution / replacement	(2)

Question Number	Answer	Additional Guidance	Mark
20(a)(iv)	An answer that makes reference to the following points: <ul style="list-style-type: none"> not redox because the oxidation number of chromium has not changed oxidation number is 6/+6/6+/VI in both $\text{Cr}_2\text{O}_7^{2-}$ and CrO_4^{2-} 	(1) Allow just 'no as the oxidation number of chromium has not changed' (1)	(2)

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> $\text{KCr}(\text{SO}_4)_2$ 	Allow ions in any order Ignore correct charges on some/all of the ions	(1)

Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	<ul style="list-style-type: none"> M1 calculation of molar mass of $\text{KCr}(\text{SO}_4)_2$ M2 moles of $\text{KCr}(\text{SO}_4)_2$ 	Example of calculation (1) $39.1 + 52 + (32.1 \times 2) + (16 \times 8) = 283.3 \text{ (g mol}^{-3}\text{)}$ Allow TE from formula in (b)(i) (1) $56.74 \div 283.3 = 0.200 \text{ (mol)}$ Allow TE from M1	(4)

Question Number	Answer	Additional Guidance	Mark
20(c)(i)	<ul style="list-style-type: none"> calculation of g dm^{-3} calculation of g cm^{-3} and calculation of ppb <p>Or</p> <ul style="list-style-type: none"> calculation of mol cm^{-3} calculation of g cm^{-3} and calculation of ppb <p>Other units can be used provided they are consistent and a comparison made. 699.4 (ppm) exceeds 400 (ppm) $6.994 \times 10^{-9} (\text{g cm}^{-3})$ exceeds $4.00 \times 10^{-9} (\text{g cm}^{-3})$</p> <p>Alternative comparison using mol dm^{-3}</p> <ul style="list-style-type: none"> $4 \times 10^{-9} \div 52 = 7.692 \times 10^{-11} \text{ mol dm}^{-3}$ $7.692 \times 10^{-11} \times 1000 = 7.692 \times 10^{-8}$ which is smaller than $1.345 \times 10^{-7} \text{ mol dm}^{-3}$ 	<p><u>Example of calculation</u></p> <p>(1) $1.345 \times 10^{-7} (\text{mol dm}^{-3}) \times 52.0 = 6.994 \times 10^{-6} (\text{g dm}^{-3})$</p> <p>$6.994 \times 10^{-6} (\text{g dm}^{-3}) \div 10^3 = 6.994 \times 10^{-9}$</p> <p>(1) $= 6.994 \times 10^{-9} \times 10^9 = 6.994 (\text{ppb})$ (which is greater than 4 ppb)</p> <p>(1) $1.345 \times 10^{-7} (\text{mol dm}^{-3}) \div 10^3 = 1.345 \times 10^{-10}$</p> <p>$1.345 \times 10^{-10} \times 52.0 = 6.994 \times 10^{-9}$</p> <p>(1) $= 6.994 \times 10^{-9} \times 10^9 = 6.994 (\text{ppb})$ (which is greater than 4 ppb)</p> <p>Ignore SF</p> <p>Correct answer with no working scores 2</p> <p>(1)</p> <p>(1)</p>	(2)

Question Number	Answer	Additional Guidance	Mark
20(c)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> (EDTA⁴⁻) is a hexadentate ligand/can form 6 dative (covalent) bonds/multiple dative (covalent) bonds with the Cr³⁺ (EDTA⁴⁻) complex is more stable than (bidentate complexes)/ is a chelating agent/ traps the Cr³⁺/can wrap around the Cr³⁺ (so the Cr³⁺ can be removed from the blood) 	<p>(1) Allow multidentate/ polydentate Allow coordinate bonds Ignore just you need fewer EDTA⁴⁻ ions than diaminoethane molecules</p> <p>(1) Allow leads to a (large) increase in total entropy/entropy of the system Allow there is an increase in disorder Ignore just EDTA⁴⁻ is more stable</p>	(2)

Question Number	Answer	Additional Guidance	Mark
20(c)(i)	<ul style="list-style-type: none"> calculation of g dm^{-3} calculation of g cm^{-3} and calculation of ppb <p>Or</p> <ul style="list-style-type: none"> calculation of mol cm^{-3} calculation of g cm^{-3} and calculation of ppb <p>Other units can be used provided they are consistent and a comparison made. 699.4 (ppm) exceeds 400 (ppm) $6.994 \times 10^{-9} (\text{g cm}^{-3})$ exceeds $4.00 \times 10^{-9} (\text{g cm}^{-3})$</p> <p>Alternative comparison using mol dm^{-3}</p> <ul style="list-style-type: none"> $4 \times 10^{-9} \div 52 = 7.692 \times 10^{-11} \text{ mol dm}^{-3}$ $7.692 \times 10^{-11} \times 1000 = 7.692 \times 10^{-8}$ which is smaller than $1.345 \times 10^{-7} \text{ mol dm}^{-3}$ 	<p><u>Example of calculation</u></p> <p>(1) $1.345 \times 10^{-7} (\text{mol dm}^{-3}) \times 52.0 = 6.994 \times 10^{-6} (\text{g dm}^{-3})$</p> <p>$6.994 \times 10^{-6} (\text{g dm}^{-3}) \div 10^3 = 6.994 \times 10^{-9}$</p> <p>(1) $= 6.994 \times 10^{-9} \times 10^9 = 6.994 (\text{ppb})$ (which is greater than 4 ppb)</p> <p>(1) $1.345 \times 10^{-7} (\text{mol dm}^{-3}) \div 10^3 = 1.345 \times 10^{-10}$</p> <p>$1.345 \times 10^{-10} \times 52.0 = 6.994 \times 10^{-9}$</p> <p>(1) $= 6.994 \times 10^{-9} \times 10^9 = 6.994 (\text{ppb})$ (which is greater than 4 ppb)</p> <p>Ignore SF</p> <p>Correct answer with no working scores 2</p> <p>(1)</p> <p>(1)</p>	(2)

Question Number	Answer	Additional Guidance	Mark
20(c)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> (EDTA⁴⁻) is a hexadentate ligand/can form 6 dative (covalent) bonds/multiple dative (covalent) bonds with the Cr³⁺ (EDTA⁴⁻) complex is more stable than (bidentate complexes)/ is a chelating agent/ traps the Cr³⁺/can wrap around the Cr³⁺ (so the Cr³⁺ can be removed from the blood) 	<p>(1) Allow multidentate/ polydentate Allow coordinate bonds Ignore just you need fewer EDTA⁴⁻ ions than diaminoethane molecules</p> <p>(1) Allow leads to a (large) increase in total entropy/entropy of the system Allow there is an increase in disorder Ignore just EDTA⁴⁻ is more stable</p>	(2)

Question Number	Answer	Additional Guidance	Mark																										
20(a)(i)	<ul style="list-style-type: none"> both electronic configurations correct 	Examples of electronic configurations: Mn atom: [Ar] <table style="display: inline-table; border-collapse: collapse; margin-right: 20px;"> <tr> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> </tr> <tr> <td colspan="5" style="text-align: center;">3d</td> </tr> </table> <table style="display: inline-table; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↓</td> </tr> <tr> <td colspan="2" style="text-align: center;">4s</td> </tr> </table> Mn ²⁺ ion: [Ar] <table style="display: inline-table; border-collapse: collapse; margin-right: 20px;"> <tr> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> <td style="border: 1px solid black; width: 20px; height: 20px; text-align: center;">↑</td> </tr> <tr> <td colspan="5" style="text-align: center;">3d</td> </tr> </table> <table style="display: inline-table; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; width: 20px; height: 20px;"></td> </tr> <tr> <td style="text-align: center;">4s</td> </tr> </table> Allow half-arrows Allow all arrows pointing downwards in 3d subshell	↑	↑	↑	↑	↑	3d					↑	↓	4s		↑	↑	↑	↑	↑	3d						4s	(1)
↑	↑	↑	↑	↑																									
3d																													
↑	↓																												
4s																													
↑	↑	↑	↑	↑																									
3d																													
4s																													

Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> there is stability associated with a half-full set of (3)d orbitals (1) Mn²⁺ has five d electrons so is more stable than Mn³⁺ (and has a higher E^\ominus value) (1) Fe²⁺ has six d electrons so is less stable than Fe³⁺ (and has a lower E^\ominus value) (1) If M2 and M3 not awarded then allow 1 rescue mark for two correct electronic configuration from Mn ³⁺ = [Ar] 3d ⁴ Fe ²⁺ = [Ar] 3d ⁶ Fe ³⁺ = [Ar] 3d ⁵ If more than two electronic configurations are given and one is incorrect then do not award the rescue mark	Allow reverse argument Allow 3d subshell with 5 electrons as alternative for half-filled Allow Mn ²⁺ has five d electrons so eqm moves to RHS / Mn ²⁺ has five d electrons so is energetically more favourable / more energy needed to remove an electron from Mn ²⁺ as it has five d electrons Allow Fe ³⁺ is more stable as it has a half-filled subshell so Fe ²⁺ tends to lose electrons, (making E^\ominus less positive) Allow Fe ²⁺ has a pair of electrons (in a d orbital) that repel so is less stable than Fe ³⁺ (and has a lower E^\ominus value)	(3)

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> Mn reduced from (+)4 to (+)2 (1) Cl oxidised from -1 to 0 and in Cl₂ (1) 	Allow oxidation numbers shown under equation Allow Mn ⁴⁺ and Mn ²⁺ Allow Cl ⁻ Comments: 0 must be linked to Cl ₂ If no other mark is awarded, allow (1) for all oxidation numbers of Mn and Cl correct	(2)

Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	<ul style="list-style-type: none"> calculation of mol O₂ (1) calculation of concentration of H₂O₂ (1) 	<p>Example of calculation:</p> <p>Mol of O₂ = $\frac{86.0}{24000} = 0.0035833 / 3.5833 \times 10^{-3}$ (mol)</p> <p>Mol H₂O₂ = $2 \times 0.0035833 = 0.0071667 / 7.1667 \times 10^{-3}$ (mol)</p> <p>and</p> <p>Conc H₂O₂ = $\frac{0.0071667 \times 1000}{100} = 0.071667 / 7.1667 \times 10^{-2}$ (mol dm⁻³)</p> <p>TE on mol O₂</p> <p>Ignore SF except 1 SF</p> <p>Comment – if M1 is rounded to 0.00358 and carried through into M1 and M2, this gives a final answer of 0.0716</p>	(2)

Question Number	Answer	Additional Guidance	Mark
20(c)	<ul style="list-style-type: none"> correct balanced equation 	<p>Example of equation:</p> $3\text{MnO}_4^{2-} + 4\text{H}^+ \rightarrow 2\text{MnO}_4^- + \text{MnO}_2 + 2\text{H}_2\text{O}$ <p>Allow multiples</p> <p>Allow reversible arrows provided reactants as shown are still on LHS</p> <p>Allow uncancelled electrons on either side</p> <p>Ignore state symbols even if incorrect</p> <p>Ignore oxidation states above atoms, even if incorrect</p>	(1)

Question Number	Answer	Additional Guidance	Mark
20(d)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> this reaction is (auto)catalysed by the Mn²⁺ ions formed (1) (the reaction in) experiment 1 starts slowly because there is no Mn²⁺ / catalyst present initially (but speeds up as Mn²⁺ ions are formed) (1) (the reaction in) experiment 2 is fast(est) at the start as Mn²⁺ ions / catalyst (already) present (1) 	<p>Mn²⁺ can be mentioned at any point</p> <p>Allow experiment 1 starts slowly but speeds up as Mn²⁺ / catalyst forms</p> <p>Allow rate decreases constantly as Mn²⁺ ions / catalyst (already) present</p>	(3)

Question Number	Answer	Additional Guidance	Mark
20(e)(i)	<ul style="list-style-type: none"> calculation of mol of KMnO_4 (1) calculation of mol of $\text{C}_6\text{H}_5\text{CH}_3$ (1) KMnO_4 is in excess because there are more than twice as many mol of KMnO_4 than mol of $\text{C}_6\text{H}_5\text{CH}_3$ (1) 	<p>Example of calculation:</p> <p>Mol $\text{KMnO}_4 = \frac{7.00}{158} = 0.044304$ (mol)</p> <p>Mol $\text{C}_6\text{H}_5\text{CH}_3 = \frac{1.73}{92} = 0.018804$ (mol)</p> <p>Accept 0.044304 mol KMnO_4 would react with 0.022152 mol $\text{C}_6\text{H}_5\text{CH}_3$ or reverse argument TE on M1 and M2</p> <p>Allow other methods e.g.</p> <p>Mol $\text{C}_6\text{H}_5\text{CH}_3 = \frac{1.73}{92} = 0.018804$ (mol) (1)</p> <p>Minimum mass of KMnO_4 needed = $2 \times 0.018804 \times 158 = 5.9421$ (g) (1)</p> <p>This is less than 7 g so KMnO_4 is in excess (1)</p> <p>Ignore SF except 1 SF in M1 and M2</p>	(3)

Question Number	Answer	Additional Guidance	Mark
20(e)(ii)	<ul style="list-style-type: none"> add H^+ ions / acidify the solution / mixture 	<p>Allow correct name or formula of any strong acid e.g. HCl, H_2SO_4, HNO_3, H_3PO_4</p> <p>Do not award carboxylic acids e.g. CH_3COOH</p> <p>Allow $\text{C}_6\text{H}_5\text{CO}_2^- + \text{H}^+ \rightarrow \text{C}_6\text{H}_5\text{COOH}$</p> <p>Ignore references to concentration / heat / reflux</p> <p>Do not award 'acid hydrolysis' / acid catalyst / H^+ ions from water / inclusion of a second incorrect reagent e.g. H^+ and LiAlH_4</p>	(1)

Question Number	Answer	Additional Guidance	Mark
20(f)(i)	<ul style="list-style-type: none"> anode half-equation (1) cathode half-equation (1) 	<p>Examples of equations:</p> <p>$\text{Zn} + 2\text{OH}^- \rightarrow \text{ZnO} + \text{H}_2\text{O} + 2\text{e}^-$</p> <p>$2\text{MnO}_2 + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Mn}_2\text{O}_3 + 2\text{OH}^-$</p> <p>Allow multiples / reversible arrows</p> <p>Ignore state symbols even if incorrect</p> <p>If no other mark is awarded allow (1) for anode and cathode half-equations written in wrong places</p> <p>If no other mark awarded allow 1 mark for Zn on the left-hand side of the anode reaction and MnO_2 on the left-hand side of the cathode reaction</p>	(2)

Question Number	Answer	Additional Guidance	Mark
20(f)(ii)	<ul style="list-style-type: none"> $(E^\ominus = +)0.15$ (V) 	Do not award -0.15 (V)	(1)

(Total for Question 20 = 19 marks)
(Total for Section C = 19 marks)

Question Number	Answer	Additional Guidance	Mark
18(a)	<ul style="list-style-type: none"> +5 / 5+ 	Allow V / 5 / V ⁵⁺	(1)

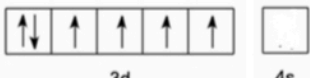
Question Number	Answer	Additional Guidance	Mark
18(b)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> V⁵⁺ / the vanadium ion is (very) small / highly charged (1) so it would polarise (two) water molecules / OH bonds (1) causing them to lose hydrogen ions / H⁺ ions / deprotonate (1) 	<p>Allow high charge density</p> <p>Allow 'so it weakens OH bonds'</p> <p>Allow 'distorts electron clouds in water'</p> <p>Allow the energy required to remove 5 electrons to form V⁵⁺ is too high (1) because the energy is not recovered by the hydration of the ion (1)</p> <p>If no marks given allow 1 mark for correct electronic configuration of V⁵⁺ e.g. [Ar]</p>	(3)

Question Number	Answer	Additional Guidance	Mark																		
18(c)	<ul style="list-style-type: none"> calculation of mol of each element (1) deduction of mol ratio (and empirical formula) (1) overall formula (1) 	<p>Example of calculation:</p> <table border="1"> <thead> <tr> <th></th> <th>K</th> <th>V</th> <th>S</th> <th>H</th> <th>O</th> </tr> </thead> <tbody> <tr> <td>moles</td> <td>$\frac{7.9}{39.1}$ = 0.202</td> <td>$\frac{10.2}{50.9}$ = 0.200</td> <td>$\frac{12.9}{32.1}$ = 0.402</td> <td>$\frac{4.8}{1}$ = 4.8</td> <td>$\frac{64.2}{16}$ = 4.01</td> </tr> <tr> <td>divide by smallest</td> <td>$\frac{0.202}{0.200}$ = 1</td> <td>$\frac{0.200}{0.200}$ = 1</td> <td>$\frac{0.402}{0.200}$ = 2</td> <td>$\frac{4.8}{0.200}$ = 24</td> <td>$\frac{4.01}{0.200}$ = 20</td> </tr> </tbody> </table> <p>Empirical formula KVS₂H₂₄O₂₀</p> <p>Ignore minor rounding errors in M1 and M2 TE on mol ratio from M1</p> <p>Example of overall formula: KV(SO₄)₂•12H₂O or K₂SO₄•V₂(SO₄)₃•24H₂O</p> <p>Allow KV(SO₄)₂(H₂O)₁₂</p> <p>Allow K₂SO₄•V₂(SO₄)₃(H₂O)₂₄</p> <p>Ignore SF</p> <p>Allow the ions in any order / correct charges shown by individual ions, even if charges are not shown on all ions / missing dot(s)</p> <p>No TE from M2 to M3</p>		K	V	S	H	O	moles	$\frac{7.9}{39.1}$ = 0.202	$\frac{10.2}{50.9}$ = 0.200	$\frac{12.9}{32.1}$ = 0.402	$\frac{4.8}{1}$ = 4.8	$\frac{64.2}{16}$ = 4.01	divide by smallest	$\frac{0.202}{0.200}$ = 1	$\frac{0.200}{0.200}$ = 1	$\frac{0.402}{0.200}$ = 2	$\frac{4.8}{0.200}$ = 24	$\frac{4.01}{0.200}$ = 20	(3)
	K	V	S	H	O																
moles	$\frac{7.9}{39.1}$ = 0.202	$\frac{10.2}{50.9}$ = 0.200	$\frac{12.9}{32.1}$ = 0.402	$\frac{4.8}{1}$ = 4.8	$\frac{64.2}{16}$ = 4.01																
divide by smallest	$\frac{0.202}{0.200}$ = 1	$\frac{0.200}{0.200}$ = 1	$\frac{0.402}{0.200}$ = 2	$\frac{4.8}{0.200}$ = 24	$\frac{4.01}{0.200}$ = 20																

Question Number	Answer	Additional Guidance	Mark
18(d)(i)	<ul style="list-style-type: none"> calculation of mol of V^{3+} (1) calculation of mol MnO_4^- (1) calculation of ratio of MnO_4^- to V^{3+} (1) 	<p>Example of calculation: $Mol V^{3+} = \frac{10.0 \times 0.132}{1000} = 0.00132 / 1.32 \times 10^{-3} \text{ (mol)}$</p> <p>$Mol MnO_4^- = \frac{26.40 \times 0.0200}{1000} = 0.000528 / 5.28 \times 10^{-4} \text{ (mol)}$</p> <p>Ratio $MnO_4^- : V^{3+} = 0.000528 : 0.00132$ $= \frac{1}{2} : \frac{2.5}{5}$ or $2 : 5$</p> <p>Allow TE on M1 and M2 Ignore SF except 1 SF in calculation of moles Allow 5 to 2 if it's clear it's $V^{3+} : MnO_4^-$</p>	(3)

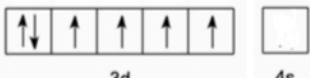
Question Number	Answer	Additional Guidance	Mark
18(d)(ii)	<ul style="list-style-type: none"> correct species on each side of equation (1) balancing (1) <p>Comment – M2 dependent on M1</p>	<p>Example of equation: $2MnO_4^- + 5V^{3+} + 2H_2O \rightarrow 2Mn^{2+} + 5VO_2^+ + 4H^+$</p> <p>Or $2MnO_4^- + 5V^{3+} + 22H_2O \rightarrow 2Mn^{2+} + 5[VO_2(H_2O)_4]^+ + 4H^+$</p> <p>Allow multiples Allow (1) for $2MnO_4^- + 5V^{3+} + 16H^+ \rightarrow 2Mn^{2+} + 5V^{5+} + 8H_2O$</p> <p>Ignore state symbols even if incorrect Allow oxidation to V(IV) if ratio 1 : 5 in (d)(i) $MnO_4^- + 5V^{3+} + H_2O \rightarrow Mn^{2+} + 5VO^{2+} + 2H^+$ species (1) balancing (1)</p>	(2)

<p>Indicative content</p> <ul style="list-style-type: none"> IP1 – vanadium(V) to vanadium(IV) Both iron and tin will reduce / convert / change V(V) to V(IV) and E°_{cell} for Fe = (+)1.44 V and E°_{cell} for Sn = (+)1.14 V IP2 – equations $2VO_2^+ + 4H^+ + Fe \rightarrow 2VO^{2+} + 2H_2O + Fe^{2+}$ and $2VO_2^+ + 4H^+ + Sn \rightarrow 2VO^{2+} + 2H_2O + Sn^{2+}$ IP3 – vanadium(IV) to vanadium(III) Both iron and tin will reduce / convert / change V(IV) to V(III) and E°_{cell} for Fe = (+)0.78 V and E°_{cell} for Sn = (+)0.48 V IP4 – equations $2VO^{2+} + 4H^+ + Fe \rightarrow 2V^{3+} + 2H_2O + Fe^{2+}$ and $2VO^{2+} + 4H^+ + Sn \rightarrow 2V^{3+} + 2H_2O + Sn^{2+}$ IP5 – vanadium(III) to vanadium(II) iron will reduce / convert / change V(III) to V(II) and $E^\circ_{cell} = (+)0.18 \text{ V}$ and tin will not reduce / convert / change V(III) to V(II) and as $E^\circ_{cell} = -0.12 \text{ V}$ IP6 – equation $2V^{3+} + Fe \rightarrow 2V^{2+} + Fe^{2+}$ 	<p>Ignore state symbols in all equations even if incorrect</p> <p>If IP1 and IP2 not awarded, allow 1 IP for either totally correct iron or totally correct tin</p> <p>If IP3 and IP4 not awarded, allow 1 IP for either totally correct iron or totally correct tin</p> <p>Comment penalise references to Fe or Sn as oxidising agents once only in IP1, IP3 and IP5</p> <p>Ignore any references to colour of vanadium species</p> <p>If no other marks awarded, allow 1 IP for idea that Fe can reduce to V^{2+} but Sn (only) to V^{3+}</p> <p>If no other marks awarded allow 1 IP for three pairs of correct E°_{cell} values</p>
--	---

Question Number	Answer	Additional Guidance	Mark
21(a)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> • Fe^{2+} [Ar]  	The electrons in the doubled orbit must be pointing in opposite directions. They can be in any of the 3d orbitals. Allow half headed arrows or a combination of both	(1)

Question Number	Answer	Additional Guidance	Mark
21(a)(ii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> • (the oxygen in the air) oxidises the Fe^{2+} • (forming the brown) Fe^{3+} • Fe^{3+} is more stable (than Fe^{2+}) due to half-filled <i>d</i>-subshell/ due to half full (<i>d</i>) orbitals 	(1) Allow it is oxidised Ignore reacts with oxygen (1) Allow iron(III) sulfate forms Allow any mention of Fe^{3+} (1) Allow reverse argument Fe^{2+} has a pair of electrons in one orbital that repel each other and so an electron is easily lost Or pair of electrons in one orbital that repel each other and so it is less stable Ignore a half-filled <i>d</i> orbital Ignore half-filled <i>d</i> shell	(3)

Question Number	Answer	Additional Guidance	Mark
21(b)	<ul style="list-style-type: none"> • M1 calculation of moles of MnO_4^- in the titre • M2 calculation of moles of Fe^{2+} in 25 cm^3 of solution • M3 calculation of moles of Fe^{2+} in 250 cm^3 of solution • M4 calculation of mass of FeSO_4 in 250 cm^3 of solution • M5 calculation of % FeSO_4 in the moss killer • M6 answer to 2 or 3 SF <p>Marks are for the processes are shown and they may be in a different order M2 = $\times 5$ M3 = $\times 10$ M4 = $\times 151.9$ M5 = $\div 6.42 \times 100$</p>	<p><u>Example of calculation</u></p> (1) $17.70 \times 0.00740 \div 1000 = 1.3098 \times 10^{-4} / 0.00013098$ (mol) (1) $1.3098 \times 10^{-4} / 0.00013098 \times 5 = 6.549 \times 10^{-4} / 0.0006549$ (mol) (1) $6.549 \times 10^{-4} \times 10 = 6.549 \times 10^{-3} / 0.006549$ (mol) (1) $6.549 \times 10^{-3} \times 151.9 = 0.99479$ (g) (1) $0.99479 \div 6.42 \times 100 = 15.495$ (%) (1) 15.5 (%) / 15 (%) This is not a standalone mark it can only be awarded if there has been an attempt to calculate a % Ignore intermediate rounding and incorrect truncating TE throughout The correct answer with or without working scores 6	(6)

Question Number	Answer	Additional Guidance	Mark
21(a)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> • Fe^{2+} [Ar]  	The electrons in the doubled orbit must be pointing in opposite directions. They can be in any of the 3d orbitals. Allow half headed arrows or a combination of both	(1)

Question Number	Answer	Additional Guidance	Mark
21(a)(ii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> • (the oxygen in the air) oxidises the Fe^{2+} • (forming the brown) Fe^{3+} • Fe^{3+} is more stable (than Fe^{2+}) due to half-filled <i>d</i>-subshell/ due to half full (<i>d</i>) orbitals 	(1) Allow it is oxidised Ignore reacts with oxygen (1) Allow iron(III) sulfate forms Allow any mention of Fe^{3+} (1) Allow reverse argument Fe^{2+} has a pair of electrons in one orbital that repel each other and so an electron is easily lost Or pair of electrons in one orbital that repel each other and so it is less stable Ignore a half-filled <i>d</i> orbital Ignore half-filled <i>d</i> shell	(3)

Question Number	Answer	Additional Guidance	Mark
21(b)	<ul style="list-style-type: none"> • M1 calculation of moles of MnO_4^- in the titre • M2 calculation of moles of Fe^{2+} in 25 cm^3 of solution • M3 calculation of moles of Fe^{2+} in 250 cm^3 of solution • M4 calculation of mass of FeSO_4 in 250 cm^3 of solution • M5 calculation of % FeSO_4 in the moss killer • M6 answer to 2 or 3 SF <p>Marks are for the processes are shown and they may be in a different order M2 = $\times 5$ M3 = $\times 10$ M4 = $\times 151.9$ M5 = $\div 6.42 \times 100$</p>	<p><u>Example of calculation</u></p> (1) $17.70 \times 0.00740 \div 1000 = 1.3098 \times 10^{-4} / 0.00013098$ (mol) (1) $1.3098 \times 10^{-4} / 0.00013098 \times 5 = 6.549 \times 10^{-4} / 0.0006549$ (mol) (1) $6.549 \times 10^{-4} \times 10 = 6.549 \times 10^{-3} / 0.006549$ (mol) (1) $6.549 \times 10^{-3} \times 151.9 = 0.99479$ (g) (1) $0.99479 \div 6.42 \times 100 = 15.495$ (%) (1) 15.5 (%) / 15 (%) This is not a standalone mark it can only be awarded if there has been an attempt to calculate a % Ignore intermediate rounding and incorrect truncating TE throughout The correct answer with or without working scores 6	(6)

Question Number	Answer	Additional Guidance	Mark												
19(a)	<ul style="list-style-type: none"> calculation of mol of K, Fe and O (1) deduction of mol ratio and empirical formula (1) <p>Alternative method</p> <ul style="list-style-type: none"> calculation of M_r value (1) deduction of elemental values and empirical formula (1) 	<p>Example of calculation:</p> <table border="1"> <thead> <tr> <th></th> <th>K</th> <th>Fe</th> <th>O</th> </tr> </thead> <tbody> <tr> <td>mol</td> <td>$\frac{39.5}{39.1} = 1.01$</td> <td>$\frac{28.2}{55.8} = 0.505$</td> <td>$\frac{32.3}{16} = 2.02$</td> </tr> <tr> <td>ratio</td> <td>2</td> <td>1</td> <td>4</td> </tr> </tbody> </table> <p>Empirical formula is K_2FeO_4 Accept symbols in any order</p> <p>Allow use of 39 as A_r of K, 56 as A_r of Fe and 0.504 as mol of Fe Allow TE for M2 from candidates own moles Correct empirical formula with no working scores (2)</p> <p>If one or two atomic numbers are used then allow TE as appropriate for (1)</p> <p>$M_r = (\text{Atomic mass} \div \text{element percentage}) \times 100$ e.g. $M_r = (55.8 \div 28.2) \times 100 = 197.87 / 197.9 / 198$</p> <p>$K = (39.5 \div 100) \times 198 = 78.2$ so 2K $Fe = (28.2 \div 100) \times 198 = 55.8$ so 1Fe $O = (32.3 \div 100) \times 198 = 64$ so 4O Empirical formula is K_2FeO_4</p>		K	Fe	O	mol	$\frac{39.5}{39.1} = 1.01$	$\frac{28.2}{55.8} = 0.505$	$\frac{32.3}{16} = 2.02$	ratio	2	1	4	(2)
	K	Fe	O												
mol	$\frac{39.5}{39.1} = 1.01$	$\frac{28.2}{55.8} = 0.505$	$\frac{32.3}{16} = 2.02$												
ratio	2	1	4												

Question Number	Answer	Additional Guidance	Mark
19(b)(i)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> reaction between two negative ions is slow due to repulsion 	<p>Allow negative species for negative ions Allow just 'the negative ions repel' Ignore references to unlikelihood of three negative ions colliding</p> <p>Do not award negative molecules</p>	(1)

Question Number	Answer	Additional Guidance	Mark
19(b)(ii)	<ul style="list-style-type: none"> ionic equation involving iron(II) (1) ionic equation involving iron(III) (1) 	<p>Examples of ionic equations $2Fe^{2+} + S_2O_8^{2-} \rightarrow 2Fe^{3+} + 2SO_4^{2-}$</p> <p>$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$</p> <p>Award (1) for balanced equations given in reverse order</p> <p>Allow (1) for two unbalanced equations with all species paired correctly Ignore state symbols even if incorrect</p>	(2)

Question Number	Answer	Additional Guidance	Mark
19(c)(i)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> because it forms one dative (covalent) / co-ordinate bond (to Fe^{2+}) (1) using a lone pair (of electrons) on oxygen (1) 	<p>Allow 'a dative/co-ordinate bond'</p> <p>Allow oxygen donates a pair of electrons Ignore water uses a lone pair of electrons</p>	(2)

Question Number	Answer	Additional Guidance	Mark
19(c)(ii)	<p>An explanation that makes reference to the following points:</p>		(2)

Question Number	Answer	Additional Guidance	Mark
19(d)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> carbon monoxide replaces / takes the place of the oxygen molecule / ligand (and it may be toxic) because it binds strongly to the Fe^{2+} ion 	<p>Accept ligand substitution / exchange reaction between oxygen and carbon monoxide COMMENT The question refers to oxygen being carried around and so there needs to be explicit reference and not just implied that to it being replaced/substituted or its place being taken</p> <p>Allow carbon monoxide forms a stronger bond to Fe^{2+} (than oxygen)</p> <p>Allow carbon monoxide binds (almost) irreversible / permanently to Fe^{2+}</p> <p>Allow carbon monoxide forms a more stable complex ion with Fe^{2+} / the complex formed has a larger equilibrium constant</p> <p>Allow prevents / reduces the amount of oxygen being carried to the cells / organs / around the body / blood – scores M2 not M1</p> <p>Allow just carbon monoxide binds more strongly to haemoglobin/globin</p>	(2)

Question Number	Answer	Additional Guidance	Mark
19(e)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> there are more particles / moles on the right (of the equation or there is an increase from 3 particles / moles / species on the left of the equation to 5 on the right so ΔS_{system} increases / is positive (and the reaction is thermodynamically feasible) 	<p>Allow species for particles Do not award reference to molecules / atoms / compounds</p> <p>Do not award incorrect numbers</p> <p>Allow ΔS_{total} is positive / increasing (and the reaction is thermodynamically feasible)</p> <p>Allow there is an increase in entropy (and the reaction is thermodynamically feasible)</p> <p>Ignore references to increases in disorder</p>	(2)

<p>Alternative method</p> <ul style="list-style-type: none"> (M1) mass of $\text{Cr}_2\text{O}_7^{2-}$ in 22.55 cm^3 (M2) calculation of mol $\text{Cr}_2\text{O}_7^{2-}$ in 22.55 cm^3 (M3) calculation of mol Fe^{2+} in 25.0 cm^3 (M4) calculation of mass of Fe^{2+} in 25.0 cm^3 and calculation of total mass of ($\text{Fe}^{2+} + \text{Fe}^{3+}$) (M5) calculation of percentage of Fe^{3+} 	<p>(1) Example of calculation Mass ($\text{Cr}_2\text{O}_7^{2-}$) = $\frac{2.56 \times 22.55}{1000} = 0.057728 \text{ (g)}$</p> <p>(1) Mol ($\text{Cr}_2\text{O}_7^{2-}$) = $\frac{0.057728}{216} = 0.00026726 / 2.6726 \times 10^{-4} \text{ (mol)}$</p> <p>(1) Mol $\text{Fe}^{2+} = 0.00026726 \times 6 = 0.0016036 / 1.6036 \times 10^{-3} \text{ (mol)}$</p> <p>(1) Mass $\text{Fe}^{2+} = 0.0016036 \times 55.8 = 0.089481 \text{ (g)}$ and Mass ($\text{Fe}^{2+} + \text{Fe}^{3+}$) = $\frac{6.28 \times 25.0}{1000} = 0.157 \text{ (g)}$</p> <p>(1) Mass $\text{Fe}^{3+} = 0.157 - 0.089481 = 0.067519 \text{ (g)}$ and % of $\text{Fe}^{3+} = \frac{0.067519 \times 100}{0.157} = 43.0 / 43 \text{ (%)}$</p>
--	---

(Total for Question 19 = 18 marks)