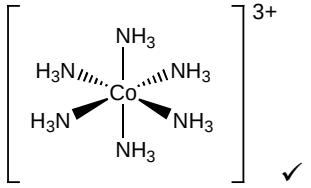
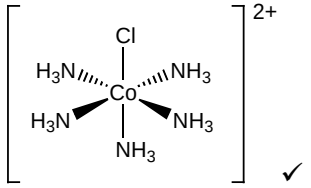
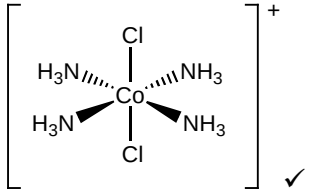
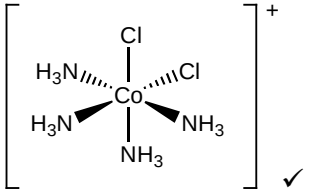
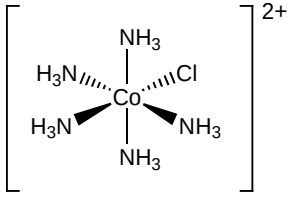
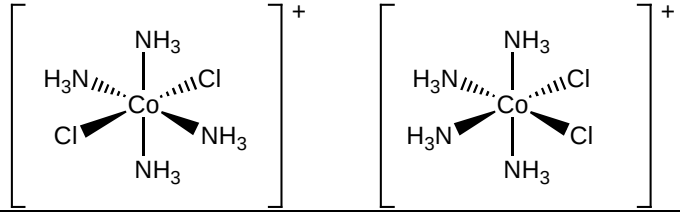
| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 1 | a | | Co: $(1s^2 2s^2 2p^6)3s^2 3p^6 3d^7 4s^2$ ✓<br><br>$Co^{3+}$: $(1s^2 2s^2 2p^6)3s^2 3p^6 3d^6$ ✓ | 2 | **ALLOW** $(1s^2 2s^2 2p^6)3s^2 3p^6 4s^2 3d^7$ (i.e. 4s before 3d)<br>**ALLOW** upper case D, etc. and subscripts, e.g. $[Ar]4S_2 3D_7$<br><br>If included, **ALLOW** $4s^0$ |
| | b | | catalyst **OR** coloured ✓ | 1 | **IGNORE** forms different oxidation states |
| | c | | Donates an electron/lone pair to a metal ion<br>**OR** forms a coordinate bond to a metal ion ✓ | 1 | **ALLOW** donates an electron pair/lone pair<br>to a metal/transition element<br>**ALLOW** dative (covalent) bond for coordinate bond |
| | d | i | $Co(OH)_2$ ✓<br><br>precipitation ✓ | 2 | Mark independently<br>**ALLOW** $Co(OH)_2(H_2O)_4$<br><br>**ALLOW** precipitate (reaction) |
| | | ii | $CoCl_4^{2-}$ ✓<br><br>ligand substitution ✓ | 2 | Mark independently<br><br>**ALLOW** ligand exchange<br>**DO NOT ALLOW** just substitution |

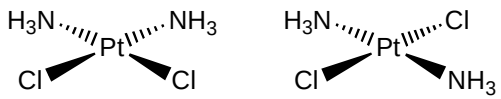
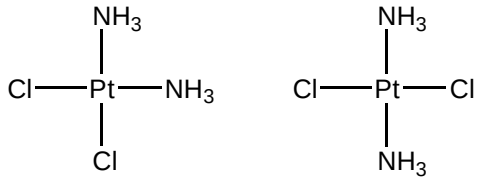
| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| | e | |  ✓  ✓  ✓  ✓ | 4 | ***ANNOTATIONS MUST BE USED***<br>**CARE**: Cl can be on any position, e.g. for **B**<br>  <br>complex ions in **C** and **D** can be other way around<br>In one complex ion, the 2 Cls must be opposite one another<br>In the other complex ion, the 2 Cls must be next to one another<br>**CARE**: Cl atoms can be on any position, e.g. for **C** and **D**<br>  |
| | | | **Marking sequence** **See also Appendix 2 for examples**<br>**1**. Mark any correct complex ions first<br>Do **not** look at these complex ions again<br><br>**2**. Mark with crosses a y complex ions with incorrect ligands. This could include Cl in complex **A**, and $NH_3Cl$ and $NH_3^+Cl^-$, but **NOT** $NH_3$------ connectivity on the **LEFT** only and **NOT** $Cl^-$ and **NOT** just $NH_3^+$<br>Do **not** look at these complex ions again<br><br>**3**. In the r maining complex ions, identify errors in ligands (See Appendix 2): e.g.<br>• $NH_3$ ligands bonded to an H on the **LEFT** only: $NH_3$----- *(connectivity error)*<br>• $Cl^-$<br>• $NH_3^+$<br>Mark these complex ions to maximise errors but treat any incorrectly bonded $NH_3$, $Cl^-$ and $NH_3$ as **ECF** | | |

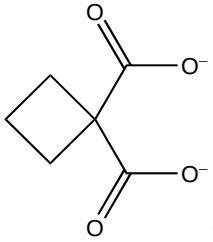
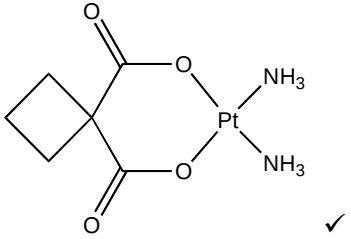
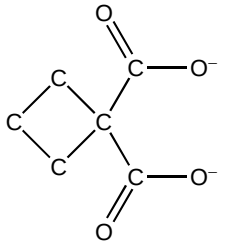
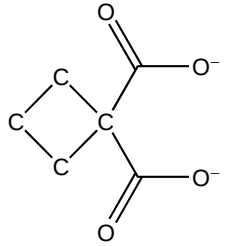
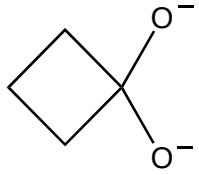
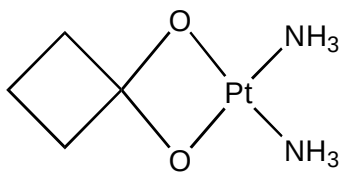
| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| | | | ***SEE APPENDIX 2 FOR EXAMPLES*** | | |
| | **e** | **ii** | 143.4 **OR** 107.9 + 35.5 (g $mol^{-1}$) used<br>*i.e. molar mass AgCl*<br>**OR** amount of AgCl = 0.02(000) mol ✓<br><br>**Ratio**<br>ratio complex : **$Cl^-$** = 1 : 2 **OR** 0.01 : 0.02 ✓<br><br>**Identification – available from 1 : 2 ratio OR 2$Cl^-$**<br>Therefore the complex is **B** ✓ | **3** | **DO NOT ALLOW** $AgCl_2$<br><br>**DO NOT ALLOW** $\frac{2.868}{0.01}$ *0.01 linked to AgCl, not complex*<br>**ALLOW** this mark **ONLY** for evidence of $Cl^-$<br><br>***Quality of Written Communication***<br>Identification as **B** is dependent on correct 1 : 2 ratio **OR 2**$Cl^-$ for this mark |
| | | | **Total** | **15** | |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 2 | (a) | | Fe: $(1s^2 2s^2 2p^6)3s^2 3p^6 3d^6 4s^2$ ✓<br><br>$Fe^{2+}$: $(1s^2 2s^2 2p^6)3s^2 3p^6 3d^6$ ✓ | 2 | **ALLOW** 4s before 3d, i.e. $(1s^2 2s^2 2p^6)3s^2 3p^6 4s^2 3d^6$<br><br>**ALLOW** $4s^0$<br>**ALLOW** subscripts<br>**IGNORE** $1s^2 2s^2 2p^6$ is written out a second time |
| | (b) | | coloured (compound/complex/precipitate/ions)<br>**OR**<br>catalyst ✓ | 1 | **IGNORE** 'variable oxidation states'<br>**….** but **ALLOW** the idea that $Fe^{2+}$ can react to form an **ion** with a different charge/oxidation state.<br>'**ion**' is essential: 'atom' or 'metal' is **not** sufficient<br><br>**IGNORE** partially filled d sub-shell/d orbital<br>(question refers to property of $Fe^{2+}$) |
| | (c) | | Fe oxidised from +2 to +3 ✓<br>Cr reduced from +6 to +3 ✓ | 2 | **CHECK** and credit oxidation numbers on equation<br><br>**ALLOW** $Fe^{2+}$ oxidised to $Fe^{3+}$<br>**ALLOW** $Cr^{6+}$ reduced to $Cr^{3+}$<br>**ALLOW** + sign after number in oxidation number, *ie* 2+, etc<br><br>**ALLOW** 1 mark only if oxidation numbers given with no identification of which species has been oxidised or reduced, *ie*<br>Fe goes from +2 to +3 **AND** Cr goes from +6 to +3<br>Fe reduced from +2 to +3 **AND** Cr oxidised from +6 to +3<br>(*oxidation and reduction the wrong way around*)<br><br>**DO NOT ALLOW** just 'Fe is oxidised **and** Cr reduced'<br><br>**IGNORE** other oxidations numbers (even if wrong)<br>**IGNORE** any references to electrons |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 2 | (d) | | ($K_{stab}$ = ) $\frac{\left[[Fe(NH_3)_6]^{2+}\right]}{\left[[Fe(H_2O)_6]^{2+}\right]\left[NH_3\right]^6}$<br><br>On **top**, **ONLY** $[Fe(NH_3)_6]^{2+}$ shown<br>**AND**<br>on bottom, $[Fe(H_2O)_6]^{2+}$ **AND** $[NH_3]^6$ shown ✓<br><br>correct use of square brackets and double square brackets in expression ✓ | 2 | **IGNORE** state symbols<br>**ALLOW** 1 mark if complete expression with correct use of double brackets is shown but upside down<br><br>**DO NOT ALLOW** round brackets for concentrations and complex ions<br>**ALLOW for 1 mark** ($K_{stab}$ = ) $\frac{\left[[Fe(NH_3)_6]^{2+}\right]\left[H_2O\right]^6}{\left[[Fe(H_2O)_6]^{2+}\right]\left[NH_3\right]^6}$ |
| | (e) | (i) | $O_2$/oxygen bonds to $Fe^{2+}$/Fe(II)/Fe ✓<br><br>When required, $O_2$ substituted **OR** $O_2$ released ✓ | 2 | **ANNOTATE WITH TICKS AND CROSSES, etc**<br><br>**ALLOW** $O_2$ binds to $Fe^{2+}$ **OR** $O_2$ donates electron pair to $Fe^{2+}$<br>**ALLOW** $O_2$ bonds to metal ion/metal<br>**DO NOT ALLOW** just $O_2$ bonds to haemoglobin<br>**OR** $O_2$ bonds to complex<br><br>**ALLOW** bond breaks between $O_2$ and $Fe^{2+}$ when $O_2$ required<br>**OR** $O_2$ replaces $H_2O$ **OR** vice versa<br>**ALLOW** $O_2$ replaces $CO_2$ **OR** vice versa<br>**ALLOW** $O_2$ replaces a ligand **OR** vice versa<br>**IGNORE** just 'by ligand substitution' (in the question) |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 2 | (e) | (ii) | (For complex) with CO, stability constant is greater (than with complex in $O_2$)<br>**OR** with CO, stability constant is high ✓<br><br>(Coordinate) bond with CO is stronger (than $O_2$)<br>**OR** bond with CO is strong ✓ | 2 | **ANNOTATE WITH TICKS AND CROSSES, etc**<br><br>**Comparison** of CO and $O_2$ is **NOT** required<br>**ALLOW** stability constant with/of CO is greater<br>**IGNORE** (complex with) CO is more stable<br><br>**ALLOW** bond with CO is less likely to break<br>**OR** bond with CO more likely to form<br>**OR** 'CO cannot be removed'<br>**OR** idea that attachment of CO is irreversible<br>**OR** CO is a stronger ligand (than $O_2$)<br>**OR** CO has greater affinity for ion/metal/haemoglobin (than $O_2$)<br><br>**IGNORE** CO bonds more easily |
| | (f) | (i) | $Pt^{2+}/Pt$ is +2/2+, 2 x $Cl^-$ –2 ✓ | 1 | **DO NOT ALLOW** response in terms of $Cl_2$ rather than $Cl^-$<br>**DO NOT ALLOW** 'charges cancel' without the charges involved being stated |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 2 | (f) | (ii) |   **OR**   ✓✓ For each structure<br><br>Ligand donates an electron pair to metal (ion)/$Pt^{2+}$/Pt<br>**OR** forms a coordinate bond to the metal (ion)/$Pt^{2+}$/Pt ✓ | 3 | **IGNORE** any charge, ie $Pt^{2+}$ **OR** $Cl^-$, even if wrong<br>**IGNORE** any angle, even if wrong<br>**ACCEPT** bonds to $H_3N$ (does not need to go to 'N')<br><br>Assume that a solid line is in plane of paper<br>Each structure **must** contain 2 'out wedges' **AND** 2 'in wedges' or **dotted** lines<br>**OR** 4 **solid** lines at right angles (all in plane of paper)<br><br>**DO NOT ALLOW any** structure that cannot be in one plane<br>**DO NOT ALLOW any** structure with $Cl_2$ as a ligand<br>**DO NOT** apply **ECF** from one structure to the other<br><br>**ALLOW** coordinate bonds shown on diagrams provide that they start from a lone pair<br><br>**ALLOW** 'dative covalent bond' or 'dative bond' as alternative for 'coordinate bond<br><br>**IGNORE** *cis* and *trans* labels (even if incorrect)<br>**IGNORE** incorrect connectivity to $NH_3$, ie **ALLOW** $NH_3$— |
| | | **(iii)** | platin binds to DNA (of cancer cells)<br>**OR** platin stops (cancer) cells dividing/replicating ✓ | 1 | |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 2 | (g) | | **1,1-cyclobutanedicarboxylate ion**<br>  <br>✓<br>**Correct charge required**<br>**(could also be 2– outside square brackets)**<br><br>**carboplatin** (*cis* isomer shown below)<br>  <br>✓ | 2 | Must show cyclobutane ring with both $COO^-$ groups bonded to same carbon<br><br>**ALLOW** $COO^-$ **OR** $CO_2^-$ for each carboxylate ion<br>**ALLOW** structures showing $CH_2$ or C atoms provided it is clear that C skeleton is shown,<br>**Note**: H atoms are not required if C atoms shown, *ie*<br>   <br>**DO NOT ALLOW** circle inside cyclobutane ring<br><br>Two bonds from Pt to O atoms<br><br>Any bonds from ligand **MUST** come from O **OR** from atom with lone pair<br><br>**IGNORE** any charge shown<br>**Note**: H atoms are not required if C atoms shown,<br>(see ion in 1st structure)<br><br>**ALLOW ECF** from 1st structure provided that the attached atoms are capable of forming coordinate bonds<br>(*ie* they contain a lone pair of electrons)<br>***Example*** if 1st structure is as below, then **ALLOW** 1 mark **ECF**<br>   <br>**X** **ECF ✓** |
| | | | **Total** | **18** | |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 3 | (a) | (i) | **amount $S_2O_3^{2-}$ used**<br>$= 0.00100 \times \frac{24.6}{1000} = 2.46 \times 10^{-5}$ mol ✓<br><br>**amount $O_2$ in 25 cm$^3$ sample**<br>$= \frac{2.46 \times 10^{-5}}{4} = 6.15 \times 10^{-6}$ mol ✓<br><br>**Concentration of $O_2$ in sample**<br>$= 6.15 \times 10^{-6} \times \frac{1000}{25} = 2.46 \times 10^{-4}$ (mol dm$^{-3}$) ✓<br><br>**mass concentration of $O_2$ in mg dm$^{-3}$**<br>$= 2.46 \times 10^{-4} \times 32$ g $= 7.872 \times 10^{-3}$ (g dm$^{-3}$)<br>$= 7.872$ (mg dm$^{-3}$) ✓ | 4 | **ANNOTATE WITH TICKS AND CROSSES, etc**<br><br>**ALLOW** 0.0000246 (mol)<br><br>**ECF** = $\frac{\text{answer above}}{4}$<br>**ALLOW** 0.00000615 g<br><br>**ECF** answer above × $\frac{1000}{25}$<br>**ALLOW** 0.000246 g<br><br>**ECF** = answer above × 32 x 1000<br>**ALLOW** 7.9 **OR** 7.87<br>**ALLOW** 2 SF up to calculator value<br>**Must be in mg for mark**<br><br>**Note:** Candidate may work out steps 3 and 4 in the opposite order, *ie*<br>**mass of $O_2$ in sample**<br>$= 6.15 \times 10^{-6} \times 32 \times 1000 = 1.968 \times 10^{-1}$ mg<br><br>**mass concentration of $O_2$ in mg dm$^{-3}$**<br>$= 1.968 \times 10^{-1} \times \frac{1000}{25} = 7.872$ (mg dm$^{-3}$) |
| | | (ii) | **Comment**<br>7.872 > 5 so fish can survive ✓ | 1 | **ECF** If final answer > 5 fish **can** survive<br>If final answer < 5 fish **cannot** survive |
| | (b) | (i) | NO ✓ | 1 | **ALLOW** $N_2H_2$ |

| Question | | | er | Mark | Guidance |
|---|---|---|---|---|---|
| | (b) | (ii) | $2H_2O + 2^- + 2NO_2^- \longrightarrow 2NO + I_2 + 4OH^-$<br>**OR** $2H^+ + {}^- + 2NO_2^- \longrightarrow 2NO + I_2 + 2OH^-$<br>**species** ✓<br>**balance** ✓ | 2 | **IGNORE** state symbols<br>**ALLOW** multiples<br>**For species ONLY, IGNORE** any extra $H_2O$ or $e^-$ on either side of the equation<br>**ALLOW** on LHS: $2HI + 2NO_2^-$ **OR** $2I^- + 2HNO_2$<br><br>**ALLOW** species and equation involving $N_2H_2$:<br>$6H_2O + 8I^- + 2NO_2^- \longrightarrow N_2H_2 + 4I_2 + 10OH^-$<br>**OR** $6H^+ + 8I^- + 2NO_2^- \longrightarrow N_2H_2 + 4I_2 + 4OH^-$<br>**species** ✓<br>**balance** ✓ |
| | | | **Total** | **8** | |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 4 | (a) | | $MnO_2 + 4OH^- \longrightarrow MnO_4^{2-} + 2H_2O$ **+ 2e⁻** ✓<br><br>$3H_2O + ClO_3^-$ **+ 6e⁻** ✓ $\longrightarrow 6OH^- + Cl^-$ | 2 | **ALLOW** 'e': i.e. – sign not required |
| | (b) | | **Role of $CO_2$**<br>$CO_2$ reacts with $H_2O$ forming an acid<br>**OR** carbonic acid/$H_2CO_3$ forms<br>**OR** $CO_2$ is acidic ✓<br><br>**Equation involving $OH^-$**<br>$H_2CO_3 + OH^- \longrightarrow H_2O + HCO_3^-$<br>**OR**<br>$H_2CO_3 + 2OH^- \longrightarrow 2H_2O + CO_3^{2-}$<br>**OR**<br>$CO_2 + OH^- \longrightarrow CO_3^{2-} + H^+$<br>**OR**<br>$CO_2 + OH^- \longrightarrow HCO_3^-$<br>**OR**<br>$CO_2 + 2OH^- \longrightarrow CO_3^{2-} + H_2O$<br>**OR**<br>$H^+ + OH^- \longrightarrow H_2O$ ✓<br><br>**Effect on equilibrium with reason**<br>equilibrium shifts to right **AND** to restore $OH^-$ ✓ | 3 | ***ANNOTATIONS MUST BE USED***<br>---<br>**ALLOW** equation:<br>$CO_2 + H_2O \longrightarrow H_2CO_3$<br>**OR** $CO_2 + H_2O \longrightarrow H^+ + HCO_3^-$<br>**OR** $CO_2 + H_2O \longrightarrow 2H^+ + CO_3^{2-}$<br><br>**ALLOW** for 'restores $OH^-$' the following: 'makes more $OH^-$', '$OH^-$ has been used up'<br>**DO NOT ALLOW** just 'equilibrium shifts to right' |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| (c) | **FOLLOW through stages to mark**<br>---<br>**Moles in titration**<br>$n(KMnO_4) = 0.0200 \times \frac{26.2}{1000} = 5.24 \times 10^{-4}$ mol ✓<br>$n(SO_3^{2-}) = 1.31 \times 10^{-3}$ mol ✓<br>**Scaling**<br>$n(SO_3^{2-})$ in original 100 $cm^3$<br>$= 4 \times 1.31 \times 10^{-3} = 5.24 \times 10^{-3}$ mol ✓<br>**Mass**<br>Mass of $Na_2SO_3$ in sample<br>$= 126.1 \times 5.24 \times 10^{-3}$ g = 0.660764 g ✓<br>**Percentage**<br>% $Na_2SO_3 = \frac{0.660764}{0.720} \times 100 = 91.8\%$ ✓ | 5 | ***ANNOTATIONS MUST BE USED***<br>***AT LEAST 3 SF for each step***<br>---<br>**ECF** 2.5 x answer above<br>**ECF** 4 x answer above<br>**ECF** 126.1 x answer above<br>**ALLOW** 0.661 g up to calculator value<br>**ECF** $\frac{\text{calculated mass above}}{0.720} \times 100$<br>**ALLOW** 91.8% (1 DP) up to calculator value of 91.77277778<br>i.e. **DO NOT ALLOW** 92% |
| | **ALLOW** alternative approach based on theoretical content of $Na_2SO_3$ for last 2 marks<br>**Theoretical amount, in moles, of $Na_2SO_3$ in sample**<br>$n(Na_2SO_3) = \frac{0.720}{126.1} = 5.71 \times 10^{-3}$ mol ✓<br>**Percentage**<br>% $Na_2SO_3 = \frac{5.24 \times 10^{-3}}{5.71 \times 10^{-3}} \times 100 = 91.8\%$ ✓ | | **COMMON ERRORS**:<br>36.8(1)% 4 marks no 2.5 factor<br>22.9(4)% 4 marks no scaling by 4<br>9.18% 3 marks no 2.5 and no x 4<br>Watch for random ECF %s for % from incorrect $M(Na_2SO_3)$, e.g. use of $M(SO_3^{2-})$ = 80.1 giving 58.3% |
| | **Total** | **10** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 5 | a | | $Fe_2O_3 + 6H^+ \longrightarrow 2Fe^{3+} + 3H_2O$ ✓ | 1 | **ALLOW** $Fe_2O_3 + 6HCl \longrightarrow 2FeCl_3 + 3H_2O$<br>**OR**<br>$Fe_2O_3 + 6HCl \longrightarrow 2Fe^{3+} + 6Cl^- + 3H_2O$<br><br>**ALLOW** correct multiples<br><br>**IGNORE** state symbols<br><br>**DO NOT ALLOW** $Fe_2Cl_6$ as a product |
| | b | | $Sn^{2+} + 2Fe^{3+} \longrightarrow Sn^{4+} + 2Fe^{2+}$ ✓<br><br>$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \longrightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$ ✓ | 2 | **IGNORE** state symbols<br><br>**ALLOW** overall equations:<br>$SnCl_2 + 2FeCl_3 \longrightarrow SnCl_4 + 2FeCl_2$<br><br>$6FeCl_2 + K_2Cr_2O_7 + 14HCl \rightarrow 6FeCl_3 + 2CrCl_3 + 2KCl + 7H_2O$<br>**ALLOW** correct multiples |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| | c | | **FIRST, CHECK THE ANSWER ON ANSWER LINE**<br>**IF** answer = 54.6%, award **5 marks**<br><br>---<br>**Amount $Fe^{2+}$ in 250 $cm^3$ solution – 3 marks**<br>amount $Cr_2O_7^{2-}$ used = $0.0200 \times \frac{26.5}{1000}$<br>$= 5.30 \times 10^{-4}$ (mol) ✓<br><br>amount $Fe^{2+}$ = **6** × 5.30 x $10^{-4}$<br>$= 3.18 \times 10^{-3}$ mol ✓<br><br>amount $Fe^{2+}$ in original 250 $cm^3$ = **10** × 3.18 x $10^{-3}$<br>$= 3.18 \times 10^{-2}$ (mol) ✓ | | ***ANNOTATIONS MUST BE USED***<br>**IF** there is an alternative answer, 1st check common errors below. Then see if there is any **ECF** credit possible using working below<br>---<br>**Working must be to at least 3 SF throughout**<br>**BUT** ignore trailing zeroes, *i.e.* for 0.490 allow 0.49<br><br>**ALLOW ECF** from different $Fe^{2+}$ ratio in equation from **8(b)**<br>**BUT** still **ALLOW** 6 : 1 even from different ratio in equation<br>If no equation use actual 6 : 1 ratio<br>**DO NOT AWARD** 'ratio mark' at all for use of 1 : 1 ratio<br>*– makes problem easier*<br><br>**ECF** 10 × answer above |
| | | | **% Fe in ore – 2 marks**<br>mass of Fe in ore = $55.8 \times 3.18 \times 10^{-2}$ g<br>= 1.77444 g ✓ | | **ECF** 55.8 × answer above<br><br>**IF** answer above has **not** been used **AND** × 55.8,<br>**DO NOT ALLOW** this mark but do **ALLOW** final %<br><br>**IF** answer above **AND** 55.8 are **BOTH not** used, then<br>**DO NOT ALLOW ANY** further marks |
| | | | percentage Fe in ore = $\frac{1.77444}{3.25} \times 100$<br>= 54.6% ✓ | **5** | **ECF** $\frac{\text{answer above}}{3.25} \times 100$<br>**ALLOW** 54.5% (from 1.77 g) **AND** any answer with > 1 decimal place that rounds back to 54.5 **OR** 54.6 |
| | | | | | **COMMON ERRORS**<br>5.46 ✓✓✓✓ × *10 omitted*<br>51.5 ✓✓✓✓ *titre taken as 25.0*<br>156.2 ✓✓✓✓ × *159.6 instead of 55.8*<br>15.62 ✓✓✓ × *159.6 and* × *10 omitted*<br>45.5 ✓✓✓✓ *5 : 1 ratio*<br>1.52 ✓✓✓✓ ÷ 6 instead of × 6 |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| | d | | $E^{\ominus}$ for $MnO_4^-$ is more positive/greater than $Cl_2$<br>**OR**<br>$E^{\ominus}$ for $Cr_2O_7^{2-}$ is less positive/smaller than $Cl_2$ ✓<br><br>$MnO_4^-$ reacts with $Cl^-$ **OR** HCl (forming $Cl_2$ gas)<br>**OR**<br>$Cr_2O_7^{2-}$ does **not** react with $Cl^-$ ions ✓ | **2** | **ORA:**<br>$E^{\ominus}$ for $Cl_2$ is less positive/smaller than $MnO_4^-$<br>**OR**<br>$E^{\ominus}$ for $Cl_2$ is more positive/greater than $Cr_2O_7^{2-}$ |
| | | | **Total** | **10** | |