Mark Scheme (Results)

January 2018

Pearson Edexcel International Advanced Level In Chemistry (WCH05) Paper 01 General Principles of Chemistry ll – Transition Metals and Organic Nitrogen Chemistry

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January 2018
Publications Code WCH05_01_1801_MS

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Section A (multiple choice)

Question Number	Correct Answer	Mark
1	**The only correct answer is D** ***A*** *is not correct because the electrode is wrong and* Mn^{2+} *ions are missing from the solution* ***B*** *is not correct because the electrode is wrong* ***C*** *is not correct because* Mn^{2+} *ions are missing from the solution*	**(1)**

Question Number	Correct Answer	Mark
2	**The only correct answer is C** ***A*** *is not correct because the oxidation number of Cr is + 3 and Mn is + 2* ***B*** *is not correct because the oxidation number of Cr is + 6 and Ti is + 3* ***D*** *is not correct because the oxidation number of Cr is + 6 and Mn is + 7*	**(1)**

Question Number	Correct Answer	Mark
3	**The only correct answer is A** ***B*** *is not correct because the oxidation number should be +3 -2 = +1* ***C*** *is not correct because the oxidation number should be +3 -2 = +1* ***D*** *is not correct because the oxidation number should be +3 -2 = +1*	**(1)**

Question Number	Correct Answer	Mark
4(a)	**The only correct answer is A** ***B*** *is not correct because the complex is linear* ***C*** *is not correct because the complex is square planar* ***D*** *is not correct because the complex is octahedral*	**(1)**

Question Number	Correct Answer	Mark
4(b)	**The only correct answer is B** ***A*** *is not correct because the oxidation number of the metal is +3* ***C*** *is not correct because the oxidation number of the metal is +2* ***D*** *is not correct because the oxidation number of the metal is +4*	**(1)**

Question Number	Correct Answer	Mark
5(a)	**The only correct answer is C** ***A*** *is not correct because it is not -4/2* ***B*** *is not correct because it is not -4/2* ***D*** *is not correct because it is not -4/2*	**(1)**

Question Number	Correct Answer	Mark
5(b)	**The only correct answer is C** ***A*** *is not correct because incorrect number of Z ligands* ***B*** *is not correct because incorrect number of Z ligands and incorrect charge* ***D*** *is not correct because incorrect charge*	**(1)**

Question Number	Correct Answer	Mark
6(a)	**The only correct answer is A** ***B*** *is not correct because although copper(I) oxide is reddish brown, it is an incorrect product* ***C*** *is not correct because copper(II) oxide is black not brownand it is an incorrect product* ***D*** *is not correct because zinc sulfate is white not brown*	**(1)**

Question Number	Correct Answer	Mark
6(b)	**The only correct answer is B** ***A*** *is not correct because it is not a white solid* ***C*** *is not correct because it is not a white solid* ***D*** *is not correct because it is soluble*	**(1)**

Question Number	Correct Answer	Mark
7	**The only correct answer is B** ***A*** *is not correct because it is not an addition reaction* ***C*** *is not correct because not it is not a nucleophilic or addition reaction* ***D*** *is not correct because it is not a nucleophilic reaction*	**(1)**

Question Number	Correct Answer	Mark
8(a)	**The only correct answer is D** ***A*** *is not correct because this is the wrong product* ***B*** *is not correct because this is the wrong product* ***C*** *is not correct because this is the wrong product*	**(1)**

Question Number	Correct Answer	Mark
8(b)	**The only correct answer is C** ***A*** *is not correct because it is electrophilic not nucleophilic* ***B*** *is not correct because electromeric effect outweighs inductive effect* ***D*** *is not correct because it is a nucleophile not an electrophile*	**(1)**

Question Number	Correct Answer	Mark
9(a)	**The only correct answer is A** ***B*** *is not correct because the locants are incorrect* ***C*** *is not correct because there are no locants for the amine groups* ***D*** *is not correct because there are no locants for the amine groups*	**(1)**

Question Number	Correct Answer	Mark
9(b)	**The only correct answer is D** ***A*** *is not correct because there is no carbonyl group* ***B*** *is not correct because there is no carbonyl group* ***C*** *is not correct because the amide groups are incorrect*	**(1)**

Question Number	Correct Answer	Mark
10(a)	**The only correct answer is C** ***A*** *is not correct because it is not an acid* ***B*** *is not correct because it is not an acid* ***D*** *is not correct because it is optically active*	**(1)**

Question Number	Correct Answer	Mark
10(b)	**The only correct answer is A** ***B*** *is not correct because Q forms phenol* ***C*** *is not correct because R does not form sodium benzoate* ***D*** *is not correct because S does not form sodium benzoate*	**(1)**

Question Number	Correct Answer	Mark
11(a)	**The only correct answer is B** ***A*** *is not correct because it is a primary alcohol and should be a secondary alcohol* ***C*** *is not correct because it is a primary alcohol and should be a secondary alcohol* ***D*** *is not correct because it is a tertiary alcohol and should be a secondary alcohol*	**(1)**

Question Number	Correct Answer	Mark
11(b)	**The only correct answer is B** ***A*** *is not correct because there would be no loss of carbon atom* ***C*** *is not correct because there would be no loss of carbon atom* ***D*** *is not correct because there would be no loss of carbon atom*	**(1)**

Question Number	Correct Answer	Mark
11(c)	**The only correct answer is D** ***A*** *is not correct because this does not react with propanoic acid to give propanoyl chloride* ***B*** *is not correct because this does not react with propanoic acid to give propanoyl chloride* ***C*** *is not correct because this does not react with propanoic acid to give propanoyl chloride*	**(1)**

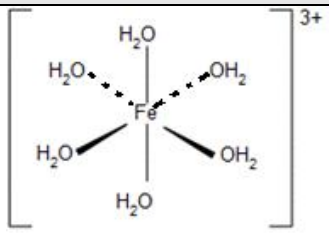
Question Number	Correct Answer	Mark
11(d)	**The only correct answer is B** ***A*** *is not correct because it is not branched* ***C*** *is not correct because it is not an amine* ***D*** *is not correct because it is not an amine*	**(1)**

Section B

Question Number	Acceptable Answers	Reject	Mark
12(a)(i)	$(Al^{3+}\ 1s^2)2s^22p^6$ (1) $(Fe^{3+}\ 1s^2)2s^22p^63s^23p^63d^5$ (1) ALLOW $2p_x^22p_y^22p_z^2$ / $3p_x^23p_y^23p_z^2$ ALLOW $4s^0$ included in Fe^{3+} / any other orbitals with 0 electrons IGNORE $1s^2$ written again		**(2)**

Question Number	Acceptable Answers	Reject	Mark
12(a)(ii)	The increase in ionisation energy is balanced by an increase in hydration/lattice enthalpy ALLOW There is (only) a gradual/ small increase in (successive) ionisation energies for iron OR Iron has (several removable) d electrons of similar energies OR The 4s / 3d electrons / orbitals have similar energies (for iron) OR The energy difference / gap between 4s and 3d is small (for iron) OR The ionisation energies are similar (for iron) IGNORE References to stability of half-full *d*-subshell / References to 3p electrons	Just 'iron is a transition element'	**(1)**

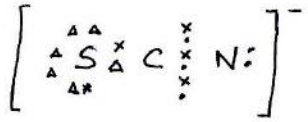
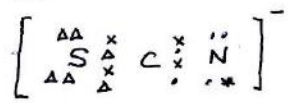
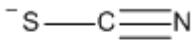
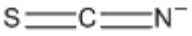
Question Number	Acceptable Answers	Reject	Mark
***12(b)**	**First mark - splitting** (3)**d** orbital**s** /(3)**d** subshell are/is split (in energy by the ligands) ALLOW "**d** orbital splitting" (1) IGNORE Just 'there is an energy difference between the (3) d orbitals' **Second mark - absorption** Electrons / photons absorb energy ALLOW Electrons absorb (visible) light Frequencies / wavelengths (of visible light) are absorbed (1) **Third mark - promotion** Electrons are promoted (from lower to higher energy d orbital(s) / levels) OR Electrons move (from lower) to higher energy (d) orbital(s) / levels ALLOW d-d transitions occur / Electrons are excited to higher energy (d) orbital(s) / levels (1) **Fourth mark - colour** Reflected / transmitted / remaining light is coloured / is in the visible region ALLOW Complementary colour seen (The frequency of) reflected / transmitted / remaining light is seen (1) IGNORE Reference to electrons relaxing / dropping to the ground state / any reference to aluminium	d orbital 'singular' is split d shell is split Penalise omission of (3)d only in First mark Light emitted	**(4)**

Question Number	Acceptable Answers	Reject	Mark
12(c)(i)	 **3D octahedral shape** Recognisable 3D octahedral shape ALLOW Wedges/dots instead of dashed lines going into the page or other recognisable representations (1) **Note** The word 'octahedral' does not rescue a poor diagram **Oxygen atoms** **6 oxygen** atoms joined to Fe (with or without lone pairs) ALLOW O_2H Oxygens to Fe joined by single bonds / arrows for this mark (1) IGNORE Omission of brackets and charge Incorrect charge Name of shape, even if incorrect	Negative charge on O	**(2)**

Question Number	Acceptable Answers	Reject	Mark
12(c)(ii)	Any 2 points from 3 **First point** Fe^{3+} is (small and) highly charged/ Fe^{3+} has a high charge density (1) **Second point** Fe^{3+} polarises / weakens / distorts the O−H bond OR Fe^{3+} attracts the electrons / electron cloud / electron density in the OH bond ALLOW Fe^{3+} polarises / distorts the water molecule (1) **Third point** (Solvent) water acts as a base OR (Solvent) water removes/ accepts a proton OR Water ligands donate a proton to (solvent) water ALLOW $[Fe(H_2O)_6]^{3+}$ / the complex (ion) / water **ligand** acts as an acid (1) IGNORE Just 'deprotonation' / just 'acid-base reaction' / alkali instead of base/ the complex is a proton donor	Water **ligands** act as a base Disproportionation	**(2)**

Question Number	Acceptable Answers	Reject	Mark
12(d)	**First mark – electron deficient** (The aluminium atom in) $AlCl_3$ has an empty (p) orbital (in the outer shell) / is electron deficient / has 6 electrons (in the outer shell) ALLOW 6 electrons shown around Al on a diagram (1) IGNORE Just '$AlCl_3$ has an incomplete (p) subhell' **Second mark - bond** It can accept a pair of / two electrons (from chlorine) OR Chlorine donates a pair of / 2 electrons (to $AlCl_3$) OR It form a dative (covalent) bond (with chlorine) ALLOW Mention of chloride ion (1) IGNORE diagram	Reference to 3d / 3s orbitals Reference to aluminium **ion** Reference to 'an electron' Chlorine molecule /Cl_2	**(2)**

Question Number	Acceptable Answers	Reject	Mark
12(e)(i)	Ligand exchange (reaction) OR Ligand substitution (reaction) OR Ligand replacement (reaction) Both words needed for the mark	Ligand change Ligand reaction Oxidation Reduction Redox	**(1)**

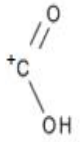
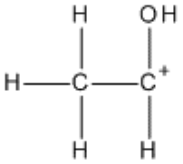
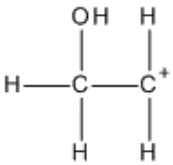
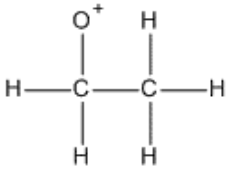
Question Number	Acceptable Answers	Reject	Mark
12(e)(ii)	**Dot-and-cross diagram**  OR  ALLOW Any symbols for electrons Bonds shown with 2 electrons on each e.g. x (1) IGNORE Missing brackets and charge **Structure and charge**  OR  Bonds correct **and** negative charge shown or stated on correct atom ALLOW This mark if bonds also shown in dot-and-cross diagram and negative charge on correct atom (1)		**(2)**

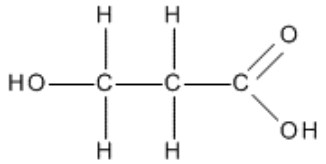
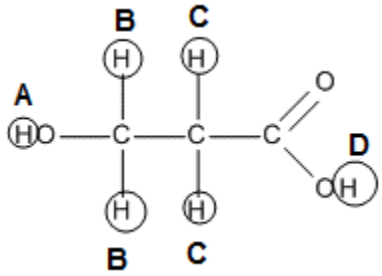
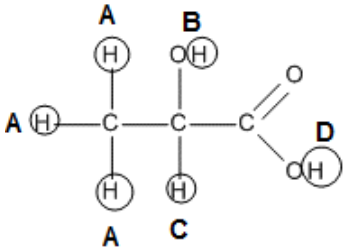
Question Number	Acceptable Answers	Reject	Mark
12(e)(iii)	Dative covalent bond / bond from lone pair (of electrons) on sulfur/S **and** from nitrogen/N (to an empty orbital in Fe^{3+}) IGNORE Ionic bond		**(1)**

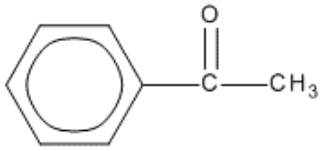
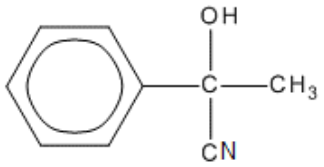
Question Number	Acceptable Answers	Reject	Mark
12(f)	**Ionic equation with hydrochloric acid** $Al(OH)_3 + 3H^+ \rightarrow Al^{3+} + 3H_2O$ ALLOW $Al(OH)_3(H_2O)_3 + 3H^+ \rightarrow Al^{3+} + 6H_2O$ $Al(OH)_3(H_2O)_3 + 3H^+ \rightarrow [Al(H_2O)_6]^{3+}$ $Al(OH)_3 + 3H^+ + 3H_2O \rightarrow [Al(H_2O)_6]^{3+}$ (1) IGNORE $H^+ + OH^- \rightarrow H_2O$ **Ionic equation with sodium hydroxide** $Al(OH)_3 + OH^- \rightarrow AlO_2^- + 2H_2O$ OR $Al(OH)_3 + OH^- \rightarrow [Al(OH)_4]^-$ ALLOW $Al(OH)_3(H_2O)_3 + OH^- \rightarrow [Al(OH)_4]^- + 3H_2O$ $Al(OH)_3(H_2O)_3 + OH^- \rightarrow [Al(OH)_4(H_2O)_2]^- + H_2O$ $Al(OH)_3 + 2OH^- \rightarrow [Al(OH)_5]^{2-}$ $Al(OH)_3(H_2O)_3 + 2OH^- \rightarrow [Al(OH)_5]^{2-} + 3H_2O$ $Al(OH)_3 + 3OH^- \rightarrow [Al(OH)_6]^{3-}$ $Al(OH)_3(H_2O)_3 + 3OH^- \rightarrow [Al(OH)_6]^{3-} + 3H_2O$ (1) If no other mark awarded, ALLOW 1 mark for two non-ionic / partially ionic equations e.g. $Al(OH)_3 + 3HCl \rightarrow AlCl_3 + 3H_2O$ **and** $Al(OH)_3 + NaOH \rightarrow NaAl(OH)_4$ IGNORE State symbols, even if incorrect / missing square brackets		**(2)**

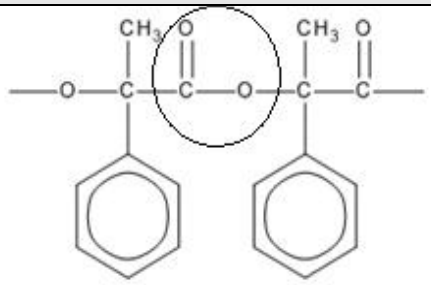
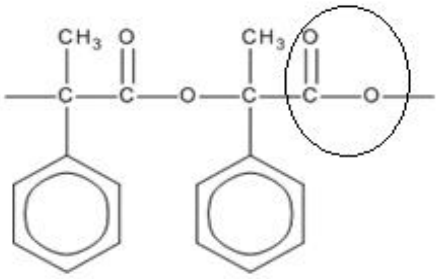
(Total for Question 12 = 19 marks)

Question Number	Acceptable Answers	Reject	Mark
13(a)(i)*	The methods below illustrate the allocation of marks. However, the marks may be scored by any correct method Correct molecular formulae with some working involving C/CO_2, H/H_2O and either O or use of 90 and subtraction of A_rs of C and H / COOH scores full marks Correct molecular formula with no working scores (1) **Method 1** mol CO_2 = 3.30/44 = 0.075 (= mol C) (1) mol H_2O = 1.35/18 = 0.075 (1) **and** mol H = 2 x mol H_2O = 0.150 **or** ratio C : H = 1 : 2 (1) mass O = 2.25 – ((12 x 0.075) + (1 x 0.150)) = 1.2 (g) (1) mol O = 1.2/16 = 0.075 (1) **Method 2** mass C = 3.30 x 12/44 = 0.90 (g) **and** mol C = 0.90/12 = 0.075 (1) mass H = 1.35 x 2/18 = 0.15 (g) **and** mol H = 0.15/1 = 0.15 (1) mass O = 2.25 – (0.90 + 0.15) = 1.2 (g) (1) mol O = 1.2/16 = 0.075 (1) **Empirical and molecular formulae from Methods 1 and 2** Empirical formula = CH_2O (1) Relative empirical formula mass CH_2O = 12 + (2 x 1) + 16 = 30 So, molecular formula is $C_3H_6O_3$ (1) TE on incorrect moles but the ratio must be a whole number **Method 3** mol T = 2.25/90 = 0.025 (1) mol CO_2 = 3.30/44 = 0.075 (= mol C) (1) mol ratio T : C / CO_2 = 1 : 3 (1) mol H_2O = 1.35/18 = 0.075 **and** mol H = 2 x mol H_2O = 0.150 **or** mol ratio C : H = 1 : 2 / 3 : 6 (1) 90 – (36 + 6) = 48 and mol O = 48/16 = 3 (1) So, molecular formula is $C_3H_6O_3$ (1)		**(6)**

Question Number	Acceptable Answers	Reject	Mark
13(a)(ii)	Any two of (1 mark for each structure)     ALLOW Structural formula i.e $COOH^+$, CH_3CHOH^+, $CH_2OHCH_2^+$,$CH_3CH_2O^+$ ALLOW Structures in brackets with positive charge outside bracket IGNORE Position of positive charge $C_2H_5O^+$ Connectivity of the OH group	Extra bonds once only e.g. $-COOH^+$ Negative charge or omission of charge once only HCO_2^+	**(2)**

Question Number	Acceptable Answers	Reject	Mark
13(a)(iii)	**Structure** of compound **T**:  (1) IGNORE Connectivity of the OH group **Explanation:** **Use of peak ratio** Use of peak ratio e.g. protons A and D are ratio 1 : 1 (as they are single protons) and protons B and C are ratio 2 : 2 (as there are two protons in each environment) ALLOW Ratio of protons /hydrogens is 1 : 2 : 2 : 1 (1) **Proton environments identified** 4 proton environments clearly identified by symbols or words e.g.  (1) **Note** If compound **T** is identified as lactic acid, (1) mark awarded for identification of four proton environments only e.g.  No TE on any other structure		**3**

Question Number	Acceptable Answers	Reject	Mark
13(b)(i)*	**Reaction 1** Reagents: CH_3COCl/ ethanoyl chloride **and** $AlCl_3$ / aluminium choride / $FeCl_3$ / iron(III) choride (1) Intermediate: stand alone or TE on acyl chloride used  (1) **Reaction 2** Reagents: conditional on a carbonyl compound HCN / hydrogen cyanide **and** KCN / potassium cyanide OR KCN / potassium cyanide **and** acid / H_2SO_4 / sulfuric acid / H^+ ions / hydrogen ions OR KCN / potassium cyanide **and** pH 8-10 /alkali ALLOW HCN / hydrogen cyanide **and** alkali / NaOH / sodium hydroxide / OH^- / hydroxide ions ALLOW Sodium for potassium and vice versa (1) Intermediate: stand alone  (1) **Reaction 3** Reagents: conditional on reaction with a CN group H^+ / hydrogen ions / (dilute) acid / name or formula of a strong acid ALLOW OH^- / hydroxide ions / alkali / name or formula of an alkali **and** followed by / then acidification / H^+ / hydrogen ions / (dilute) acid / name or formula of a strong acid (1) IGNORE Concentration of acid or alkali	Just 'CN^- in alkali' Additional reagent(s) e.g. $KMnO_4$ Acid and alkali added together	**(5)**

Question Number	Acceptable Answers	Reject	Mark
13(b)(ii)	 OR  **First mark** One correct ester linkage (as circled above) (1) **Second mark** Conditional on one (or more) ester linkage Rest of structure correct with 2 repeat units and extension bonds ALLOW C_6H_5 for benzene ring (1) IGNORE Brackets and n / bond lengths and bond angles	Os at both ends or no O at either end loses second mark only	**(2)**

(Total for Question 13 = 18 marks)

Question Number	Acceptable Answers	Reject	Mark
14(a)(i)	$V^{2+} + 2H_2O \rightarrow VO_2^+ + 4H^+ + 3e^{(-)}$ ALLOW Multiples Reversible arrow, provided equation written in the direction shown $V^{2+} + 2H_2O - 3e^{(-)} \rightarrow VO_2^+ + 4H^+$ IGNORE State symbols even if incorrect		**(1)**

Question Number	Acceptable Answers	Reject	Mark
14(a)(ii)	**First mark – reducing agent** Reducing agent: Fe^{2+}((aq)) / iron(II) (ions) This can be shown in an equation (1) Justification: **Second mark – V(V) to V(IV)** Fe^{2+}/Fe^{3+} electrode potential / SEP / $E^{\ominus}$ value is less positive / lower than the VO_2^+/VO^{2+} value / (+)0.77 < (+)1.00 (so V(V) is reduced to V(IV)) OR VO_2^+/VO^{2+} electrode potential / SEP / $E^{\ominus}$ value is more positive / greater / higher than the Fe^{2+}/Fe^{3+} value / (+)1.00 > (+)0.77 (so V(V) is reduced to V(IV)) OR $E^{\ominus}_{cell}$ for the reaction between VO_2^+ and Fe^{2+} is positive / (+)0.23 V / >0 (so V(V) is reduced to V(IV)) ALLOW Any of the above 3 explanations if SO_2, Zn, V^{3+} or V^{2+} chosen as reducing agent e.g. $E^{\ominus}$ for SO_2/SO_4^{2-} = (+)0.83 or $E^{\ominus}$ for Zn/Zn^{2+} =(+)1.76 or $E^{\ominus}$ for V^{3+} / VO^{2+} =(+)0.66 or $E^{\ominus}$ for V^{2+} / V^{3+} = (+)1.26 (so V(V) is reduced to V(IV)) (1) **Third mark – V(IV) to V(III)** Fe^{2+}/Fe^{3+} electrode potential / SEP / $E^{\ominus}$ value is more positive / greater / higher than the VO^{2+}/V^{3+} value / (+)0.77 > (+)0.34 (so V(IV) is not reduced to V(III)) OR VO^{2+}/V^{3+} electrode potential / SEP / $E^{\ominus}$ value is less positive / lower than the Fe^{2+}/Fe^{3+} value / (+)0.34 < (+)0.77 (so V(IV) is not reduced to V(III)) OR $E^{\ominus}_{cell}$ for the reaction between VO^{2+} and Fe^{2+} is negative / -0.43 V / <0 (so V(IV) is not reduced to V(III)) (1)	Incorrect value Incorrect value Incorrect value	**(3)**

Question Number	Acceptable Answers	Reject	Mark
14(a)(iii)	**First mark - equation** $2V^{3+} + H_2O \rightarrow V^{2+} + VO^{2+} + 2H^+$ ALLOW Multiples Reversible arrow, provided reaction is written in the direction shown (1) IGNORE State symbols even if incorrect Cancelled / crossed out electrons **Second mark - $E^{\ominus}_{cell}$ value** $E^{\ominus}_{cell}$ = −0.26 −0.34 = −0.6(0) (V) NO TE on equation written in reverse (1) **Third mark - feasibility** $E^{\ominus}_{cell}$ is negative / <0 **and** so the disproportionation is not feasible / V^{2+} and VO^{2+} will react to form V^{3+} ALLOW this mark even if an incorrect negative value is calculated for $E^{\ominus}_{cell}$ TE on a positive value for $E^{\ominus}_{cell}$ e.g. $E^{\ominus}_{cell}$ is positive / > **and** so the disproportionation is feasible (1)	Equation with uncancelled electrons	**(3)**

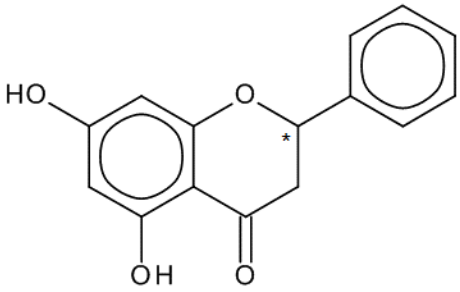
Question Number	Acceptable Answers	Reject	Mark
14(b)(i)	Correct answer, with or without working scores both marks **First mark – mol I_2** Mol $S_2O_3^{2-}$ used = 24.20 x 0.100/1000 = 0.00242 /2.42 x 10^{-3} **and** Mol I_2 = 0.00242/2 = 0.00121 /1.21 x 10^{-3} (1) **Second mark – conc Br_2** (Mol Br_2 = mol I_2 = 0.00121) Conc Br_2 = 0.00121 x 1000/25.0 = 0.0484 (mol dm^{-3}) (1) TE on mol $S_2O_3^{2-}$ and mol I_2 IGNORE SF except 1SF		**(2)**

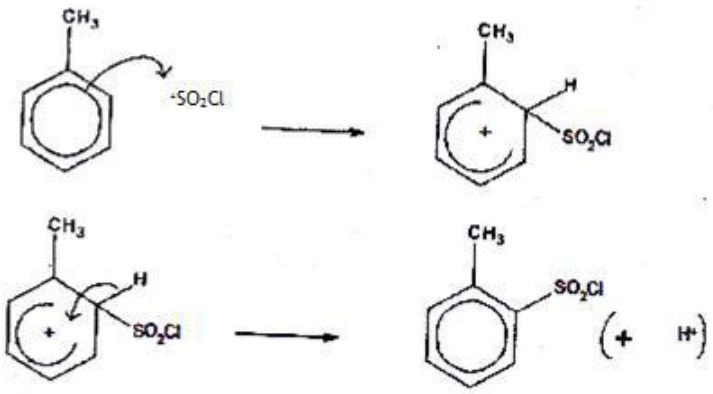
Question Number	Acceptable Answers	Reject	Mark
14(b)(ii)	Allow correct expressions if intermediate values not evaluated **First mark – original mol Br_2** Original mol Br_2 = 100.0 x 0.0484/1000 = 0.00484 / 4.84 x 10^{-3} (1) TE on conc Br_2 in (i) **Second mark – mol I_2** Mol $S_2O_3^{2-}$ used = 16.80 x 0.100/1000 = 0.00168 /1.68 x 10^{-3} **and** Mol I_2 = 0.00168/2 = 0.00084 / 8.4 x 10^{-4} (1) **Third mark – mol Br_2 reacted** (mol Br_2 in excess = mol I_2 = 0.00084) Mol Br_2 reacted with $S_2O_3^{2-}$ = 0.00484 – 0.00084 = 0.00400 /4.00 x 10^{-3} (1) TE on original mol Br_2 and mol I_2/ Br_2 in excess **Fourth mark – mol ratio** Mole ratio $S_2O_3^{2-}$: Br_2 = 0.00100 : 0.00400 = 1 : 4 (1) TE on mol $S_2O_3^{2-}$ and mol Br_2 reacted **Fifth mark – equation – stand alone** $S_2O_3^{2-} + 4Br_2 + 5H_2O \rightarrow 2SO_4^{2-} + 10H^+ + 8Br^-$ ALLOW $8HBr + 2Br^-$ on RHS (1) No TE on incorrect mol ratio IGNORE State symbols even if incorrect		**(5)**

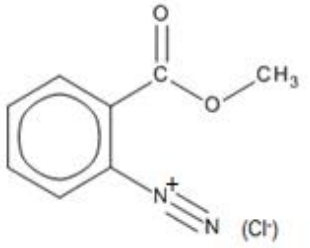
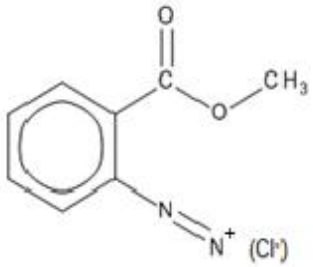
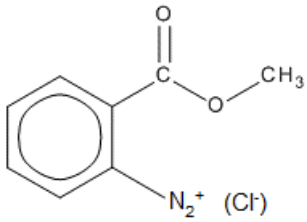
(Total for Question 14 = 14 marks)

Section C

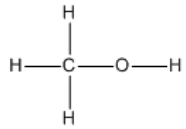
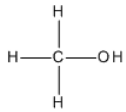
Question Number	Acceptable Answers	Reject	Mark
15(a)(i)	$C_{15}H_{12}O_4$ ALLOW symbols in any order, i.e. $C_{15}O_4H_{12}$, $H_{12}O_4C_{15}$, $H_{12}C_{15}O_4$, $O_4H_{12}C_{15}$, $O_4C_{15}H_{12}$ IGNORE Any other formulae as working	Numbers written as superscripts e.g. $C^{15}H^{12}O^4$	**(1)**

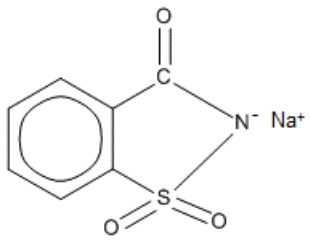
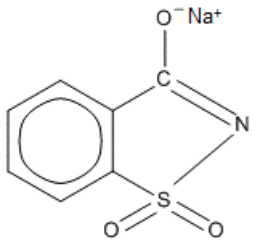
Question Number	Acceptable Answers	Reject	Mark
15(a)(ii)	 ALLOW Any way of identifying the chiral carbon, including a circle, provided that it does not include any other carbon atoms	Any additional carbon atoms indicated	**(1)**

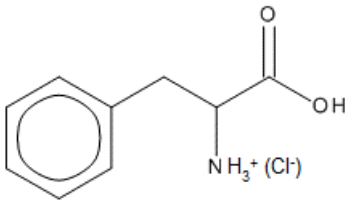
Question Number	Acceptable Answers	Reject	Mark
15(b)	 **First mark – first curly arrow** Curly arrow from on or within the circle to the S of $^{+}SO_2Cl$ ALLOW Curly arrow from anywhere within the hexagon ALLOW Curly arrow to any part of the $^{+}SO_2Cl$ ion, including the + charge (1) **Second mark - intermediate** Intermediate structure including charge with horseshoe covering at least 3 carbon atoms **and** facing the tetrahedral carbon atom **and** some part of the positive charge must be within the horseshoe (1) **Note** Do not award this mark If benzene used instead of methylbenzene or if final product is not the 2-isomer **Third mark – second curly arrow** Curly arrow from C–H bond to anywhere in the hexagon, reforming the delocalised structure (1) IGNORE Missing H^+ Involvement of any other ion / molecule in removal of H^+ Correct Kekule structures score full marks	Curly arrow on or outside the hexagon / incorrect electrophile / missing + Dotted bonds to H and SO_2Cl unless part of a 3D structure	**(3)**

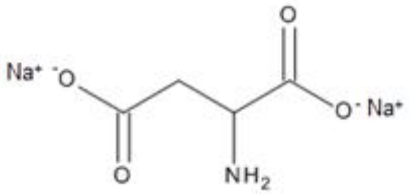
Question Number	Acceptable Answers	Reject	Mark
15(c)(i)	 OR  OR  IGNORE Missing Cl^- on the structures shown above	+ on wrong nitrogen atom Covalent bond to Cl	**(1)**

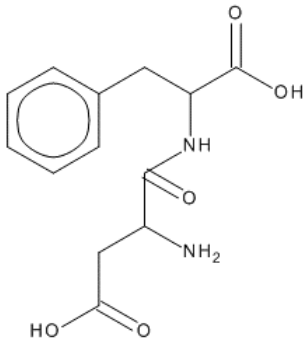
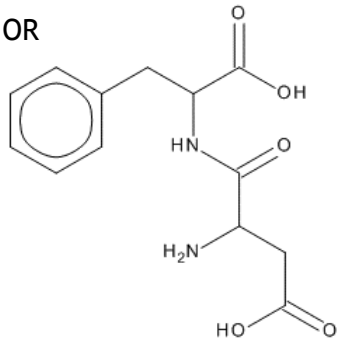
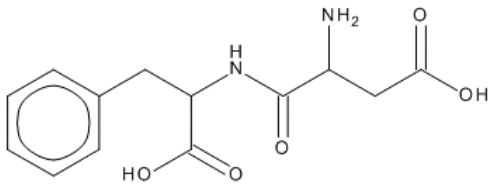
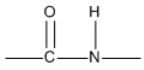
Question Number	Acceptable Answers	Reject	Mark
15(c)(ii)	(alcoholic / ethanolic) ammonia / NH_3 ALLOW Aqueous ammonia / $NH_3(aq)$ IGNORE Concentration / heat		**(1)**

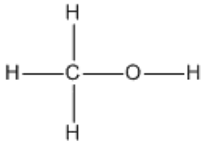
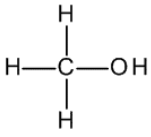
Question Number	Acceptable Answers	Reject	Mark
15(c)(iii)	CH_3OH OR  OR  ALLOW CH_4O	CH_3OH^+ CH_4O^+	**(1)**

Question Number	Acceptable Answers	Reject	Mark
15(c)(iv)	 OR  Both charges needed ALLOW Correct structure in brackets with charge outside and Na^+	Bond between N and Na or between O and Na Partial charges	**(1)**

Question Number	Acceptable Answers	Reject	Mark
15(d)(i)	 ALLOW displayed, structural or skeletal formula or any combination of these ALLOW $-NH_3Cl$ as side group IGNORE Missing Cl^- ions	Bond between N and Cl	**(1)**

Question Number	Acceptable Answers	Reject	Mark
15(d)(ii)	 ALLOW No charges, provided there is no bond between O and Na ALLOW Displayed, structural or skeletal formula or any combination of these e.g. $COONaCH_2CH(NH_2)COONa$ IGNORE Missing Na^+ ions	Partial charges δ+ / δ–	**(1)**

Question Number	Acceptable Answers	Mark
I5(d)(iii)	 OR  OR  Any one amide/peptide **link** shown e.g.  /-CONH- Do not award this mark if other functional groups are joined directly to the amide (1) Rest of structure correct ALLOW Displayed or structural formula or any combination of these (1) IGNORE Bond angles and bond lengths	**(2)**

Question Number	Acceptable Answers	Reject	Mark
15(d)(iv)	Methanol OR Any unambiguous formula e.g. CH_3OH /  /  If name and formula are given, both must be correct	CH_4O	**(1)**

Question Number	Acceptable Answers	Reject	Mark
15(e)(i)	$LiAlH_4$ / lithium tetrahydridoaluminate / lithium aluminium hydride (in dry ether) OR $NaBH_4$ / sodium tetrahydridoborate / sodium borohydride (in aqueous / alcohol solution) IGNORE Lithal / heat	$LiAlH_4$ in water / aqueous solution Just '[H] / H^-'	**(1)**

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>15(e)(ii)</td><td>
<table>
<tr><th>Reagent</th><th>Glucose</th><th>Sorbitol</th></tr>
<tr><td>Fehling’s / Benedict’s (solution and heat/boil)</td><td>Red / red-brown /brown / orange and precipitate</td><td>Stays blue / no change / no ppt</td></tr>
<tr><td>Tollens’ (reagent) / ammoniacal silver nitrate (and warm)</td><td>Silver mirror or grey /black /silver and precipitate</td><td>No change / no ppt</td></tr>
<tr><td>Brady’s (reagent) / 2,4-dinitro-phenyl-hydrazine / 2,4-DNP(H)</td><td>Orange / yellow / red and precipitate</td><td>Stays orange /no change / no ppt</td></tr>
</table>
Reagent (1)
Matching observation for glucose (1)
Matching observation for sorbitol (1)

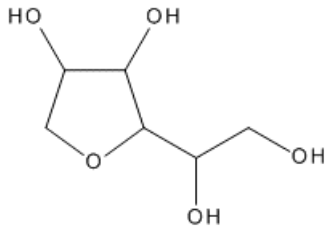
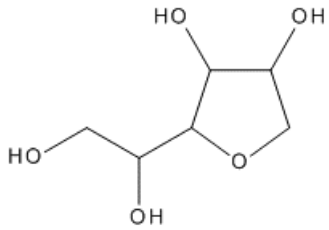
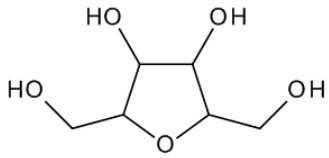
ALLOW
Correct formulae

ALLOW
No reaction / no observation / nothing happens for sorbitol

IGNORE
Sodium hydroxide in Tollens’ reagent

No TE on incorrect reagents
</td><td>Observations not linked to a reagent

Potassium dichromate(VI)</td><td>(3)</td></tr>
</table>

Question Number	Acceptable Answers	Reject	Mark
15(e)(iii)	 OR  OR  ALLOW Structural or displayed formulae or any combination of these IGNORE Bond angles and bond lengths OH connectivity		**(1)**

(Total for Section C = 19 marks)
TOTAL FOR PAPER = 90 MARKS