Mark Scheme (Results)

October 2019

Pearson Edexcel International Advanced Level In Chemistry (WCH05)
Paper 01 Transition Metals and Organic Nitrogen Chemistry

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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.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A (multiple choice)

Question Number	Answer	Mark
1	**The only correct answer is D (+3, +2, +6)** **A** *is not correct because the oxidation states in columns 1 and 3 are incorrect* **B** *is not correct because the oxidation states in columns 1, 2 and 3 are incorrect* **C** *is not correct because the oxidation state in column 2 is incorrect*	1

Question Number	Answer	Mark
2	**The only correct answer is A (K_2FeO_4)** **B** *is not correct because the oxidation number of iron is +2* **C** *is not correct because the oxidation number of iron is +3* **D** *is not correct because the oxidation number of iron is +2*	1

Question Number	Answer	Mark
3	**The only correct answer is B (1,2-diaminoethane)** ***A** is not correct because ammonia is monodentate so there would be 6 ligands in an octahedral complex* ***C** is not correct because EDTA is hexadentate so there would be 1 ligand in an octahedral complex* **D** *is not correct because water is monodentate so there would be 6 ligands in an octahedral complex*	1

Question Number	Answer	Mark
4	**The only correct answer is C (tetrahedral, square planar)** **A** *is not correct because $[Pt(NH_3)_2Cl_2]$ is not tetrahedral* **B** *is not correct because $[CrCl_4]^-$ is not square planar and $[Pt(NH_3)_2Cl_2]$ is not tetrahedral* **D** *is not correct because $[CrCl_4]^-$ is not square planar*	1

Question Number	Answer	Mark
5	**The only correct answer is B (+3)** **A** *is not correct because the oxidation number of sulfur increases by 2 so the oxidation number of each Q decreases by 1* **C** *is not correct because the oxidation number of sulfur increases by 2 so the oxidation number of each Q decreases by 1* **D** *is not correct because the oxidation number of sulfur increases by 2 so the oxidation number of each Q decreases by 1*	1

Question Number	Answer	Mark
6	**The only correct answer is D (ionic precipitation)** **A** *is not correct because the oxidation number of iron does not change* **B** *is not correct because the oxidation number of iron does not change* **C** *is not correct because the water is not produced from H and OH in different molecules*	1

Question Number	Answer	Mark
7	**The only correct answer is A (CH_3CHO to CH_3CH_2OH)** **B** *is not correct because carboxylic acids cannot be reduced to ketones* **C** *is not correct because hydride ions could not attack an alkene group* **D** *is not correct because hydride ions could not attack a benzene ring*	1

Question Number	Answer	Mark
8	**The only correct answer is B (SO_3)** **A** *is not correct because sulfur dioxide does not react to give benzenesulfonic acid* **C** *is not correct because the negative ion could not attack a benzene ring* **D** *is not correct because the negative ion could not attack a benzene ring*	1

Question Number	Answer	Mark
9	**The only correct answer is D (diazonium ion decomposes above 10°C)** **A** *is not correct because nitrous acid does not nitrate the benzene ring* **B** *is not correct because the reaction is not highly exothermic* **C** *is not correct because the low activation energy does not limit the upper temperature value in the range*	1

Question Number	Answer	Mark
10	**The only correct answer is D (is alkaline)** **A** *is not correct because ethylamine has only one functional group so cannot form a zwitterion* **B** *is not correct because ethylamine has a lone pair on the N atom which attracts protons, lowering* $[H^+]$ *in water* **C** *is not correct because ethylamine has a lone pair on the N atom which attracts protons, lowering* $[H^+]$ *in water*	1

Question Number	Answer	Mark
11	**The only correct answer is A** $(CH_3CONHC_6H_5)$ **B** *is not correct because* $C_2H_5CONHC_6H_5$ *is the product of* C_2H_5COCl *and* $NH_2C_6H_5$ **C** *is not correct because* $C_6H_5CONHCH_3$ *is the product of* C_6H_5COCl *with* NH_2CH_3 **D** *is not correct because* $C_6H_5CONHC_2H_5$ *is the product of* C_6H_5COCl *with* $NH_2C_2H_5$	1

Question Number	Answer	Mark
12	**The only correct answer is C** (CH_3NH_3Cl) **A** *is not correct because this is the product of HCl and ammonia* **B** *is not correct because an H atom is missing from the formula* **D** *is not correct because there is no CO group in methylamine*	1

Question Number	Answer	Mark
13	**The only correct answer is C (butanone)** **A** *is not correct because but-1-ene has four peaks in the low resolution nmr spectrum* **B** *is not correct because butanal has four peaks in the low resolution nmr spectrum* **D** *is not correct because butanoic acid has four peaks in the low resolution nmr spectrum*	1

Question Number	Answer	Mark
14	**The only correct answer is D (ketone)** **A** *is not correct because an alkyl (methyl) group is present* **B** *is not correct because an alkene group is present* **C** *is not correct because an amide group is present*	1

Question Number	Answer	Mark
15	**The only correct answer is D (ΔS_{total} and ln K)** **A** *is not correct because* E_{cell} *for a chemical reaction is proportional to both* ΔS_{total} *and ln K* **B** *is not correct because* E_{cell} *for a chemical reaction is proportional to both* ΔS_{total} *and ln K* ***C*** *is not correct because* E_{cell} *for a chemical reaction is proportional to both* ΔS_{total} *and ln K*	1

Question Number	Answer	Mark
16	**The only correct answer is C (298K and [H^+(aq)] = 1.00 mol dm^{-3})** **A** *is not correct because temperature should not be 273 K* **B** *is not correct because temperature should not be 273 K and hydroxide ions are not 1.00 mol* dm^{-3} **D** *is not correct because hydroxide ions are not 1.00 mol* dm^{-3}	1

Question Number	Answer	Mark
17	**The only correct answer is C ($Fe^{2+}(aq)$)** **A** *is not correct because H^+ is not a catalyst which can be oxidised by one reactant and reduced by the other.* **B** *is not correct because Mg^{2+} is not a catalyst which can be oxidised by one reactant and reduced by the other.* **D** *is not correct because the negative hydroxide ions would repel the reactant ions.*	1

Question Number	Answer	Mark
18(a)	**The only correct answer is B (X)** **A** *is not correct because a polymer formed from an amino acid would contain a CONH (peptide) group* **C** *is not correct because a polymer formed from an amino acid would contain a CONH (peptide) group* **D** *is not correct because this polymer is formed from a diamine and a dicarboxylic acid, not from an amino acid*	1

Question Number	Answer	Mark
18(b)	**The only correct answer is A (W)** **B** *is not correct because the polymer is a condensation polymer and propenamide is an addition polymer* **C** *is not correct because there is no amide group present* **D** *is not correct because the polymer is not formed from an amide*	1

Question Number	Answer	Mark
19	**The only correct answer is B (3.66)** **A** *is not correct because the molar masses have been reversed* **C** *is not correct because the percentage yields have not been used* **D** *is not correct because moles at each stage have been divided by the percentage yields, not multiplied*	1

Total for Section A = 20 marks

Section B

Question Number	Acceptable Answers	Reject	Mark
20(a)	**M1** Al / Mg ALLOW Redox couple eg Mg^{2+}/Mg Al or Mg used in equation (1) **M2** $2Al + 3Mn^{2+} \rightarrow 2Al^{3+} + 3Mn$ OR $Mg + Mn^{2+} \rightarrow Mg^{2+} + Mn$ ALLOW Ba, Ca or V for Mg in **M2** as TE Ce for Al in **M2** as TE $2M + Mn^{2+} \rightarrow 2M^{+} + Mn$ where M= Li, Na, K as TE (1) IGNORE State symbols even if incorrect Reversible arrows but with correct direction	Li, Na, K, Ca, Rb, U, Ce Use of Ba (not based on data) Use of Ca^{2+} or Al^{3+} use of metal below Mn in series (except V which can score a TE in **M2**)	**(2)**

Question Number	Acceptable Answers	Reject	Mark
20(b)(i)	**A** platinum / Pt (1) ALLOW Platinum with platinum black **B** potassium nitrate / KNO_3 / Sodium nitrate / $NaNO_3$ (1) Allow C and D in either order **C** potassium manganate(VII) / $KMnO_4$((aq)) ALLOW Potassium permanganate (1) **D** manganese(II) sulfate / $MnSO_4$ / $MnCl_2$ / Correct formula for other Mn^{2+} salts ALLOW 1 mark for formulae of two ions in C and D Mn^{2+} / Mn^{+2} / manganese(II) ions MnO_4^-((aq)) / Manganate(VII) ions IGNORE Concentrations of solutions (1)	Pt with hydrogen on the surface KBr, KI, KCl, NaCl, KOH, K_2SO_4, just 'nitrate ions' potassium manganate with incorrect oxidation number	**(4)**

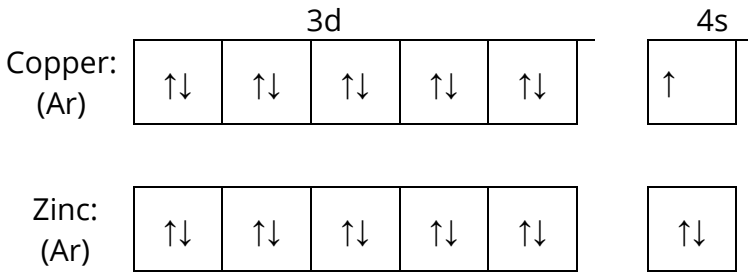
Question Number	Acceptable Answers	Reject	Mark
20(b)(ii)	(+) 2.70(V) / 2.7	Any negative value	**(1)**

Question Number	Acceptable Answers	Reject	Mark
20(c)	$4OH^- \rightarrow O_2 + 2H_2O + 4e^{(-)}$ / $4OH^- - 4e^{(-)} \rightarrow O_2 + 2H_2O$ ALLOW multiples Half equations shown as working before correct final equation IGNORE state symbols even if incorrect reversible arrows	Unbalanced equations Ionic equations including MnO_4^- and MnO_4^{2-} but without electrons	**(1)**

Question Number	Acceptable Answers	Reject	Mark
20(d)(i)	$3MnO_4^{2-} + 2H_2O \rightarrow MnO_2 + 2MnO_4^- + 4OH^-$ ALLOW $3K_2MnO_4 + 2H_2O \rightarrow MnO_2 + 2KMnO_4 + 4KOH$ ALLOW Reversible arrows Correct species including charges on each side of equation OR Two correctly written half equations (2nd and 3rd in the table) (1) Correct balancing (1) Fully correct equation in reverse scores (1) IGNORE state symbols even if incorrect		**(2)**

Question Number	Acceptable Answers	Reject	Mark
20(d)(ii)	$E^\ominus$ = (0.59 – 0.56) = (+) 0.03((V)) **and** thermodynamically feasible (because $E^\ominus$ is positive) ALLOW Spontaneous		**(1)**

(Total for Question 20 = 11 marks)

Question Number	Acceptable Answers	Reject	Mark
21(a)	 ALLOW Half headed arrows		**(1)**

Question Number	Acceptable Answers	Reject	Mark
***21(b)(i)**	**M1** Zinc has one more proton/ more protons (so nuclear attraction is greater) OR Zinc has greater nuclear charge OR Copper has one fewer proton so nuclear attraction is smaller OR Atomic number of zinc is higher than copper (1) **M2** Both have their first electron removed from 4s ALLOW The 4s shell in zinc is full (1) IGNORE Comments on atomic radius Comments about shielding	Cu has lower charge density	**(2)**

Question Number	Acceptable Answers	Reject	Mark
***21(b)(ii)**	In Cu, second electron is taken from 3d subshell / orbital (which must require more energy than from the 4s in zinc) (1) 3d is less well shielded (than 4s in zinc) ALLOW 3d is closer to the nucleus (1)		**(2)**

Question Number	Acceptable Answers	Reject	Mark
***21(b)(iii)**	There are no transitions of electrons (from a lower**)** to a **higher** energy level (in the visible region) ALLOW there are no possible d-d transitions (1) the (3)d sub-shell in zinc is full / there are no empty levels in zinc for transitions to occur / (3)d orbitals are completely full OR Reverse arguments for why other ions are coloured (1)	d orbitals are not split no electrons get excited 3d orbital is full The 3d shell is full Zn has a full d orbital Just "Zn is $3d^{10}$" Zn has no unpaired electrons	**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	precipitate (pale) blue **and** solution dark blue Solution colour must be a darker blue than the precipitate colour IGNORE Gelatinous(precipitate)	Answers where solution is not darker blue than precipitate	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii)	$[Cu(H_2O)_4(OH)_2]+ 4NH_3 \rightarrow [Cu(H_2O)_2(NH_3)_4]^{2+} + 2H_2O + 2OH^-$ formula of complex ion (1) rest of equation (1) ALLOW Equation with products written $[Cu(NH_3)_4]^{2+} + 4H_2O + 2OH^-$ can score both marks Equation using $6NH_3$ $[Cu(H_2O)_4(OH)_2]+ 6NH_3 \rightarrow [Cu(NH_3)_6]^{2+} + 4H_2O + 2OH^-$ can score for correct balancing (1) IGNORE Order of ligands in complex ions state symbols even if incorrect	$[Cu(H_2O)_4(OH)_2]+ 4NH_3 \rightarrow [Cu(OH)_2(NH_3)_4] + 4H_2O$ scores 0 Equations using $2NH_3$	**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(d)(i)	Amphoteric		**(1)**

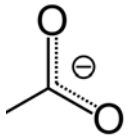
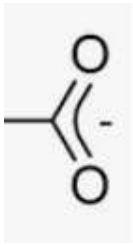
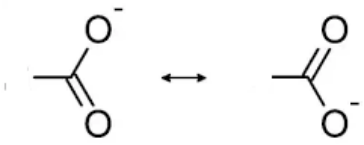
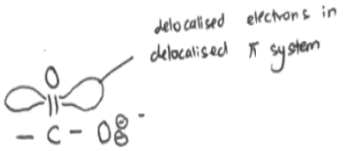
Question Number	Acceptable Answers	Reject	Mark
21d(ii)	$Zn(OH)_2 + 2NaOH \rightarrow Na_2ZnO_2 + 2H_2O$ $Zn(OH)_2 + 2OH^- \rightarrow Zn(OH)_4^{2-}$ ALLOW $Zn(OH)_2 + 2OH^- \rightarrow ZnO_2^{2-} + 2H_2O$ $Zn(OH)_2(H_2O)_4 + 2OH^- \rightarrow Zn(OH)_4(H_2O)_2^{2-} + 2H_2O$ $Zn(OH)_2(H_2O)_4 + 2OH^- \rightarrow Zn(OH)_4^{2-} + 4H_2O$ IGNORE State symbols even if incorrect	$Zn(OH)_3^-$ $Zn(OH)_6^{4-}$	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(e)(i)	$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ IGNORE State symbols even if incorrect		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(e)(ii)	**M1** Mol thiosulfate = ((24.50 x 0.150)/1000) = 3.675×10^{-3} / 0.003675 (1) **M2** (Mol I_2 = ((3.675×10^{-3} /2))= 1.8375×10^{-3}/ 0.0018375) Mol Cu in 25 cm^3 = (($2 \times 1.8375 \times 10^{-3}$)) = 3.675×10^{-3} / 0.003675 (mol) Mass Cu in 25 cm^3 = (0.003675 x 63.5) =2.3336×10^{-1} / 0. 23336 (g) (1) **M3** Mass Cu in 250 cm^3 = M2 × 10 = 2.3336 (g) (1) **M4** % Cu in brass = ((2.3336 x 100/3.50) = 66.675 = 66.7 (1) Allow correct rounding to 2 or more SF e.g. Rounding to 0.00368 in M1 gives final answer 66.7657 = 66.8% Total score (4) Rounding to 2.33 in M3 gives final answer 66.5714 = 66.6% Total score (4) Allow TE at each stage Use of 2:1 ratio only once can give 33.4% scores 3 Correct answer with no working scores 4 The multiplications in M2 and M3 (x 63.5 and x10) can be done in either order.	Use of incorrect ratio Answers > 100% Answers not to 3SF (M4)	**(4)**

(Total for Question 21 = 17 marks)

Question Number	Acceptable Answers	Reject	Mark
22(a)	Electrons are not fixed in a particular **bond** OR not associated with a particular **atom**/ pair of **atoms**/ covalent **bond** OR electrons are shared between three or more **atoms** OR electrons are not found in a fixed position/in one place OR Electrons are free to move from one bond to another OR electrons are free to move from atom to atom ALLOW Electrons are free to move around a system / molecule / ion / compound IGNORE Just 'electrons are free to move'	Just "electrons which can move" Electrons are not bonded Electrons shared between two or more atoms	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(b)(i)	 OR  OR  OR (with arrows added)  ALLOW Bracketed with charge shown outside IGNORE Lone pairs Bond angles	Diagrams with the bond to the R group of the ion not shown Diagrams with no minus sign or two minus signs Dot and cross diagrams  Only one arrow	**(1)**

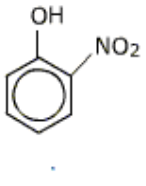
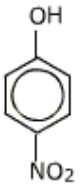
Question Number	Acceptable Answers	Reject	Mark
22(b)(ii)	Angle within the range 120-123 (°) Mark independently from 22(b)(i) IGNORE Name given with angle even if incorrect	Just >120	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	Number:**6** electrons Type of orbital: p OR 2p / $2p_z$ / $2p_y$ / $2p_x$ IGNORE Hybridised orbitals	pi electrons ϖ electrons ϖ orbitals	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(c)(ii)	x-ray diffraction / x-ray crystallography (1) bonds (between carbon atoms) would be the same length in benzene / Bond length is intermediate between double and single / Bond angles (in ring) are 120° / the same ALLOW Information in **labelled** diagrams (1) IGNORE It would not show double and single bonds	x-rays x-ray imaging electron density map hydrogenation enthalpy data Bond length is between a pi bond and a sigma bond	**(2)**

Question Number	Acceptable Answers	Reject	Mark
***22(d)**	The lone pair on the O (of phenol) is delocalised / interacts with the delocalised ring (in benzene) / increases the electron density of the ring OR The lone pair on the O of methanol is not delocalised / has no delocalised ring to interact with (1) The (C-O) bond in phenol has a partial double bond character ALLOW The (C-O) bond is stronger (1)	The lone pair on O attracts the delocalised ring	**(2)**

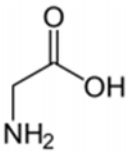
Question Number	Acceptable Answers	Reject	Mark
22(e)(i)	**Dilute /dil** nitric acid OR Nitric acid of concentration between 0.5 and 2 mol dm^{-3} (3% to 12% nitric acid) ALLOW Use of HNO_3 instead of the name Use of concentrated/conc if qualified by a concentration in the correct range e.g conc. HNO_3 of 2.0 mol dm^{-3}	Nitrating mixture Any use of sulfuric acid Dilute / dil nitric acid with incorrect concentration quoted.	**(1)**

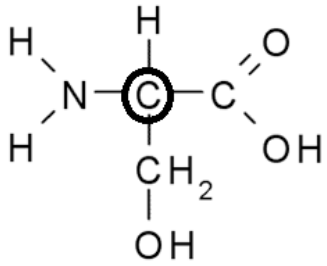
Question Number	Acceptable Answers	Reject	Mark
22(e)(ii)	Any two from   ALLOW any pair of isomeric di, tri, or tetranitrophenols Kekule structures IGNORE Connectivity of OH and NO_2 (1)	NO_3 substituents Any two non-isomeric compounds Substituted cyclohexanes	**(1)**

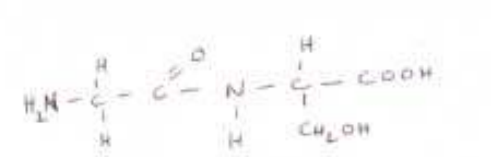
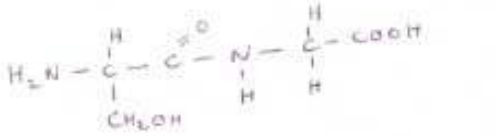
Question Number	Acceptable Answers	Reject	Mark
22(e)(iii)	**Concentrated** nitric acid and **concentrated** sulfuric acid ALLOW **"Concentrated** nitric and sulfuric acids" H_2SO_4(l) HNO_3(l) (1) heat in the range of 50-60 ^oC any temperature in this range ALLOW M2 provided nitric and/or sulfuric acid is mention in M1. (1)	Just "heat" Juse "Heat under reflux"	**(2)**

(Total for Question 22 = 12 marks)

Question Number	Acceptable Answers	Reject	Mark
23(a)	IGNORE Comments about London Forces **M2** in each method depends on which approach is used. Marks from the two methods cannot be mixed. Information may be given in diagrams. **Method 1** **M1** amino acids exist as zwitterions (1) **M2** the charges are attracted to the (polar) water molecules OR the charges are attracted to the $H^{\delta+}$ or $O^{\delta-}$ in water OR There are ion dipole attractions with the water molecules ALLOW There are dipole/dipole attractions with the water molecules (1) **Method 2** **M1** hydrogen bonds can form (with water) from the amine / NH_2 group OR hydrogen bonds can form from the carboxylic acid / COOH / OH group (1) **M2** This compensates for energy required to breaking H bonds between water OR Energy change is larger than lattice energy of acid (1)	Just "both amino acids and water are polar molecules" Ionic bonding with water Just "they form hydrogen bonds" H bonds can form between the H in the amino acid and the H in water	**(2)**

Question Number	Acceptable Answers	Reject	Mark
23(b)	Ninhydrin (solution) ALLOW Ninhydrine (solution) Nin-hydrin (solution)	Nin**o**hydrin Ninhydr**a**n Ninhydr**a**in Ninhydr**ate** Ninhydr**ide**	**(1)**
Question Number	Acceptable Answers	Reject	Mark
23(c)(i)	$^{+}NH_3CH_2COO^-$ / NH_2CH_2COOH OR  OR fully displayed formula		**(1)**

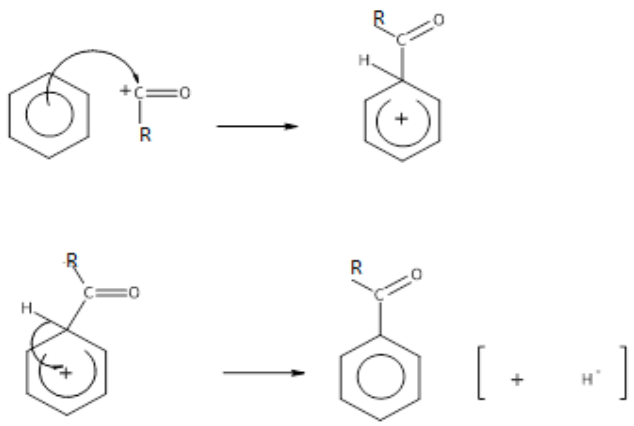
Question Number	Acceptable Answers	Reject	Mark
23(c)(ii)	**M1** Z contains two OH groups OR Z contains an OH / alcohol group as well as the COOH ALLOW OH and COOH shown in formula (1) **M2** formula  **Look carefully for different orientations of this formula.** **Amino group, COOH and an H should be on the same C and CH_2OH in a side chain.** ALLOW undisplayed NH_2, COOH / zwitterion (1) **M3** chiral C circled or highlighted in some way ALLOW TE on a chiral C in an incorrect amino acid NH_2CH_2**C**H(OH)COOH NH_2**C**H(OH)CH_2 COOH (1)	Just "contains COOH" Contains groups other than OH and COOH Contains 2 alcohol groups Answer which does not match formula Eg is an acyl chloride Acid with NH_2 and COOH not on same C: $NH_2CH_2CH(OH)COOH$ $NH_2CH(OH)CH_2COOH$ $NH_2C(OH)(CH_3)COOH$	**(3)**

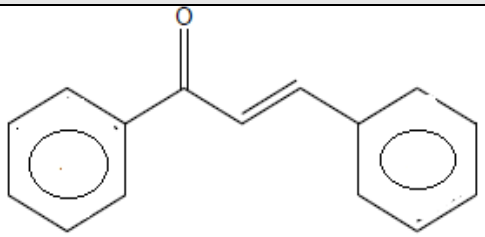
Question Number	Acceptable Answers	Reject	Mark
23(c)(iii)	**You will see different orientations of the dipeptide. Look carefully.** Dipeptide with peptide bond from either COOH of glycine or serine  OR  Correct peptide (CONH) group (1) Rest of dipeptide correct ALLOW TE from $NH_2CH_2CH(OH)COOH$ or $NH_2CH(OH)CH_2COOH$ in (c)(ii) OR from incorrect Y as long as it is an amino If two are given both must be correct (1)	Molecules without CONH (peptide) link	**(2)**

(Total for Question 23 = 9 marks)
Total for Section B = 49 marks

Section C

Question Number	Acceptable Answers	Reject	Mark
24(a)	$C_{10}H_{16}O$ $C_{10}H_{16}O_1$	$C_{10}H_{15}OH$	1

Question Number	Acceptable Answers	Reject	Mark
24(b)	$C_2H_5COCl + AlCl_3 \rightarrow C_2H_5CO^+ + AlCl_4^-$ (1) **Fully correct mechanisms making propyl benzene from chloropropane score max 3**  (R = —CH_2CH_3 / —C_2H_5) Curly arrow from on or within the circle to positively charged carbon ALLOW Curly arrow from anywhere within the hexagon Positive charge on any part of the electrophile Arrow to any part of the $C_2H_5CO^+$ including to the + charge TE on incorrect electrophile eg CH_3CO^+ , $C_3H_7^+$, $C_3H_5O^+$ (1) Intermediate structure including charge with horseshoe covering at least 3 carbon atoms, **and** facing the tetrahedral carbon **and** some part of the positive charge must be within the horseshoe (1) Curly arrow from C—H bond to anywhere in the benzene ring. Correct product shown. TE on incorrect electrophile eg CH_3CO^+, $C_2H_5^+$ (1) Correct Kekulé structures score full marks Ignore any involvement of $AlCl_4^-$ at end	$C_3H_5O^+$ for electrophile Curly arrow on or outside the hexagon All bonds to H and CO dotted **unless** clearly a dots & wedge 3-D structure Bond from benzene ring to C of alkyl group H_2 as product	4

Question Number	Acceptable Answers	Reject	Mark
24(c)	 OR Formula drawn right to left ALLOW Formula written with -COCH=CH- between benzene rings *cis*- / *Z*- isomer IGNORE Reaction intermediate (with OH)		1

Question Number	Acceptable Answers	Reject	Mark
24(d)	Intermediate OR  CN may be shown in either position ALLOW CN represented as ≡N coming from line representing C (1) Step 1: HCN + KCN ALLOW KCN + acid / HCN + alkali / HCN pH 8 IGNORE Ethanol (1) Step 2: (dilute) HCl / other strong acid ALLOW HCl + water Concentrated HCl (1) Step 2 depends on appearance of CN in Step 1 or in the intermediate IGNORE Heat, warm, reflux throughout	Concentrated HCl concentrated H_2SO_4 Carboxylic acids $LiAlH_4$	3

Question Number	Acceptable Answers	Reject	Mark
24(e)(i)	Water: (anhydrous) calcium chloride / magnesium sulfate / sodium sulfate / silica gel/ $CaCl_2$ /$MgSO_4$/ Na_2SO_4 (1) Carbon dioxide: Calcium hydroxide/ lime/ slaked lime /quick lime /soda lime/ sodium hydroxide/ potassium hydroxide/ $Ca(OH)_2$ / CaO / NaOH/ KOH ALLOW Lime water (1)	Name with incorrect formula Copper sulfate /$CuSO_4$ Cobalt chloride / $CoCl_2$ Concentrated sulfuric acid Calcium sulfate Silicon dioxide Concentrated sulfuric acid Sodium carbonate Sodium hydrogencarbonate Lime soda limestone Gas syringe	2

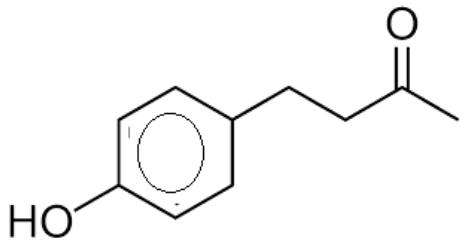
Question Number	Acceptable Answers	Reject	Mark
24(e)(ii)	Mass of oxygen in CO_2 and H_2O includes O in compound and O from air/ atmosphere OR Mass of oxygen in CO_2 and H_2O includes mass provided for combustion ALLOW Oxygen comes from air as well (as from the compound) IGNORE Oxygen is in both carbon dioxide and water	Oxygen is lost Oxygen evaporates	1

Question Number	Acceptable Answers	Reject	Mark
24(f)(i)	Mol C: (73.17/12) = 6.0975 Mol H = 7.32 Mol O: (19.51/16) = 1.219375 (1) Empirical formula C_5H_6O (1) No TE on incorrect moles Answer with no working scores (1) IGNORE sf except 1 sf		2

Question Number	Acceptable Answers	Reject	Mark
24(f)ii)	$C_{10}H_{12}O_2$ Mark independently		1

Question Number	Acceptable Answers	Reject	Mark
24(f)(iii)	Find *m/e* value for the line farthest to the right (of the mass spectrum) (excluding minor isotopes) OR find the line with highest *m/e* value ALLOW *m/z* for *m/e*	m/e of the highest peak / The molecular peak The largest peak Peak with highest molecular mass Just 'position of last peak'	1

Question Number	Acceptable Answers	Reject	Mark
24(f)(iv)	Any matching pair M2 depends on a suitable test in M1 If 2 tests are given both must be correct Add bromine(water) ALLOW Add liquid bromine / $Br_2(l)$ (1) a white precipitate (of tribromophenol) is formed IGNORE Decolorisation Antiseptic smell (1) OR Add sodium (1) Effervescence occurs with phenol (and white solid) ALLOW Hydrogen forms with phenol (1) OR Add iron(III) chloride solution (1) Red/ blue/ purple/ violet colour (1) OR Add ethanoyl chloride/ an acyl chloride (1) Characteristic smell/ fruity smell (1)	use of PCl_5 use of sodium carbonate White solid without gas formation	2

Question Number	Acceptable Answers	Reject	Mark
24(f)(v)	**M1** Structure showing CH_3CO group **M2**  ALLOW Substituents on any position on benzene ring (1) **M3** H in right hand CH_3 labelled as singlet **AND** H in both adjacent CH_2 labelled as triplet (1) Award M3 for correct labelling of positions of singlet and triplet on skeletal formula M3 can be awarded following errors in M2 e.g. missing phenolic group.	Missing phenolic OH	3

(Total for Question 24 = 21 marks)
Total for SECTION C = 21 MARKS
TOTAL FOR PAPER = 80 MARKS

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