



Mark Scheme (Results)

Summer 2025

Pearson Edexcel International Advanced Level
In Chemistry (WCH15)
Paper 01A Transition Metals and Organic
Nitrogen Chemistry

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Summer 2025

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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

Question Number	Answer	Mark
1(a)	<p>The only correct answer is D (zinc platinum)</p> <p><i>A is incorrect because zinc is part of the reaction so electrode 1 must be zinc</i></p> <p><i>B is incorrect because zinc is part of the reaction so electrode 1 must be zinc</i></p> <p><i>C is incorrect because iron will react with iron ions in solution</i></p>	(1)

Question Number	Answer	Mark
1(b)	<p>The only correct answer is B (209 g)</p> <p><i>A is incorrect because the value is the A_r of iron</i></p> <p><i>C is incorrect because the water of crystallisation has been ignored and each mole of salt contains 2 mol Fe^{3+}</i></p> <p><i>D is incorrect because each mole of salt contains 2 mol Fe^{3+}</i></p>	(1)

Question Number	Answer	Mark
2(a)	<p>The only correct answer is C $(2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l}))$</p> <p><i>A is incorrect because oxygen is a reactant in the fuel cell and the charges are not balanced</i></p> <p><i>B is incorrect because oxygen is a reactant in the fuel cell</i></p> <p><i>D is incorrect because this is the reverse of the correct equation</i></p>	(1)

Question Number	Answer	Mark
2(b)	<p>The only correct answer is B (+1.23 V)</p> <p><i>A is incorrect because the hydrogen electrode potential has been doubled</i></p> <p><i>C is incorrect because both electrode potentials have been reversed and added together</i></p> <p><i>D is incorrect because the two electrode potentials have been added together</i></p>	(1)

Question Number	Answer	Mark
3(a)	<p>The only correct answer is B (+1)</p> <p><i>A is incorrect because the carbon atoms have been oxidised not reduced</i></p> <p><i>C is incorrect because this is the oxidation number of C in $\text{C}_2\text{O}_4^{2-}$</i></p> <p><i>D is incorrect because this is the oxidation number of C in CO_2</i></p>	(1)

Question Number	Answer	Mark
3(b)	<p>The only correct answer is A (5.00)</p> <p><i>B is incorrect because the difference in solution concentrations has been ignored</i></p> <p><i>C is incorrect because the stoichiometry of the reaction has been ignored</i></p> <p><i>D is incorrect because the mole ratio has been reversed</i></p>	(1)

Question Number	Answer	Mark
4	<p>The only correct answer is D (the total entropy change, $\Delta S^\circ_{\text{total}}$, is positive)</p> <p><i>A is incorrect because $\Delta S^\circ_{\text{total}}$ must be positive but $\Delta S^\circ_{\text{system}}$ could be negative</i></p> <p><i>B is incorrect because $\Delta S^\circ_{\text{total}}$ must be positive but $\Delta S^\circ_{\text{surroundings}}$ could be negative</i></p> <p><i>C is incorrect because $\Delta S^\circ_{\text{total}}$ must be positive but $\Delta S^\circ_{\text{system}}$ or $\Delta S^\circ_{\text{surroundings}}$ could be negative</i></p>	(1)

Question Number	Answer	Mark
5	<p>The only correct answer is B ([Ar] 3d¹⁰)</p> <p><i>A is incorrect because the ion would be coloured</i></p> <p><i>C is incorrect because this is not the electronic configuration of an ion of a transition metal</i></p> <p><i>D is incorrect because this is not the electronic configuration of an ion of a transition metal</i></p>	(1)

Question Number	Answer	Mark
6	<p>The only correct answer is C ($[\text{CrCl}_2(\text{H}_2\text{O})_4]^+$)</p> <p><i>A is incorrect because this formula would produce a precipitate of 3×14.35 g of AgCl</i></p> <p><i>B is incorrect because this formula would produce a precipitate of 2×14.35 g of AgCl</i></p> <p><i>D is incorrect because this species would not produce a precipitate because there are no chloride ions outside the complex</i></p>	(1)

Question Number	Answer	Mark
7(a)	<p>The only correct answer is A ($[\text{CrCl}_4]^-$)</p> <p><i>B is incorrect because the complex ion is octahedral</i></p> <p><i>C is incorrect because the complex is square planar</i></p> <p><i>D is incorrect because the complex ion is octahedral</i></p>	(1)

Question Number	Answer	Mark
7(b)	<p>The only correct answer is A ($[\text{CuCl}_2]^-$)</p> <p><i>B is incorrect because the oxidation number of the metal is +3</i></p> <p><i>C is incorrect because the oxidation number of the metal is +2</i></p> <p><i>D is incorrect because the oxidation number of the metal is 0</i></p>	(1)

Question Number	Answer	Mark
8	<p>The only correct answer is C (the formation of the EDTA complex produces more particles in solution.)</p> <p><i>A is incorrect because the strength of the bonds does not determine which complex is favoured</i></p> <p><i>B is incorrect because the number of dative covalent bonds is the same</i></p> <p><i>D is incorrect because the hydrogen bonding in the ligands does not affect the stability of the complex</i></p>	(1)

Question Number	Answer	Mark
9	<p>The only correct answer is C (a reducing agent)</p> <p><i>A is incorrect because this is not a dehydration reaction</i></p> <p><i>B is incorrect because cobalt(II) ions are oxidised not an oxidising agent</i></p> <p><i>D is incorrect because cobalt(II) ions are oxidised not an oxidising agent</i></p>	(1)

Question Number	Answer	Mark
10	<p>The only correct answer is C (protonates the nitric acid)</p> <p><i>A is incorrect because benzene does not dissolve in concentrated sulfuric acid</i></p> <p><i>B is incorrect because benzene does not undergo addition reactions</i></p> <p><i>D is incorrect because benzene is not protonated</i></p>	(1)

Question Number	Answer	Mark
11	<p>The only correct answer is D (X-ray diffraction)</p> <p><i>A is incorrect because infrared spectroscopy gives information about bond frequencies</i></p> <p><i>B is incorrect because mass spectrometry gives information about molecule fragmentation</i></p> <p><i>C is incorrect because proton NMR gives information about local atomic environments</i></p>	(1)

Question Number	Answer	Mark
12	<p>The only correct answer is B (amide)</p> <p><i>A is incorrect because there is no aldehyde group</i></p> <p><i>C is incorrect because there is no ketone group</i></p> <p><i>D is incorrect because there is no nitrile group</i></p>	(1)

Question Number	Answer	Mark
13	<p>The only correct answer is C (the phenol ring has greater electron density than the benzene ring)</p> <p><i>A is incorrect because the carbon-oxygen bond is not broken in the reaction of phenol with chlorine</i></p> <p><i>B is incorrect because the greater electronegativity does not increase the rate of reaction</i></p> <p><i>D is incorrect because the acidity of phenol does not affect the rate of reaction</i></p>	(1)

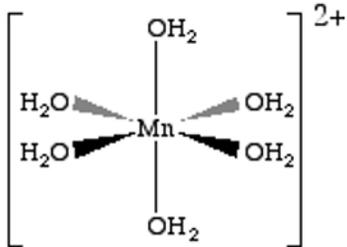
Question Number	Answer	Mark
14	<p>The only correct answer is D (soluble in water)</p> <p><i>A is incorrect because poly(ethenol) is not a bactericide</i></p> <p><i>B is incorrect because it does not react with detergents</i></p> <p><i>C is incorrect because its flexibility is not a significant factor</i></p>	(1)

Question Number	Answer	Mark
15(a)	<p>The only correct answer is B (ethanoic anhydride and sulfuric acid)</p> <p><i>A is incorrect because an ethyl group would be substituted into the ring</i></p> <p><i>C is incorrect because an ester would be formed with the acid substituent of the benzene ring</i></p> <p><i>D is incorrect because these reagents are oxidising</i></p>	(1)

Question Number	Answer	Mark
15(b)	<p>The only correct answer is A (47.3 g)</p> <p><i>B is incorrect because an average of the yields has been used and a single step assumed.</i></p> <p><i>C is incorrect because this is the expected amount for 100% yield</i></p> <p><i>D is incorrect because this is the expected amount for 1 mol starting material</i></p>	(1)

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Answer	Additional Guidance	Mark
16(a)(i)	<ul style="list-style-type: none"> octahedral arrangement of water molecules around central ion 	<p>Example of diagram</p>  <p>Allow 2+ charge anywhere on the structure Square brackets do not need to be shown Some attempt at 3D must be shown Allow bonds shown as arrows Ignore connectivity of ligands</p>	(1)

Question Number	Answer	Additional Guidance	Mark
16(a)(ii)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> (manganese is bonded to the ligands) with dative (covalent) / co-ordinate (bonds) (1) (donation of a) pair of electrons on the oxygen atom (to the metal ion) (1) 	<p>Allow this to be shown on the diagram in (i) by : and →</p>	(2)

Question Number	Answer	Additional Guidance	Mark
16(a)(iii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • splitting (in energy) of d sub-shell/ d orbitals by water ligands (1) • absorption of light/photon/ (electromagnetic) radiation/energy and electronic promotion (1) • origin of observed colour of complex ion (1) 	<p>Do not award d orbital (singular) Allow degenerate d orbitals split into non-degenerate d orbitals by water ligands</p> <p>Allow light etc causes (d-d) electron transitions Ignore colour absorbed Do not award reference to electron de-excitation</p> <p>colour due to reflected/transmitted light Allow due to wavelengths/frequencies of light that are not absorbed Allow complementary colour observed Do not award reference to emission/release of light</p>	(3)

Question Number	Answer	Additional Guidance	Mark
16(b)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • (the metal ion) polarises the water ligands / attracts the bonding electrons in the water molecules (1) • the higher the charge / charge density on the metal ion the greater the polarisation / attraction (of the electrons) (1) • (so) H⁺ is more easily removed /deprotonated (by a water molecule from the solvent)/ O-H bond (in water molecule) is more weakened (1) 	<p>Do not award metal ion is polarisable</p> <p>Accept references to charge from the table e.g. Iron (III) has a greater charge than Fe(II) so polarises more Ignore references to ionic radius</p> <p>M3 dependent on correct M2 or near miss</p> <p>If no other mark awarded, one mark scored for either the equation $[M(H_2O)_6]^{n+} + H_2O \rightleftharpoons [M(H_2O)_5(OH)]^{(n-1)+} + H_3O^+$ </p> <p>OR</p> <p>The higher the charge density the more acidic the solution</p>	(3)

Question Number	Answer	Additional Guidance	Mark
16(c)(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> a pale brown / buff precipitate is formed (1) which darkens/ turns dark brown (on shaking) (1) 	<p>Ignore incorrect initial colours Allow suspension for precipitate</p> <p>Allow black Mark independently If no other mark awarded award one mark for brown precipitate formed</p>	(2)

Question Number	Answer	Additional Guidance	Mark
16(c)(ii)	<ul style="list-style-type: none"> moles $\text{S}_2\text{O}_3^{2-}$(aq) in titre (1) moles MnO_2 in aliquot (1) 	<p><u>Example of calculation</u></p> <p>$0.00284 \times 12.20 \div 1000 = 3.4638 \times 10^{-5} / 0.000034648$ (mol)</p> <p>$0.000034648 \div 2 = 1.7324 \times 10^{-5} / 0.000017324$ (mol)</p> <p>Ignore SF except 1 SF Correct answer with no working scores 2 marks</p>	(2)

Question Number	Answer	Additional Guidance	Mark
16(c)(iii)	<ul style="list-style-type: none"> moles of dissolved oxygen in 50 cm³ of river water (1) mass of dissolved oxygen in 50 cm³ of river water (1) concentration of dissolved oxygen in river water in g dm⁻³ (1) answer in ppm (1) 	<p><u>Example of calculation</u> $0.000017324 \div 2 = 8.662 \times 10^{-6} / 0.000008662$ (mol)</p> <p>$0.000008662 \times 32 = 2.7718 \times 10^{-4} / 0.00027718$ (g)</p> <p>$0.000277184 \times \frac{1000}{50} = 5.5437 \times 10^{-3} / 0.0055437$ (g dm⁻³)</p> <p>$5.5437 \times 10^{-3} \times 10^3 = 5.5437$(ppm or mg kg⁻¹)</p> <p>Do not award incorrect units</p> <p>Ignore SF except 1 SF TE from (c)(ii) and at each stage Correct answer with no working scores 4 marks</p>	(4)

Question Number	Answer	Additional Guidance	Mark
16(d)(i)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> the half-equation for the reduction of nitrate(III) ions in acidic conditions 	<p><u>Example of equation</u></p> $\text{NO}_2^- + 2\text{H}^+ + \text{e}^- \rightarrow \text{NO} + \text{H}_2\text{O}$ <p>Allow multiples Ignore state symbols even if incorrect</p>	(1)

Question Number	Answer	Additional Guidance	Mark
16(d)(ii)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> the equation for the reduction of nitrate(III) ions by iodide ions 	<p><u>Example of equation</u></p> $2\text{NO}_2^- + 4\text{H}^+ + 2\text{I}^- \rightarrow 2\text{NO} + 2\text{H}_2\text{O} + \text{I}_2$ <p>Allow multiples Ignore state symbols even if incorrect TE from d(i) but equation must balance</p>	(1)

Question Number	Answer	Additional Guidance	Mark
16(d)(iii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> (because) more iodine would be present/more iodide ions will react (with nitrite ions) (1) (the apparent value) of dissolved oxygen would increase (1) 	<p>M2 dependent on correct M1 or near miss</p>	(2)

(Total for Question 16 = 21 marks)

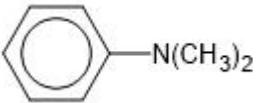
Question Number	Answer	Additional Guidance	Mark
17(a)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> • ethylamine can form hydrogen bonds with water (1) • the small size of the ethyl group has little effect (on the miscibility) (1) • (so) the intermolecular forces/hydrogen bonds in the solution are similar in strength to those in the solute / solvent (1) 	<p>Allow intermolecular forces are greater in the solution than in the solute/solvent separately</p>	(3)

Question Number	Answer	Additional Guidance	Mark																				
*17(b)	<p>This question assesses the student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>The following table shows how the marks should be awarded for indicative content.</p> <table border="1" data-bbox="353 533 1135 778"> <thead> <tr> <th>Number of indicative marking points seen in answer</th> <th>Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <tr> <td>6</td> <td>4</td> </tr> <tr> <td>5-4</td> <td>3</td> </tr> <tr> <td>3-2</td> <td>2</td> </tr> <tr> <td>1</td> <td>1</td> </tr> <tr> <td>0</td> <td>0</td> </tr> </tbody> </table> <p>The following table shows how the marks should be awarded for structure and lines of reasoning</p> <table border="1" data-bbox="353 914 1135 1326"> <thead> <tr> <th></th> <th>Number of marks awarded for structure of answer and sustained lines of reasoning</th> </tr> </thead> <tbody> <tr> <td>Answer shows a coherent logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td> <td>2</td> </tr> <tr> <td>Answer is partially structured with some linkages and lines of reasoning</td> <td>1</td> </tr> <tr> <td>Answer has no linkages between points and is unstructured</td> <td>0</td> </tr> </tbody> </table>	Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	6	4	5-4	3	3-2	2	1	1	0	0		Number of marks awarded for structure of answer and sustained lines of reasoning	Answer shows a coherent logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2	Answer is partially structured with some linkages and lines of reasoning	1	Answer has no linkages between points and is unstructured	0	<p>Guidance on how the mark scheme should be applied.</p> <p>The mark for indicative content should be added to the mark for lines of reasoning. For example, a response with five indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).</p> <p>If there were no linkages between the points, then the same indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</p> <p>In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks 3 or 4 indicative points would get 1 reasoning mark 0, 1 or 2 indicative points would get zero reasoning marks</p> <p>If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).</p> <p>Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning</p>	(6)
Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points																						
6	4																						
5-4	3																						
3-2	2																						
1	1																						
0	0																						
	Number of marks awarded for structure of answer and sustained lines of reasoning																						
Answer shows a coherent logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2																						
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Answer has no linkages between points and is unstructured	0																						

	Indicative content		
	IP1 correct trend in basicity	methylamine > ammonia > phenylamine	
	IP2 one ionic equation showing protonation	$\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$ $\text{CH}_3\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$ $\text{C}_6\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{C}_6\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$ Ignore state symbols	
	IP3 (methylamine is more basic than ammonia) because the methyl group releases electron density/ is electron-releasing / is positively inductive (to the nitrogen)	Allow methyl group is electron donating Reference to more advanced theory on basicity can be awarded credit	
	IP4 the lone pair is more available for donation (to a proton)/ the nitrogen has more electron density so accepts protons more readily	Allow the nitrogen is more negative (in methylamine) so accepts protons more readily Do not award “charge density for electron density” - penalise in IP4 or IP6 once only	
	IP5 the lone pair electrons on N in phenylamine are delocalised (with the “ring electrons” / π system)	Allow overlaps/conjugates with the phenyl group Do not award lone pair donated to “ring electrons” / π system	
	IP6 so are less available for donation (to a proton) in phenylamine		

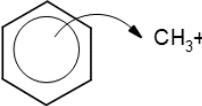
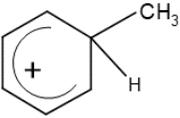
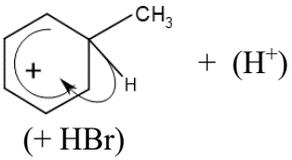
Question Number	Answer	Additional Guidance	Mark
17(c)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> fuming sulfuric acid / $\text{H}_2\text{S}_2\text{O}_7$ 	Accept Oleum / fuming H_2SO_4 Accept H_2SO_4 and SO_3 Ignore concentrated sulfuric acid	(1)

Question Number	Answer	Additional Guidance	Mark
17(c)(ii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> sodium / potassium nitrate(III) / nitrite / NaNO_2 / KNO_2 and hydrochloric acid / HCl temperature $0-5^\circ\text{C}$ 	(1) Allow nitrous / nitric(III) acid/ HNO_2 Ignore concentration Do not award other acids or any alkalis (1) Allow $0-10^\circ\text{C}$ Allow ice bath / Allow any temperature within the range	(2)

Question Number	Answer	Additional Guidance	Mark
17(d)(i)	An answer that makes reference to the following point: 	Allow structural/ Kekulé/ skeletal formula	(1)

Question Number	Answer	Additional Guidance	Mark
17(d)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • protons A peaks have a chemical shift in the range 6.4 – 8.4 and protons B peak have a chemical shift in the range of 2.4 – 3.7. (1) • protons A peaks have a relative intensity of 4 and protons B peak have relative intensity of 6 (1) • protons B peak is a singlet (1) 	<p>Allow a single value or range within the stated range Do not award 3.1– 4.8 for B</p> <p>Accept relative intensities A:B = 2:3</p> <p>Do not award just “1”</p>	(3)

(Total for Question 17 = 16 marks)

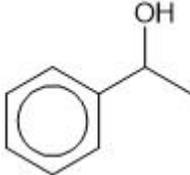
Question Number	Answer	Additional Guidance	Mark
18(a)	<ul style="list-style-type: none"> generation of electrophile curly arrow from within the circle towards the CH_3^+ intermediate with attachment of CH_3^+ at any carbon atom but delocalisation must be on opposite side and extend over at least 3 carbon atoms. Positive charge within delocalisation curly arrow from C–H to anywhere in the hexagon reforming the delocalised structure and a correct structure of methylbenzene 	<p>Example of mechanism</p> $\text{CH}_3\text{Br} + \text{FeBr}_3 \rightarrow \text{CH}_3^+ + \text{FeBr}_4^-$ <p>Allow FeCl_3, AlBr_3, AlCl_3</p> <p>(1) </p> <p>Allow the arrow from anywhere in the hexagon</p> <p>(1) </p> <p>(1) </p> <p>Ignore regeneration of catalyst even if incorrect</p>	(4)

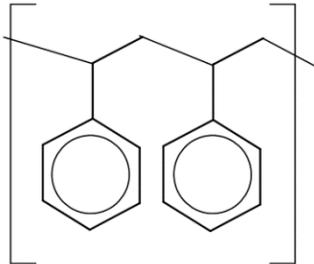
Question Number	Answer	Additional Guidance	Mark
18(b)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> sodium/potassium hydroxide / NaOH / KOH (heat under reflux) in aqueous solution 	<p>(1)</p> <p>(1) Accept NaOH(aq) / KOH(aq) for 2 marks M2 dependent on M1</p>	(2)

Question Number	Answer	Additional Guidance	Mark
18(c)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> O–H bond (stretch at 3300–2500 cm⁻¹) present for carboxylic acid (1) C–H bond stretch at 2900–2820 / 2775–2700 present for aldehyde (1) C=O present in both products but at 1740–1720 cm⁻¹ for aldehyde and 1700–1680 cm⁻¹ for carboxylic acid (1) 	<p>Penalise misplaced bond e.g.-OH once only</p> <p>Ignore C-H in benzene ring</p>	(3)

Question Number	Answer	Additional Guidance	Mark
18(d)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> use excess alcohol / reduce amount of oxidising agent (1) distil (off aldehyde as formed) (1) 	<p>Allow control amount of oxidising agent</p> <p>Ignore fractional</p>	(2)

Question Number	Answer	Additional Guidance	Mark
18(e)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> a Grignard reagent 	<p>Allow phonetic spelling</p>	(1)

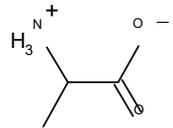
Question Number	Answer	Additional Guidance	Mark
18(f)	<ul style="list-style-type: none"> structure of K / 1-phenylethanol 	<p><u>Example of diagram</u></p>  <p>Allow delocalised ring formula. Allow structural /Kekulé displayed formula 3D structure is not required</p>	(1)

Question Number	Answer	Additional Guidance	Mark
18(g)	<ul style="list-style-type: none"> two repeat units with extension bonds 	<p><u>Example of diagram</u></p>  <p>Allow absence of bracket Allow displayed/structural/mixed formula Ignore n Allow phenyl groups on adjacent carbons or 1,4 position</p>	(1)

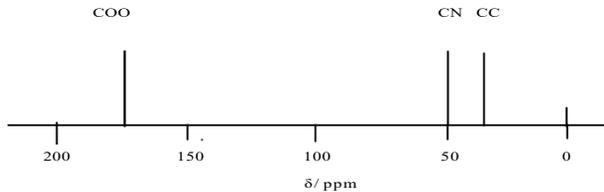
(Total for Question 18 = 14 marks)
TOTAL FOR SECTION B = 51 MARKS

Section C

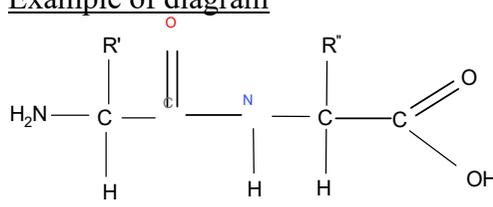
Question Number	Answer	Additional Guidance	Mark
19(a)(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> 2-aminopropanoic acid 	Ignore punctuation errors	(1)

Question Number	Answer	Additional Guidance	Mark
19(a)(ii)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> the main intermolecular force in butanoic acid is hydrogen bonding the main attractive force in alanine is ionic bonding (which is stronger than hydrogen bonding) because alanine exists as a zwitterion 	<p>(1) Allow butanoic acid/ alanine has hydrogen bonding</p> <p>(1) Allow ionic bonding in alanine is stronger (than intermolecular force in butanoic acid)</p> <p>(1) Allow drawn structure e.g.</p>  <p>Ignore discussion of London forces</p>	(3)

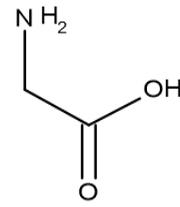
Question Number	Answer	Additional Guidance	Mark
19(a)(iii)	An answer that makes reference to the following point: <ul style="list-style-type: none"> TMS / tetramethylsilane / (CH₃)₄Si 		(1)

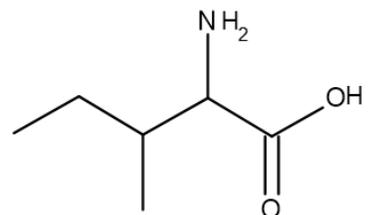
Question Number	Answer	Additional Guidance	Mark
19(a)(iv)	An answer that makes reference to the following points: <ul style="list-style-type: none"> COO peak / line in the range 165-186 (ppm) (1) CN peak / line in the range 35-65 (ppm) (1) CC peak / line in the range 5-56 (ppm) (1) 	 <p>Ignore peak heights, splitting patterns and numbers Penalise lack of label once only List principle applies to additional peaks</p>	(3)

Question Number	Answer	Additional Guidance	Mark
19(a)(v)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> alanine has an asymmetric carbon atom/ has one /a chiral centre/carbon (1) so the isomers are non-superimposable mirror images/enantiomers (1) (enantiomers) rotate the plane of (plane-)polarised light (in opposite directions) (1) 	<p>One carbon atom in alanine has four different groups bonded to it</p> <p>May be shown as two diagrams</p> <p>Allow reference to a polarimeter used to measure optical rotation Allow reference to optical rotation cancelling in racemic mixtures</p>	(3)

Question Number	Answer	Additional Guidance	Mark
19(b)(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> peptide bond (1) structure of dipeptide (1) <p>M2 dependent on M1</p>	<p><u>Example of diagram</u></p>  <p>Allow R and R' reversed Allow CONH for peptide bond Allow cyclic structure</p>	(2)

Question Number	Answer	Additional Guidance	Mark																								
19(b)(ii)	<ul style="list-style-type: none"> calculation of % oxygen and moles (1) ratio and empirical formula (1) as there are two nitrogen atoms / three oxygen atoms, the molecular formula must be the same as the empirical formula (1) 	<p><u>Example of calculation</u></p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>C</th> <th>H</th> <th>N</th> <th>O</th> </tr> </thead> <tbody> <tr> <td><u>51.1</u></td> <td><u>8.51</u></td> <td><u>15.1</u></td> <td><u>25.29</u></td> </tr> <tr> <td>12</td> <td>1</td> <td>14</td> <td>16</td> </tr> <tr> <td>4.26</td> <td>8.51</td> <td>1.08</td> <td>1.58</td> </tr> <tr> <td>4</td> <td>8</td> <td>1</td> <td>1.5</td> </tr> <tr> <td>8</td> <td>16</td> <td>2</td> <td>3</td> </tr> </tbody> </table> <p>C₈H₁₆N₂O₃</p>	C	H	N	O	<u>51.1</u>	<u>8.51</u>	<u>15.1</u>	<u>25.29</u>	12	1	14	16	4.26	8.51	1.08	1.58	4	8	1	1.5	8	16	2	3	(3)
C	H	N	O																								
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Question Number	Answer	Additional Guidance	Mark
19(c)(i)	<ul style="list-style-type: none"> structure of glycine 	<p><u>Example of diagram</u></p>  <p>Allow displayed/structural formulae</p>	(1)

Question Number	Answer	Additional Guidance	Mark
19(c)(ii)	<ul style="list-style-type: none"> any C₆ amino acid (1) structure of isoleucine (1) 	<p><u>Example of diagram</u></p>  <p>Allow displayed/structural formulae Ignore incorrect vertical connectivity</p>	(2)

(Total for Question 19 = 19 marks)

TOTAL FOR SECTION C = 19 MARKS

TOTAL FOR PAPER = 90 MARKS

