Pearson

Mark Scheme (Results)

Summer 2026

Pearson Edexcel International Advanced Level In Chemistry
WCH14/01A

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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)	**The only correct answer is D** (2-bromo-2-methylbutane) ***A*** *is incorrect because 1-bromopentane is a primary bromoalkane and is less likely to react by a first order mechanism* ***B*** *is incorrect because 1-bromo-2-methylbutane is a primary bromoalkane and is less likely to react by a first order mechanism* ***C*** *is incorrect because 2-bromo-3-methylbutane is a secondary bromooalkane and is less likely to react by a first order mechanism*	**(1)**

Question Number	Answer	Mark
1(b)	**The only correct answer is A** (decreasing the concentration of the aqueous silver nitrate) ***B*** *is incorrect because increasing the concentration of RBr would increase the rate of reaction so the time taken would decrease* ***C*** *is incorrect because increasing the temperature would increase the rate of reaction so the time taken would decrease* ***D*** *is incorrect because an iodoalkane would react faster than a bromoalkene so the time taken would decrease*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is C** (nitrogen) ***A*** *is incorrect because chlorine is more reactive than nitrogen* ***B*** *is incorrect because hydrogen is more reactive than nitrogen* ***D*** *is incorrect because oxygen is more reactive than nitrogen*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is C** (hexan-1-ol hexanal hexane) ***A*** *is incorrect because hexane is non-polar and would have the longest retention time because it forms the strongest interactions with the stationary phase* ***B*** *is incorrect because hexan-1-ol is more polar than hexanal so would have a shorter retention time because it forms the stronger interactions with the mobile phase* ***D*** *is incorrect because hexane is non-polar and would have the longest retention time because it forms the strongest interactions with the stationary phase*	**(1)**

Question Number	Answer	Mark
4(a)	**The only correct answer is A** (MgO) ***B*** *is incorrect because the sulfide ion has a greater ionic radius than the oxide ion so forms weaker ionic bonds with the magnesium ion releasing less energy* ***C*** *is incorrect because the calcium ion has a greater ionic radius than the magnesium ion so forms weaker ionic bonds with the oxide ion releasing less energy* ***D*** *is incorrect because the calcium ion and the sulfide ion have greater radii so form weaker ionic bonds releasing less energy*	**(1)**

Question Number	Answer	Mark
4(b)	**The only correct answer is B** (LiI) ***A*** *is incorrect because the fluoride ion is smaller than the iodide ion so less polarisable* ***C*** *is incorrect because the sodium ion is larger than the lithium ion so less polarising and the fluoride ion is smaller than the iodide ion so less polarisable* ***D*** *is incorrect because the sodium ion is larger than the lithium ion so less polarising*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is C** (first electron affinity of oxygen) ***A*** *is incorrect because the atomisation of sodium breaks the metallic bonds so is endothermic* ***B*** *is incorrect because the removal of electrons from sodium needs to overcome the electrostatic attraction from the nucleus so is endothermic* ***D*** *is incorrect because the addition of an electron to a negative ion has to overcome repulsion so is endothermic*	**(1)**

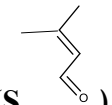
Question Number	Answer	Mark
6(a)	**The only correct answer is D** (1.75) ***A*** *is incorrect because 0.125 mol is the amount of P remaining after 3 half-lives* ***B*** *is incorrect because 0.250 mol is double the amount of P remaining after 3 half-lives* ***C*** *is incorrect because 0.875 mol is the amount of Q produced if the reaction stoichiometry is 1:1*	**(1)**

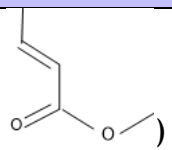
Question Number	Answer	Mark
6(b)	**The only correct answer is A** () ***B*** *is incorrect because this sketch graph shows the reactant concentration change for an auto-catalysed reaction* ***C*** *is incorrect because this sketch graph shows the reactant concentration decreasing linearly* ***D*** *is incorrect because this is the sketch graph for a reactant-concentration against time plot for a zero order reaction*	**(1)**

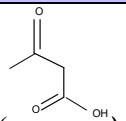
Question Number	Answer	Mark
7(a)	**The only correct answer is D** (the position of equilibrium shifts to the right and K_p is unchanged) ***A*** *is incorrect because* K_p *does not change with a change in pressure* ***B*** *is incorrect because the position of equilibrium does not shift to the side with more gaseous moles* ***C*** *is incorrect because the increase in pressure will shift the position of equilibrium to the right*	**(1)**

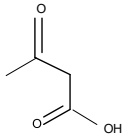
Question Number	Answer	Mark
7(b)	**The only correct answer is C** (3.6) ***A*** *is incorrect because the equilibrium moles are not mole fractions have been used* ***B*** *is incorrect because the expression for* K_p *has been inverted* ***D*** *is incorrect because the expression for* K_p *has been inverted and the equilibrium moles have been used instead of mole fractions*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is B** (endothermic higher at 90°C) ***A*** *is incorrect because an increase in temperature will result in the dissociation equilibrium moving to the side with a higher concentration of ions* ***C*** *is incorrect because if the dissociation of water was exothermic the dissociation equilibrium would move to the side with a lower concentration of hydrogen ions and the pH would increase* ***D*** *is incorrect because if the dissociation of water was exothermic the dissociation equilibrium would move to the side with a lower concentration of hydrogen ions and the pH would increase*	**(1)**

Question Number	Answer	Mark
9(a)	**The only correct answer is D (S**  **)** ***A*** *is incorrect because Tollens' reagent does not react with either the ketone or carboxylic acid groups in P* ***B*** *is incorrect because Tollens' reagent does not react with the carboxylic acid group in Q* ***C*** *is incorrect because Tollens' reagent does not react with either the alkene or ester groups in R*	**(1)**

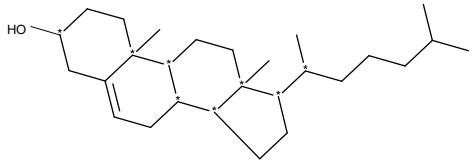
Question Number	Answer	Mark
9(b)	**The only correct answer is C (R**  **)** ***A*** *is incorrect because in P neither the ketone nor the carboxylic acid group can be hydrolysed* ***B*** *is incorrect because in Q the carboxylic acid group cannot be hydrolysed* ***D*** *is incorrect because in S neither the alkene group nor the ketone group can be hydrolysed*	**(1)**

Question Number	Answer	Mark
9(c)	 **The only correct answer is A (P)** ***B*** *is incorrect because in Q the carboxylic acid group would be reduced to a primary alcohol* ***C*** *is incorrect because in R the ester would be reduced to a mixture of primary alcohols* ***D*** *is incorrect because in S the aldehyde would be reduced to a primary alcohol*	**(1)**

Question Number	Answer	Mark
9(d)	 **The only correct answer is A (P)** ***B*** *is incorrect because although Q has a carboxylic acid group which can hydrogen bond, the remainder of the molecule cannot form hydrogen bonds and has fewer electrons than P* ***C*** *is incorrect because it has a similar number of electrons but no group that can hydrogen bond* ***D*** *is incorrect because it has fewer electrons but no group that can hydrogen bond*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is C** (1-chloro-2-methylpropane) ***A*** *is incorrect because 1-chlorobutane would have 4 peaks* ***B*** *is incorrect because 2-chlorobutane would have 4 peaks* ***D*** *is incorrect because 2-chloro-2-methylpropane would have 2 peaks*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is B** (43) ***A*** *is incorrect because both pentan-2-one and pentan-3-one have* $CH_3CH_2^+$ *fragments with m / z = 29* ***C*** *is incorrect because pentan-2-one has a* $CH_3COCH_2^+$ *and pentan-3-one has a* $CH_3CH_2CO^+$ *fragment both with m / z = 57* ***D*** *is incorrect because pentan-2-one has a* $CH_3COCH_2CH_2^+$ *and pentan-3-one has a* $CH_3CH_2COCH_2^+$ *fragment both with m / z = 71*	**(1)**

Question Number	Answer	Mark
12	 **The only correct answer is C** (8) ***A*** *is incorrect because this ignores C-H bonds on chiral carbons* ***B*** *is incorrect because three of the C-H bonds have been ignored* ***D*** *is incorrect because this includes the carbon with the dimethyl group which is not chiral*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is C** (propyl propanoate) ***A*** *is incorrect because propan-1-ol would have a broad absorption at 3750-3200 cm^{-1}* ***B*** *is incorrect because propanoyl chloride would have an absorption at 1795 cm^{-1} and not at 1750-1735 cm^{-1}* ***D*** *is incorrect because propanoic acid would not have an absorption at 1725-1700 cm^{-1} and would have a broad absorption at 3300- 2500 cm^{-1}*	**(1)**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Answer	Additional Guidance	Mark
14(a)	An answer that makes reference to the following point: • (the heat released from) the exothermic reaction (once started, maintains the temperature(at 1200 K))	Ignore references to activation energy	**(1)**

Question Number	Answer	Additional Guidance	Mark
14(b)(i)	An answer that makes reference to two of the following points: • 1st order wrt $[O_2]$ and 2nd order wrt[NO] **(1)** • justification for O_2 **(1)** • justification for NO **(1)**	 (Expt 1 and 2)$[O_2]$ doubled and rate doubles (Expt 2 and 3)$[O_2]$ doubled and [NO] doubled and rate increases by a factor of 8 . Or (Expt 1 and 3) $[O_2]$ increases x 4 and [NO] doubled and rate increases by a factor of 16	**(3)**

Question Number	Answer	Additional Guidance	Mark
14(b)(ii)	An answer that makes reference to the following point: • rate = k $[O_2]$ $[NO]^2$	 TE from (i)	**(1)**

Question Number	Answer	Additional Guidance	Mark
14(b)(iii)	An answer that makes reference to two of the following points: • rearrangement of rate equation in (ii) and calculation of k **(1)** • units **(1)**	<u>Example of calculation</u> $k = 5.10 \times 10^{-4} \div (0.01 \times 0.025^2) = 81.6$ $dm^6\ mol^{-2}\ s^{-1}$ Allow units in any order TE from ii	**(2)**

Question Number	Answer	Additional Guidance	Mark
14(c)	An answer that makes reference to two of the following points: • Step 2 is more likely to be the rate-determining/slow step **(1)** • (since) if the first step was slow then the reaction would be zero order wrt oxygen / the reaction rate would be second order wrt NO only **(1)**	M1 dependent on some attempt at M2 Allow: the species in the rate equation must appear in r.d.s/ both NO and O_2 are in the rate-determining step	**(2)**

Question Number	Answer	Additional Guidance	Mark
14(d)(i)	An answer that makes reference to the following point: • equation	$2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$ Allow multiples Ignore state symbols even if incorrect	**(1)**

Question Number	Answer	Additional Guidance	Mark
14(d)(ii)	An answer that makes reference to the following points: • (type of reaction) disproportionation **(1)** • nitrogen oxidation number goes both up and down **(1)**	Allow phonetic spelling. Nitrogen goes from (+)4 up to (+)5 and down to (+)3 If oxidation numbers are given they must be correct Changes in oxidation numbers can be awarded from annotations of correct equation. Ignore incorrect oxidation/reduction references	**(2)**

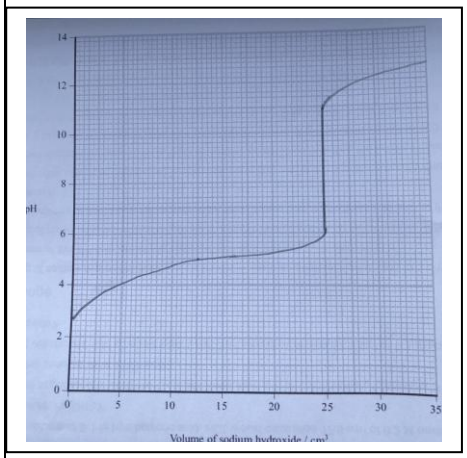
(Total for Question 14 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
15(a)(i)	An answer that makes reference to the following points: • weak means it is dissociated/ionised to a small extent **(1)** • acid means proton donor **(1)**	Accept only partially dissociated/ionised/not fully dissociated Allow H^+ / hydrogen ion donor	**(2)**

Question Number	Answer	Additional Guidance	Mark
15(a)(ii)	• expression for K_a **(1)** • rearrangement and substitution **(1)** • calculation of pH **(1)**	Example of calculation $K_a = \frac{[H^+][C_2H_5COO^-]}{[C_2H_5COOH]}$ $[H^+] = \sqrt{[1.3 \times 10^{-5} \times 0.25]} = 1.8028 \times 10^{-3} (\text{mol dm}^{-3})$ $pH = -\log_{10}(1.8028 \times 10^{-3}) = 2.74/2.7$ Correct answer with some working scores (3) T.E. on incorrect calculation of $[H^+]$ provided answer is <7.	**(3)**

Question Number	Answer	Additional Guidance	Mark
15(b)(i)	• calculation of mols acid at start **and** calculation of mols alkali added to acid **(1)** • (so) acid is half-neutralised and pH = pK_a **(1)**	Example of calculation $0.25 \times 10 \div 1000 = 0.0025$(mols) $0.10 \times 12.5 \div 1000 = 0.00125$(mols) $pH = -\log_{10}(1.3 \times 10^{-5}) = 4.89/4.9$ Correct answer with some working scores (2) Ignore SF except 1SF	**(2)**

Question Number	Answer	Additional Guidance	Mark
15(b)(ii)	An explanation that makes reference to the following points: • the mixture is a **buffer** (solution)/ this is the **buffering** region of the titration **(1)** • equation for the reaction of the alkali **(1)** • due to the large reserve of the acid and its salt, there is no (significant) change **(1)**	 $OH^- + CH_3CH_2COOH \rightarrow CH_3CH_2COO^- + H_2O$ This can be shown as two steps: $CH_3CH_2COOH \rightleftharpoons CH_3CH_2COO^- + H^+$ $OH^- + H^+ \rightarrow H_2O$ Allow ratio of propanoic acid to propanoate is not significantly changed	**(3)**

Question Number	Answer	Additional Guidance	Mark
15(c)(i)	A description that makes reference to the following points: • an S-shaped curve with a vertical section at 25 cm^3 **(1)** • starting at pH 2.5 and finishing between pH 11.5 and 13 **(1)** • vertical section should cover at least 3 pH units between pH 6 and 11 **(1)**	<u>Example of curve</u>  Allow 1 small square tolerance for pH values	**(3)**

Question Number	Answer	Additional Guidance	Mark
15(c)(ii)	An explanation that makes reference to the following points: • no **and** because bromophenol blue changes colour between **pH 2.8 and 4.6** **(1)** • which is not in the vertical section of the titration curve/ between 6 and 11 pH units **(1)**	Allow: bromophenol blue will have already changed colour before the end point TE from graph	**(2)**

(Total for Question 15 = 15 marks)

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*16</td>
<td>This question assesses the student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<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>
</table>

The following table shows how the marks should be awarded for structure and lines of reasoning
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained lines of reasoning</th></tr>
<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>
</table>
</td>
<td>Guidance on how the mark scheme should be applied.

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).

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).

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

If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).

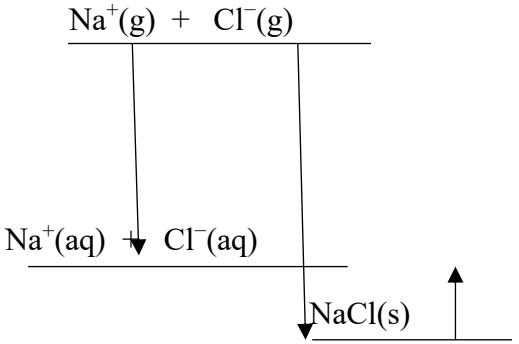
Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning</td>
<td>(6)</td>
</tr>
</table>

	Indicative content **IP1** reaction of propanoic acid and ethanol requires sulfuric acid (as a catalyst) **IP2** reaction of propanoyl chloride and ethanol takes place at room temperature **and** reaction of propanoic acid and ethanol requires heating **IP3** reaction of propanoyl chloride and ethanol produces HCl/hydrogen chloride which is toxic/ needs a fume cupboard **IP4** reaction of propanoic acid and ethanol(reaches an equilibrium/ is reversible) so has a lower yield/ does not go to completion **IP5** $C_2H_5OH + C_2H_5COOH \rightleftharpoons C_2H_5COOC_2H_5 + H_2O$ **IP6** $C_2H_5OH + C_2H_5COCl \rightarrow C_2H_5COOC_2H_5 + HCl$	Ignore references to solvents/intermolecular forces/ mechanisms even if incorrect Accept any strong acid/ H^+ Allow over equilibrium sign Ignore concentration	

(Total for Question 16 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
17(a)	An answer that makes reference to the following point: • (the enthalpy change) when 1 mol of (an ionic) solid is dissolved in water (to give an infinitely dilute solution)	Allow substance/compound for (ionic) solid Accept enthalpy change per mole for $MA(s) \rightarrow M^+(aq) + A^-(aq)$	**(1)**

Question Number	Answer	Additional Guidance	Mark
17(b)(i)	• application of Hess's Law **(1)** • calculation of enthalpy change of solution **(1)**	Example of calculation LE(NaCl) + $\Delta_{sol}H$ (NaCl) = $\Delta_{hyd}H(Na^+(g))$ + $\Delta_{hyd}H$ ($Cl^-(g)$) $\Delta_{sol}H$ (NaCl) = 771 – 406 – 364 = 1.00 (kJ mol^{-1}) Final answer with no working scores 2 Ignore SF No TE from incorrect expression −1.00 (kJ mol^{-1}) scores 1	**(2)**

Question Number	Answer	Additional Guidance	Mark
17(b)(ii)	• correct species including state symbols **(1)** • correct positions and arrows in the right direction **(1)**	 if negative lattice energy quoted (771) then arrow is up TE only for $\Delta_{sol}H$ (NaCl) = −1 (kJ mol^{-1}) M2 dependent on M1 or near miss	**(2)**

Question Number	Answer	Additional Guidance	Mark
17(c)	An answer that makes reference to the following points: • the entropy change of surroundings is negative **(1)** • the entropy change of the system is positive **(1)** • because the ions in solution are more randomly arranged(than in the solid) **(1)** • the positive change in entropy of the system outweighs the negative entropy change of the surroundings **(1)**	Allow ions are moving (in solution) Allow more particles/moles (in solution)	**(4)**

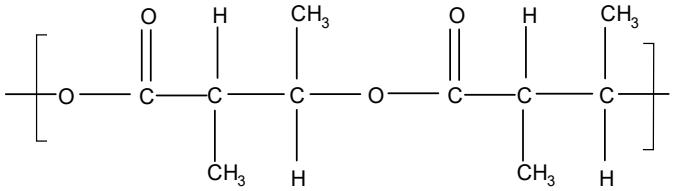
(Total for Question 17 = 7 marks)

Question Number	Answer	Additional Guidance	Mark
18(a)	An answer that makes reference to the following point: • 2-hydroxy-2-methylbutanoic acid	Allow 2-methyl-2-hydroxybutanoic acid Ignore commas, absence of hyphens Allow hydroxyl	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(b)	An answer that makes reference to the following points: • Isomer **1** will remain orange/ does not change colour **(1)** • Isomer **1** has a tertiary alcohol group/ cannot be oxidised (by acidified sodium dichromate(VI)) **(1)**	Allow all other isomers will change dichromate colour from orange to green Do not award: just no observation	**(2)**

Question Number	Answer	Additional Guidance	Mark
18(c)	An answer that makes reference to the following points: • there must be six protons in a similar/same environment (so must be Isomer **2** or Isomer **3)** **(1)** • (and) it must be Isomer **3** since these protons must be attached to a carbon adjacent to one with a single proton/ hydrogen (which gives a doublet splitting pattern) **(1)**	Allow two methyl groups on one carbon	**(2)**

Question Number	Answer	Additional Guidance	Mark
18(d)	An answer that makes reference to the following points: • a methyl secondary alcohol / can be oxidised to -$COCH_3$ **(1)** • (so) the most likely isomer is **4** **(1)**	M2 is dependent on M1 or near miss	**(2)**

Question Number	Answer	Additional Guidance	Mark
18(e)	• ester link **(1)** • two correct repeat units **(1)**	 Allow O on LHS Ignore ‘n’ and absence of square brackets Allow displayed or structural or combination formulae	**(2)** **Expert**

(Total for Question 18 = 9 marks)
TOTAL FOR SECTION B = 50 MARKS

Section C

Question Number	Answer	Additional Guidance	Mark
19(a)	An explanation that makes reference to the following points: • the removal of the Ag^+ ions / the formation of the (AgSCN) ppt **(1)** • would cause the equilibrium in Reaction **1** to move to the left **(1)** • which would reduce the value of K_c **(1)**	Ignore references to concentration Allow titre value would increase/ more KSCN would be used Allow the reaction would continue until all of the Ag^+ ions were removed M3 is standalone but there must be some attempt at an explanation to score.	**(3)**

Question Number	Answer	Additional Guidance	Mark
19(b)(i)	• equilibrium constant expression	$K_c = \dfrac{[Fe^{3+}]}{[Fe^{2+}]\,[Ag^+]}$ Do not award use of rounded brackets	**(1)**

Question Number	Answer	Additional Guidance	Mark
19(b)(ii)	• calculation of moles of silver ions in titre **(1)** • calculation of moles of silver ions and Fe(II) ions in equilibrium mixture **(1)** • calculation of concentration of Fe(II) and silver ions in equilibrium mixture **(1)** • calculation of initial moles of silver ions **(1)** • calculation of moles of Fe(III) ions in equilibrium mixture and calculation of concentration of Fe(III) in equilibrium mixture **(1)** • calculation of K_c to 2/3 SF **(1)** • units **(1)**	<u>Example of calculation</u> n = (15.6 × 0.02 ÷ 1000 =) 3.12×10^{-4} / 0.000312/0.00031(mol) n = (3.12×10^{-4} ÷ 25 × 200 =) 2.496×10^{-3} = 0.002496 / 0.00250 / 0.0025(mol) c = (2.496×10^{-3} ÷ 200 × 1000 =)0.01248 0.0125/0.013 (mol dm^{-3}) n = (0.095 ÷ 1000 × 100 =) 0.0095 (mol) n = 0.0095−0.002496 = 7.004×10^{-3} (mols) and c = (7.004×10^{-3} ÷ 200 × 1000 =) 3.502×10^{-2} = 0.03502/0.035 (mol dm^{-3}) K_c = ($0.03502 \div 0.01248^2 = 224.85$) = 220 / 225 ($dm^3\ mol^{-1}$) $dm^3\ mol^{-1}$ Allow units in any order Correct answer with some working scores (7) TE at each stage and from (b)(i)	**(7)**

Question Number	Answer	Additional Guidance	Mark
19(c)(i)	• calculation of total entropy	Example of calculation ΔS_{total} = (8.31 × ln 224.85 =) (+)45.002 (J K^{-1} mol^{-1}) TE from b (ii)	**(1)**

Question Number	Answer	Additional Guidance	Mark
19(c)(ii)	An explanation that makes reference to the following points: • the products are more ordered/ less disordered than the reactants / there are fewer ways of distributing energy quanta **(1)** • because the reactants are (both ions) in solution but one of the products has ions in a solid structure **(1)**	Allow there is an increase in order/ decrease in disorder in the system Mark independently	**(2)**

Question Number	Answer	Additional Guidance	Mark
19(c)(iii)	• calculation of entropy change of the surroundings	Example of calculation $\Delta S^{\ominus}_{surroundings}$ = 45.002 – (−208) = (+)253.002 J $K^{-1}mol^{-1}$ Ignore SF except 1 SF TE from c(i)	**(1)**

Question Number	Answer	Additional Guidance	Mark
19(c)(iv)	• $\Delta S^{\ominus}_{\text{surroundings}} = -\frac{\Delta_r H^{\ominus}}{T}$ and substitution of values and rearrangement **(1)** • calculation of enthalpy change of reaction **and** sign and units **(1)**	Example of calculation $\Delta_r H^{\ominus} = -253.002 \times 298$ $= -75394 \text{ J mol}^{-1} / -75.394 \text{ kJ mol}^{-1}$ Ignore SF except 1 SF TE from c (iii) Penalise incorrect units once only in iii/iv	**(2)**

Question Number	Answer	Additional Guidance	Mark
19(c)(v)	An answer that makes reference to the following points: • $\Delta S^{\ominus}_{\text{surroundings}}$ would become smaller/less(positive or negative) or $\Delta S^{\ominus}_{\text{total}}$ / K_c would be reduced **(1)** • so equilibrium would move to LHS/ in the endothermic direction. **(1)**	Allow $-\frac{\Delta_r H^{\ominus}}{T}$ for $\Delta S^{\ominus}_{\text{surroundings}}$ TE from sign of enthalpy change in (c)(iv)	**(2)**

(Total for Question 19 = 19 marks)

TOTAL FOR SECTION C = 19 MARKS
TOTAL FOR PAPER = 90 MARKS