GradeMax

Pearson

Mark Scheme (Results)

January 2026

Pearson Edexcel International Advanced Level in Chemistry
Paper 01: Rates, Equilibria and Further Organic Chemistry

WCH14/01

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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.

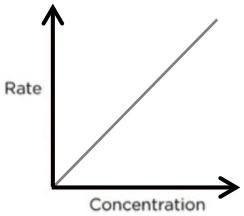
Quality of Written Communication

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 C** (70) ***A*** *is incorrect because 0.0007 is the change in concentration for half the maximum time shown on the graph* ***B*** *is incorrect because 0.0025 is half the initial concentration* ***D*** *is incorrect because 200 is half the time taken for the reaction*	**(1)**

Question Number	Answer	Mark
1(b)	**The only correct answer is B** () ***A*** *is incorrect because this shows the reaction is zero order with respect to the reactant* ***C*** *is incorrect because this shows the reaction is second order with respect to the reactant* ***D*** *is incorrect because this is not a sketch of rate versus concentration*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is A** (colour intensity) ***B*** *is incorrect because pH cannot be measured in gases* ***C*** *is incorrect because the pressure would not change as the reaction progressed* ***D*** *is incorrect because the volume would not change as the reaction progressed*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is C** (secondary, S_N1) ***A*** *is incorrect because the halogenoalkane is secondary* ***B*** *is incorrect because the halogenoalkane is secondary and the rate equation only involves one species* ***D*** *is incorrect because the rate equation only involves one species*	**(1)**

Question Number	Answer	Mark
4(a)	**The only correct answer is B** (homogeneous catalyst) ***A*** *is incorrect because the catalyst is in the same phase as the reactants* ***C*** *is incorrect because* I^- *acts as a catalyst and the oxygen is both oxidised and reduced* ***D*** *is incorrect because* I^- *acts as a catalyst in the overall reaction*	**(1)**

Question Number	Answer	Mark
4(b)	**The only correct answer is C** ($2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$) ***A*** *is incorrect because the equation includes uncancelled species* ***B*** *is incorrect because* OI^- *is not a reactant or a product* ***D*** *is incorrect because the* I^- *is not cancelled and* OI^- *is not a product*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is B** ($\Delta S_{total} = R \ln K$) ***A*** *is incorrect because the expression should be positive* ***C*** *is incorrect because* ΔS_{total} *is calculated and the expression should be positive* ***D*** *is incorrect because* ΔS_{total} *is calculated*	**(1)**

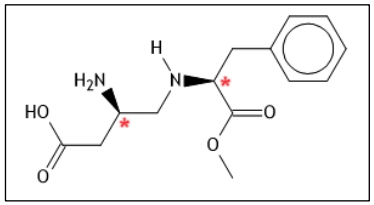
Question Number	Answer	Mark
6	**The only correct answer is B** ($S(g) + e^- \rightarrow S^-(g)$) ***A*** *is incorrect because this is the first ionisation energy of sulfur* ***C*** *is incorrect because this is an equation for the first and second electron affinities* ***D*** *is incorrect because this is the second electron affinity of sulfur*	**(1)**

Question Number	Answer	Mark
7	**The only correct answer is D** (sodium chloride) ***A*** *is incorrect because the ions are more highly charged so greater electrostatic attraction* ***B*** *is incorrect because the ions are smaller so greater electrostatic attraction* ***C*** *is incorrect because the ions are smaller and more highly charged*	**(1)**

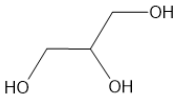
Question Number	Answer	Mark
8(a)	**The only correct answer is C** ($K_c = \frac{[NOBr]^2}{[Br_2][NO]^2}$) ***A*** *is incorrect because the expression is inverted* ***B*** *is incorrect because the expression is inverted and concentrations are not raised to the power of the coefficients* ***D*** *is incorrect because the concentrations are not raised to the power of the coefficients*	**(1)**

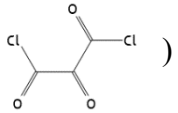
Question Number	Answer	Mark
8(b)	**The only correct answer is A** (increases, increases) ***B*** *is incorrect because the yield of NOBr increases* ***C*** *is incorrect because* K_c *increases* ***D*** *is incorrect because* K_c *increases and the yield of NOBr increases*	**(1)**

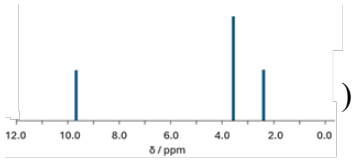
Question Number	Answer	Mark
9	**The only correct answer is B** (1.04 × 10^{-2} mol dm^{-3}) ***A*** *is incorrect because this is the concentration of* $[H^+]$ *obtained from* $10^{-12.32}$ ***C*** *is incorrect because this is the concentration of* $[OH^-]$ ***D*** *is incorrect because this is the concentration of* $[H^+]$ *obtained from* $10^{12.32}$	**(1)**

Question Number	Answer	Mark
10(a)	**The only correct answer is B** (2) ***A*** *is incorrect because there are 2 asymmetric carbon atoms* ***C*** *is incorrect because there are 2 asymmetric carbon atoms* ***D*** *is incorrect because there are 2 asymmetric carbon atoms* 	**(1)**

Question Number	Answer	Mark
10(b)	**The only correct answer is D** (18) ***A*** *is incorrect because the* CH_2 *and alkyl CH hydrogens have not been counted* ***B*** *is incorrect because the alkyl CH hydrogens have not been counted* ***C*** *is incorrect because only one of the alkyl CH hydrogens has been counted*	**(1)**

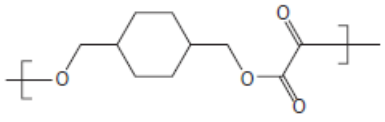
Question Number	Answer	Mark
11(a)	**The only correct answer is D** () ***A*** *is incorrect because the ketone group has not been reduced* ***B*** *is incorrect because the aldehyde and the ketone group have not been reduced and the alcohol group has been oxidised* ***C*** *is incorrect because the aldehyde group has not been reduced*	**(1)**

Question Number	Answer	Mark
11(b)	**The only correct answer is C** () ***A*** *is incorrect because only one of the carboxylic acid groups in* ***Y*** *has reacted* ***B*** *is incorrect because the ketone group has been substituted and only one of the carboxylic acid groups in* ***Y*** *has reacted* ***D*** *is incorrect because the ketone group has been substituted*	**(1)**

Question Number	Answer	Mark
11(c)	**The only correct answer is D** () ***A*** *is incorrect because the peak for the two protons of the* CH_2 *group should not be between 0 and 1.7* ***B*** *is incorrect because there is no aldehyde proton peak between 11 and 12 and the peak for the two protons of the* CH_2 *group should not be between 0 and 1.7* ***C*** *is incorrect because the aldehyde proton peak should not be between 11 and 12*	**(1)**

Question Number	Answer	Mark
11(d)	**The only correct answer is A** (singlet) ***B*** *is incorrect because there are no protons on adjacent carbon atoms* ***C*** *is incorrect because there are no protons on adjacent carbon atoms* ***D*** *is incorrect because there are no protons on adjacent carbon atoms*	**(1)**

Question Number	Answer	Mark
12(a)	**The only correct answer is A** (3) ***B*** *is incorrect because of the symmetry of the molecule, there are only 3 different carbon environments* ***C*** *is incorrect because of the symmetry of the molecule, there are only 3 different carbon environments* ***D*** *is incorrect because of the symmetry of the molecule, there are only 3 different carbon environments*	**(1)**

Question Number	Answer	Mark
12(b)	**The only correct answer is A** () ***B*** *is incorrect because both alcohol oxygens are missing from the ester linkages* ***C*** *is incorrect because the left-hand alcohol oxygen is missing* ***D*** *is incorrect because there is an extra oxygen on the right-hand side*	**(1)**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Answer	Additional Guidance	Mark
13(a)(i)	An answer that makes reference to the following points: • experiment 2 compared to 1 the concentration of O_2 doubles (while NO remains constant) and the rate doubles **(1)** • experiment 3 compared to experiment 2, multiplying concentration of NO by four (while keeping O_2 constant) results in an increase in rate of 16× **(1)** • so first order with respect to oxygen **and** second order with respect to nitrogen monoxide **(1)** • rate = $k[NO]^2[O_2]$ **(1)**	Allow calculation as explanation Allow reference to rate being directly proportional to concentration Allow calculation as explanation Allow annotations on the table for M1 and M2 Allow (1) for M1 and M2 if experiment numbers are not referred to. Allow rate = $k[NO]^2[O_2]^1$ Comment: Check part 13(a)(ii) for this answer	**(4)**

Question Number	Answer	Additional Guidance	Mark
13(a)(ii)	• value **(1)** • units **(1)**	<u>Example of calculation</u> $k = rate \div [NO]^2[O_2]$ (e.g. $0.00802 \div ((0.00100)^2 \times 0.00100) =$) $8020000 / 8.02 \times 10^6$ Ignore SF except 1SF $dm^6\ mol^{-2}\ s^{-1}$ Allow in any order Allow TE from (a)(i)	**(2)**

Question Number	Answer	Additional Guidance	Mark
13(a)(iii)	An answer that makes reference to the following points: • equation **(1)** • (one mole of) O_2 is needed in the rate determining step (because it is first order) **(1)** • the two moles of NO required from the rate equation are in the first step **(1)**	$N_2O_2 + O_2 \rightarrow 2NO_2$ Allow reversible arrow Allow slow step as rate determining step Allow the intermediate/N_2O_2 is formed from the 2 mols of NO from the rate equation Allow TE from (a)(i)	**(3)**

Question Number	Answer	Additional Guidance	Mark
13(b)	• measures increase in ln k and increase in 1/T and used in correct expression **(1)** • gradient multiplied by −R / E_a value **(1)** • positive sign and units **(1)**	Gradient $= \frac{9.50 - 9.00}{1.6125 \times 10^{-3} - 1.7375 \times 10^{-3}}$ $= \frac{0.50}{-1.25 \times 10^{-4}}$ $= -4000$ Ignore graph unless insufficient answer given in space $E_a = -4000 \times -8.31 = 33240$ TE on M1 +33.2 kJ mol^{-1} / +33240 J mol^{-1} Ignore SF including 1SF Comment: Correct answer scores (3) unless a gradient of 4 or −4 is seen	**(3)**

Question Number	Answer	Additional Guidance	Mark
13(c)	A description that makes reference to the following points: • nitrous acid / HNO_2 **(1)** • because the product must be a weak acid (since it has a K_a value) **(1)**	Comment: Allow HNO_4 / $H_2N_2O_2$ Do not award nitric acid / HNO_3 is a weak acid Allow product does not fully dissociate Marks are independent	**(2)**

(Total Question 13 = 14 marks)

Question Number	Answer	Additional Guidance	Mark
14(a)(i)	An answer that makes reference to the following points: • $O^{-}(g)$ **and** $Mg^{2+}(g) + e(^{-})$		**(1)**

Question Number	Answer	Additional Guidance	Mark
14(a)(ii)	An answer that makes reference to the following point: • enthalpy (change) of formation (for magnesium oxide / MgO (solid))	Allow $\Delta_f H$ Allow ΔH_f Ignore "standard"	**(1)**

Question Number	Answer	Additional Guidance	Mark
14(a)(iii)	• value of $\Delta_f H$ (MgO(s)) **(1)** • correct sign **and** units **(1)**	Example of calculation $\Delta_f H$ = Σ(all other enthalpies) = −3795+ (−)141 +798 +738 +1451 +249 + 148 = (−)552 Comment: Allow 552 / +522 minus sign **and** kJ mol^{-1} Comment: Allow kJ/mol and kJ mol^{-} Marks are independent	**(2)**

Question Number	Answer	Additional Guidance	Mark
14(a)(iv)	An explanation that makes reference to the following points: • magnesium oxide is (very nearly) purely **ionic** **(1)** • because the oxide ion is small and very difficult to polarise / the sulfide ion is large and is more easily polarised **(1)** • magnesium sulfide has a (high) degree of covalency **(1)** • resulting in more exothermic experimental lattice energy (than the theoretical lattice energy) **(1)**	Do not award reference to atom / atomic radius Allow oxygen ion / sulfur ion Allow combination comparisons for M2 Allow a description of polarisation Allow covalent character Allow so the bonds are stronger Allow more negative experimental LE Ignore experimental lattice energy is lower Comment: Reference to molecules would lose M1 if referencing MgO and M3 if referencing MgS Allow reference to S is larger than O if mention of ions somewhere in the answer Ignore MgS is more polarised than MgO Ignore MgO_2	**(4)**

Question Number	Answer	Additional Guidance	Mark
14(b)(i)	An answer that makes reference to the following point: • ($\Delta_{sol}H^{\ominus}$=) $\Delta_{hyd}H(M^{n+}(g)) + \Delta_{hyd}H(X^{n-}(g)) - LE$	Accept $\Sigma\Delta_{hyd}H - LE$ Allow $\Delta_{hyd}H - LE$ Allow $\Delta_{lattice}H$ in expression Allow terms in any order Allow ΔH_{hyd} Allow names and specific symbols in expression	**(1)**

Question Number	Answer	Additional Guidance	Mark
14(b)(ii)	• expression **(1)** • calculation of chloride ion enthalpy change of hydration energy **(1)**	<u>Example of calculation</u> $-2526 + -155 - -1956 = 2x$ $x = -362.5$ (kJ mol^{-1}) TE on M1 if answer is negative Correct answer scores (2) Comment: (+)362.5 scores (1) −725 scores (1)	**(2)**

(Total for Question 14 = 11 marks)

Question Number	Answer	Additional Guidance	Mark
15(a)	An answer that makes reference to the following point: • correct expression	$K_p = \frac{pNH_3}{pN_2^{½} \times pH_2^{1½}}$ Allow round brackets Allow pp Allow $\sqrt{N_2}$ Do not award square brackets	**(1)**

Question Number	Answer	Additional Guidance	Mark
15(b)	• value to 3SF	Example of calculation (= 80 ÷ (20 + 80 + 50)) = 0.533 Ignore units even if incorrect	**(1)**

Question Number	Answer	Additional Guidance	Mark
15(c)	• calculation of remaining mole fractions **(1)** • calculation of partial pressures **(1)** • substitution into the expression **(1)** • value and units **(1)** Comment: 2.34 atm^{-1} scores 3 (for omission of total pressure) 1.44×10^{-4} atm^{-2} scores 4 (for doubling the equation in 15(a))	Example of a calculation: $N_2 = 20/150 = 0.13333$ $NH_3 = 50/150 = 0.33333$ $N_2 = 0.13333 \times 195 = 26.0$ $NH_3 = 0.33333 \times 195 = 65.0$ $H_2 = 0.53333 \times 195 = 104.0$ $K_p = \frac{65}{26^{0.5} \times 104^{1.5}}$ 0.01202 / 0.0120 atm^{-1} Allow 0.012 Ignore SF except 1 SF TE throughout (including from (a) and (b))	**(4)**

Question Number	Answer	Additional Guidance	Mark
15(d)(i)	An explanation that makes reference to the following points: • increase in temperature would decrease yield / shift the equilibrium position to the left **and** because the reverse reaction is endothermic **(1)** • increase in pressure would increase the yield / shift the equilibrium position to the right **and** because there are fewer moles (of gas) on the right-hand side **(1)** • addition of a catalyst has no effect on the yield / equilibrium position **and** because (both) the rates of the forward and backward reactions are increased (equally) **(1)**	Allow as the forward reaction is exothermic Allow molecules in place of moles Allow only increases the rate of reaction Allow lets equilibrium to be reached faster Allow (1) for three correct effects or explanations if no other mark awarded	**(3)**

Question Number	Answer	Additional Guidance	Mark
15(d)(ii)	An explanation that makes reference to the following points: • the value of K_p would decrease with increasing temperature **and** because the equilibrium would shift towards the reactants **(1)** • the value of K_p would not change due to increased pressure or the presence of a catalyst **and** (but) temperature changes K_p **(1)**	Allow M1 if the shift towards reactants is stated for the first part of M1 in (d)(i). Allow reference to the denominator increasing relative to the numerator (or converse). Allow only temperature changes K_p Allow reference to K_p initially increases with pressure but reverts once equilibrium is reestablished	**(2)**

(Total for Question 15 = 11 marks)

Question Number	Answer		Additional Guidance	Mark
16(a)	A description that makes reference to the following points:			**(5)**
	• equation for the equilibrium with hydrogencarbonate **and** equation for the equilibrium with carbon dioxide	**(1)**	$H_2CO_3 \rightleftharpoons HCO_3^- + H^+$ $CO_2 + H_2O \rightleftharpoons H_2CO_3$ Allow equations to be combined Comment: Allow single arrows	
	• description of addition of CO_2 (from respiration)	**(1)**	Additional CO_2 results in more carbonic acid	
	• description of removal of CO_2 (due to exhalation)	**(1)**	When CO_2 decreases, both equilibria move to the left	
	• (but) there is a large excess of hydrogencarbonate / HCO_3^-	**(1)**	Allow reservoir Ignore reference to large excess of H_2CO_3	
	• the ratio of salt / acid remains the same	**(1)**	Allow the concentration of H^+ remains almost the same / constant so pH is maintained If no other mark is awarded, then a definition of a buffer resisting small additions of H^+ and OH^- scores (1)	

Question Number	Answer		Additional Guidance	Mark
16(b)	• calculation of concentration of NaH_2PO_4	**(1)**	Example of calculation $(29.48 \div 120) \div 5 = 0.049133$ (mol dm^{-3})	**(5)**
	• calculation of concentration of Na_2HPO_4	**(1)**	$(3.18 \times 0.08) \div 5 = 0.05088$ (mol dm^{-3})	
	• K_a expression or rearrangement	**(1)**	$K_a = \frac{[HPO_4^{2-}][H^+]}{[H_2PO_4^-]}$ / $[H^+] = \frac{[H_2PO_4^-][K_a]}{[HPO_4^{2-}]}$ $([H^+] = \frac{[0.049133][6.21\times10^{-8}]}{[0.05088]})$	
	• calculation of $[H^+]$	**(1)**	$[H^+] = 5.9968 \times 10^{-8}$ (mol dm^{-3})	
	• calculation of pH	**(1)**	$(pH = -\log[H^+])$ pH = 7.22(21) Allow 7.2 Correct answer with some working scores 5 Ignore SF except 1SF (penalise once only) TE throughout, though TE for M5 must be between 5 and 9 Using the Henderson-Hasselbalch equation: M1 and M2 are the same M3 calculation of $pK_a = 7.207$ M4 for expression $pKa + \log_{10}(\frac{[0.05088]}{[0.04913]})$ M5 for pH = 7.22(21) Allow 7.23	

(Total for Question 16 = 10 marks)

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*17</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><td>Number of indicative marking points seen in answer</td><td>Number of marks awarded for indicative marking points</td></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><td></td><td>Number of marks awarded for structure of answer and sustained lines of reasoning</td></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>
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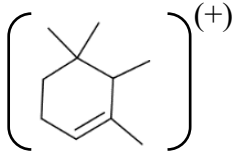
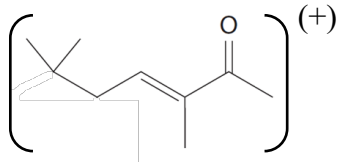
	Indicative content **IP1** chemical reactions are feasible when ΔS_{total} is positive **IP2** $\Delta S_{total} = \Delta S_{system} + \Delta S_{surroundings}$ **and** $\Delta S_{surroundings} = -\Delta H \div T$ For an exothermic reaction / ΔH is negative: **IP3** if ΔS_{system} is positive then the reaction is (always) feasible **IP4** if ΔS_{system} is negative then the reaction is feasible (only) if $-\Delta H \div T > \Delta S_{system}$ For an endothermic reaction / ΔH is positive: **IP5** if ΔS_{system} is positive then the reaction is feasible (only) if $\Delta S_{system} > -\Delta H \div T$ **IP6** if ΔS_{system} is negative then the reaction is never feasible	See below for alternative MS for ΔG Allow feasible if entropy is positive Allow both to be written as prose Accept $\Delta S_{surroundings}$ for $-\Delta H \div T$ for IP4 and 5 Ignore references to E_a Ignore explanations about positive or negative ΔS_{sys}	
	IP1 chemical reactions are feasible when ΔG is (0 or) negative **IP2** $\Delta G = \Delta H - T\Delta S_{system}$ For an exothermic reaction to be feasible **IP3** if ΔS_{system} is positive then T can be any value **IP4** if ΔS_{system} is negative then $T\Delta S_{system}$ must be smaller than ΔH For an endothermic reaction **IP5** if $T\Delta S_{system}$ is larger and ΔS_{system} is positive than ΔH then the reaction is always feasible **IP6** if ΔS_{system} is negative then the reaction is never feasible		

(Total for Question 17 = 6 marks)

TOTAL FOR SECTION B = 52 MARKS

Section C

Question Number	Answer	Additional Guidance	Mark
18(a)(i)	A description that makes reference to the following points: • (high energy) electrons are fired at the molecules **(1)** • breaking the bonds (between atoms) **(1)**	 Ignore just 'electron gun' Accept forming radicals and cations Ignore forming ions Ignore references to later steps in mass spectrometry	**(2)**

Question Number	Answer	Additional Guidance	Mark
18(a)(ii)	An answer that makes reference to the following point: • a fragment $m / z = 136$ (with a positive charge)	e.g.  Ignore molecular formulae e.g. $[C_9H_{12}O]^+$ Do not award negative charges Comment: Allow 	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(b)(i)	• calculation of moles of butanone **(1)** • calculation of maximum mass of alpha-isomethylionone **(1)**	Example of calculation $(25 \times 10^3 \div 72) = 347.22$ (mol) $(347.22 \times 206) = 71528$ (g) $= 71.528$ kg Ignore SF except 1SF TE from M1 Correct answer with no working scores (2) Comment: Allow 71.52 kg. Do not award 71 kg	**(2)**

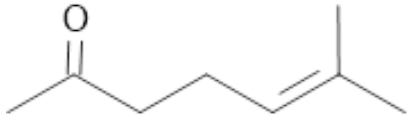
Question Number	Answer	Additional Guidance	Mark
18(b)(ii)	• 91.964% / 92.0 %	Example of calculation $(206 \div (72 + 152)) \times 100 = 91.964\%$ Allow TE if M_r miscalculated in (b)(i)	**(1)**

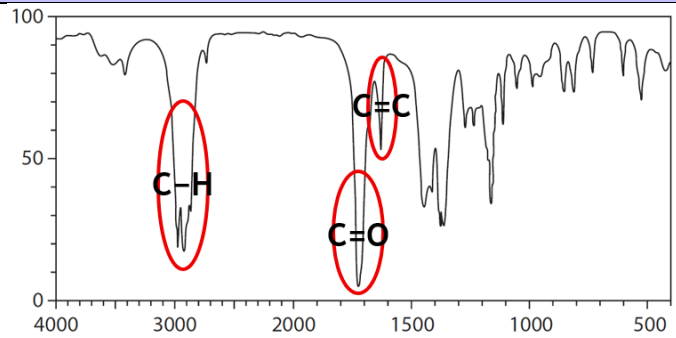
Question Number	Answer	Additional Guidance	Mark
18(c)(i)	An answer that makes reference to the following points: • molecule B **and** because it will form (stronger) attractions with the amine groups / stationary phase **(1)** • OH can form more/stronger hydrogen bonds (with the amine group) **(1)**	Allow molecule B can form hydrogen bonds with the amine groups If no other mark given, allow molecule B can form more hydrogen bonds for (1)	**(2)**

Question Number	Answer	Additional Guidance	Mark
18(c)(ii)	An answer that makes reference to the following point: • gas chromatography	Allow GC Allow gas liquid chromatography / GLC Do not award if multiple techniques given Do not award HPGC	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(d)(i)	An explanation that makes reference to the following points: • (both) carboxylic acids can form hydrogen bonds (with water) **(1)** • the larger the (nonpolar hydrocarbon) chain **and** the lower the solubility **(1)** • because the London forces between large acid molecules are stronger (due to them having more electrons) **(1)**	Accept reverse argument Accept converse Allow hydrophobic carbon chain Ignore references to branching and temperature	**(3)**

Question Number	Answer	Additional Guidance	Mark
18(d)(ii)	• substitution into the K_a expression **(1)** • calculation of $[H^+]^2$ **(1)** • evaluation of $[H^+]$ **and** pH calculated **(1)**	<u>Example of a calculation:</u> $1.58 \times 10^{-5} = \frac{[H^+]^2}{[25 \div 102]}$ $[H^+]^2 = 3.8725 \times 10^{-6}$ TE from M1 if value for $[H^+]^2$ shown $[H^+] = 0.0019679$ $-\log_{10}[0.0019679] = 2.7060$ / 2.71 TE M2 to M3 provided answer is <7 Ignore SF except 1 SF Correct answer with no working scores (3)	**(3)**

Question Number	Answer	Additional Guidance	Mark
18(e)(i)	An answer that makes reference to the following point: • skeletal formula		**(1)**

Question Number	Answer	Additional Guidance	Mark
18(e)(ii)	An answer that makes reference to the following points: Three correct absorbances scores **(2)** Two correct absorbance(s) scores **(1)** • C−H between 3095-3010 (cm^{-1}) [for the alkene] • C−H between 2962-2853 (cm^{-1}) [for the alkane] • C=O between 1720-1700 (cm^{-1}) [for the ketone] • C=C between 1669-1645 (cm^{-1}) [for the alkene]	 Allow any single wavenumber or range within the range If bonds are omitted then three correct absorbances score 1 Comment: Bonds could be labelled on the spectrum to gain credit with the correct ranges. The relevant compounds are not required in the answer and are there to help you when marking. Do not penalise candidates if the compounds are wrong but have the correct bond and range e.g. C=O aldehyde 1720-1700	**(2)**

(Total for Question 18 = 18 marks)

TOTAL FOR SECTION C = 18 MARKS
TOTAL FOR PAPER = 90 MARKS