Pearson

Mark Scheme (Results)

January 2026

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

WCH14/01A

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

January 2026
Question Paper Log Number P87626A
Publication Code WCH14_01A_2601_MS

General Marking Guidance

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

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	**The only correct answer is D** (S_N1; Two steps in mechanism) ***A*** *is incorrect because the halogenoalkane is tertiary so would not take place in one step* ***B*** *is incorrect because the halogenoalkane is tertiary so mechanism would not be S_N2* ***C*** *is incorrect because the halogenoalkane is tertiary so would not take place in one step*	**(1)**

Question Number	Answer	Mark
2	**The only correct answer is D** (SO_2) **A** *is not correct because it has two atoms and two electrons* **B** *is not correct because it has two atoms and fourteen electrons* **C** *is not correct because although it has four atoms, it has only fourteen electrons*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is B** ($Hg(l) \rightarrow Hg(g)$) ***A*** *is incorrect because the increase in disorder from (s) to (l) is less than that from (l) to (g)* ***C*** *is incorrect because there is no significant change in the number of particles or the state* ***D*** *is incorrect because there is a decrease in disorder as the gaseous ion is hydrated*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is A** (-198.8) ***B*** *is incorrect because the number of moles of NH_3 and H_2 have not been considered* ***C*** *is incorrect because the number of moles of NH_3 and H_2 have not been considered and the expression to find the standard entropy of the system has been reversed* ***D*** *is incorrect because the expression to find the standard entropy of the system has been reversed*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is B** (enthalpy change of formation of Na_2SO_4) ***A*** *is incorrect because lattice energy is used to find the energy required to break up the lattice* ***C*** *is incorrect because the enthalpy change of hydration of the cation is required* ***D*** *is incorrect because the enthalpy change of hydration of the anion is required*	**(1)**

Question Number	Answer	Mark
6	**The only correct answer is D** (W, X, Y and Z but there is more Y and Z than W and X) ***A*** *is incorrect because this would require a very large value for K_c* ***B*** *is incorrect because this requires a very small value for $K_c < 1$.* ***C*** *is incorrect because this requires a value for $K_c < 1$.*	**(1)**

Question Number	Answer	Mark
7a	**The only correct answer is C** (flasks 1 and 4 only) ***A*** *is incorrect because flask 4 also contains substances from the right hand side of the equilibrium (HCl(aq) includes some water)* ***B*** *is incorrect because flask 1 also contains substances from the right hand side of the equilibrium* ***D*** *is incorrect as flasks 2 and 3 do not contain any ester*	**(1)**

Question Number	Answer	Mark
7b	**The only correct answer is A** (the equilibrium reaction is slow) ***B*** *is incorrect because rapid hydrolysis would affect the position of equilibrium* ***C*** *is incorrect because the acid is neutralised* ***D*** *is incorrect because the formation of a buffer will not affect the position of the ester equilibrium*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is D** (they are neutralised by 20 cm^3 of 0.10 mol dm^{-3} NaOH(aq)) ***A*** *is incorrect because one acid is strong and the other is weak* ***B*** *is incorrect because the solutions have different concentrations and ethanoic acid is a weak acid* ***C*** *is incorrect because the solutions have different concentrations and ethanoic acid is a weak acid*	**(1)**

Question Number	Answer	Mark
9	**The only correct answer is D** (Structure D) ***A*** *is incorrect because it is identical to B and C* ***B*** *is incorrect because it is identical to A and C* ***C*** *is incorrect because it is identical to A and B*	**(1)**

Question Number	Answer	Mark
10(a)	**The only correct answer is C** (3) ***A*** *is incorrect because menthol has 3 chiral atoms* ***B*** *is incorrect because menthol has 3 chiral atoms* ***D*** *is incorrect because menthol has 3 chiral atoms*	**(1)**

Question Number	Answer	Mark
10(b)	**The only correct answer is B** (two) ***A*** *is incorrect because the oxidation product is a ketone so would not react with* PCl_5 ***C*** *is incorrect because the oxidation product is a ketone so would not react with Fehling's solution* ***D*** *is incorrect because the oxidation product is a ketone so would not react with* PCl_5 *but would react with* 2,4-DNPH	**(1)**

Question Number	Answer	Mark
11(a)	**The only correct answer is A** (compound 1) ***B*** *is incorrect because aldehydes do not change the pH of water* ***C*** *is incorrect because aldehydes do not change the pH of water* ***D*** *is incorrect because aldehydes do not change the pH of water*	**(1)**

Question Number	Answer	Mark
11(b)	**The only correct answer is A** (compound 1) ***B*** *is incorrect because aldehydes do not react with amines to form an N-substituted amide* ***C*** *is incorrect because ketones do not react with amines* ***D*** *is incorrect because amides do not react with amines*	**(1)**

Question Number	Answer	Mark
11(c)	**The only correct answer is C** (compound 3) ***A*** *is incorrect because it does not have an α-methyl carbonyl group* ***B*** *is incorrect because it does not have an α-methyl carbonyl group* ***D*** *is incorrect because it does not have an α-methyl carbonyl group*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is D** (phosphorus(V) chloride) ***A*** *is incorrect because chlorine will not react with ethanoic acid to form ethanoyl chloride* ***B*** *is incorrect because chloroethane will not react with ethanoic acid to form ethanoyl chloride* ***C*** *is incorrect because hydrogen chloride will not react with ethanoic acid to form ethanoyl chloride*	**(1)**

Question Number	Answer	Mark
13	**The only correct answer is A** (NaOOCCH=CHCOONa) ***B*** *is incorrect because only one of the -COOH groups has reacted* ***C*** *is incorrect because OH groups have been added across the double bond* ***D*** *is incorrect because only one of the -COOH groups has reacted and the other has been reduced*	**(1)**

Question Number	Answer	Mark
14	**The only correct answer is B** (condensation) **A** *is incorrect as neither monomer has a carbon-carbon double bond* **C** *is incorrect because this is not a type of polymerisation* **C** *is incorrect because this is not a type of polymerisation*	**(1)**

Question Number	Answer	Mark
15(a)	**The only correct answer is C** (potassium bromide) ***A*** *is not correct because the least exothermic lattice energy is between the largest ions with the smallest charge and calcium ions are smaller and have a higher charge than potassium ions* ***B*** *not correct because the least exothermic lattice energy is between the largest ions with the smallest charge and magnesium ions are smaller and have a higher charge than potassium ions* ***D*** *is not correct because sodium ions are smaller than potassium ions*	**(1)**

Question Number	Answer	Mark
15(b)	**The only correct answer is B** (magnesium chloride) ***A*** *is not correct because* Ca^{2+} *ions are larger than magnesium ions so will polarise less* ***C*** *is not correct because* K^{+} *ions are larger than magnesium ions and have a lower charge so will polarise less* ***D*** *is not correct because* Na^{+} *ions are larger than magnesium ions and have a lower charge so will polarise less*	**(1)**

TOTAL FOR SECTION A = 20 MARKS

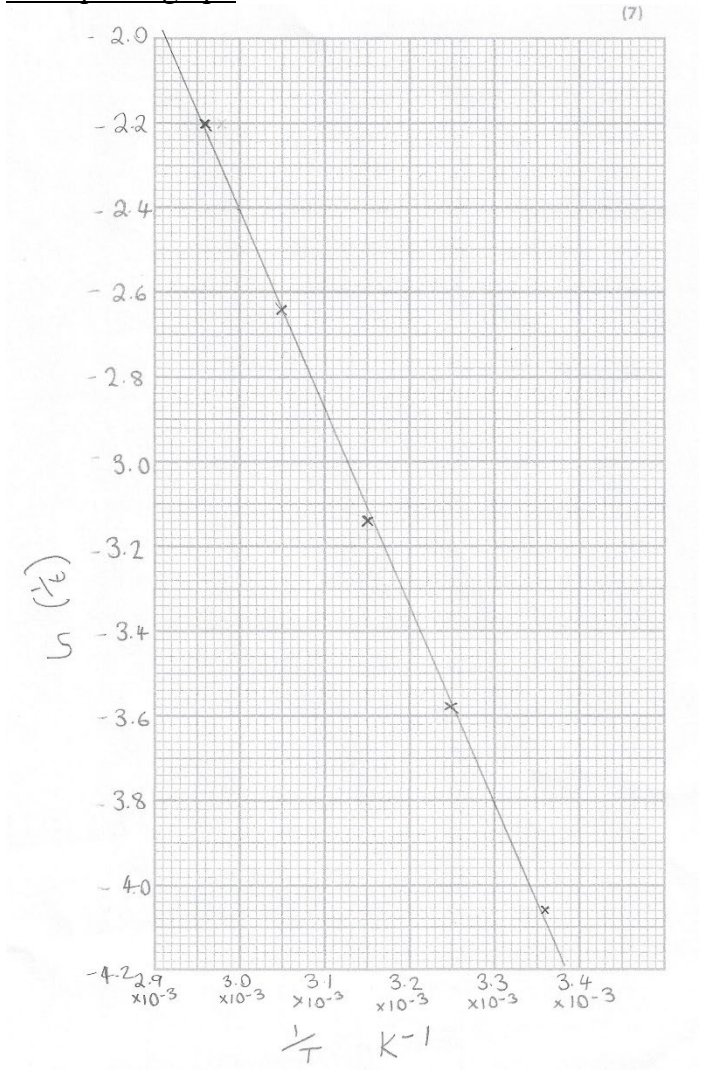
Section B

Question Number	Answer	Additional Guidance	Mark
16(a)(i)	A description that makes reference to the following point • sulfur/S **and** solid / precipitate / (s) is formed	 Do not award any other product Allow insoluble for precipitate	**(1)**

Question Number	Answer	Additional Guidance	Mark
16(a)(ii)	An explanation that makes reference to two of the following points: • the rate of reaction = $\frac{\text{(change in) mass/amount of sulfur}}{\text{time}}$ **(1)** • the same mass/concentration of sulfur is needed to cover the cross in each experiment **(1)**	 Allow rate of reaction $\propto (\Delta)$ [S] ÷ time Allow concentration / moles / n / [ ] for mass Allow rate is the change in mass / amount of sulfur per unit time Allow mass of sulfur / product formed is constant Do not award constant mass of reactant Do not award reaction goes to completion	**(2)**

Question Number	Answer	Additional Guidance	Mark
16(b)(i)	• calculation of $1 \div T$ value **and** $1 \div t$ **(1)** • calculation of $\ln(1 \div t)$ value **(1)**	3.36×10^{-3} **and** 0.0172 −4.06 TE from incorrect value for $1 \div t$ Penalise values not to 3SF once only in M1 and M2	**(2)**

Question Number	Answer	Additional Guidance	Mark
16(b)(ii)	• axes the correct way round and in the correct direction, labelled with units **(1)** • suitable scale so points cover at least ½ of graph **(1)** • all points plotted correctly, with best-fit straight line **(1)** • calculation of gradient **(1)** • sign and units of gradient **(1)** • calculation of activation energy **(1)** • conversion to $kJmol^{-1}$ **(1)**	Accept use of $\times 10^{3}$ or $\times 10^{-3}$ on x axis Do not award $\ln(1 \div \mathbf{T})$ on x axis or $1 \div \mathbf{t}$ on y axis TE from values calculated in b(i) Allow a square tolerance (−)4670 Allow range (−)4170 to (−)5170 Negative sign and unit of K E_a =(–4670 × −8.31 =) 38807.7 E_a = (+) 38.8077 / 38.8 / 39 ($kJmol^{-1}$) Do not award a negative activation energy for M7 only Ignore SF throughout except 1SF Allow TE from M4	**(7)**

		Example of graph  	

Question Number	Answer	Additional Guidance	Mark
16(c)(i)	An answer that makes reference to the following point: • (so) only the (concentration of) sodium thiosulfate changes/affects the rate	Allow so that the thiosulfate is the limiting reagent Allow the concentration of HCl is (nearly) constant Ignore all the thiosulfate reacts / the reaction reaches completion Ignore to ensure the concentration of acid does not affect the rate	**(1)**

Question Number	Answer	Additional Guidance	Mark
16(c)(ii)	An answer that makes reference to two of the following points: • it is first order **(1)** • the rate is proportional to the concentration (of the thiosulfate) / because the graph is a straight line (through the origin) **(1)**	Allow linear / constant gradient / when concentration doubles, so does the rate Ignore 'when concentration increases, rate increases' Do not award any reference to a curve M1 and M2 standalone marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
16(d)(i)	An answer that makes reference to the following point: • it is the slowest step (in the reaction mechanism)	Allow slow step / step with the lowest rate / step with the highest activation energy Do not award involves all the substances in the equation Do not award lowest step	**(1)**

Question Number	Answer	Additional Guidance	Mark
16(d)(ii)	An answer that makes reference to the following point • $HS_2O_3^-$	Allow $S_2O_3H^-$ Allow $H^+ + S_2O_3^{2-} \rightarrow S_2O_3H^-$	**(1)**

(Total for Question 16 = 17 marks)

Question Number	Answer	Additional Guidance	Mark
17(a)(i)	An answer that makes reference to the following point • $K_c = \frac{[NO]^2[Cl_2]}{[NOCl]^2}$	Ignore state symbols Do not award round brackets or partial pressures	**(1)**

Question Number	Answer	Additional Guidance	Mark
17(a)(ii)	• calculation of mols at equilibrium **(1)** • calculation of equilibrium concentrations **(1)** • value of K_c to 2/3 SF **(1)** • units of K_c **(1)**	Example of calculation | | NOCl(g) | NO(g) | Cl_2(g) | | --- | --- | --- | --- | | mols at start | 2.00 | 0 | 0 | | mols at equ^m | **1.778** | (0.222) | **0.111** | | conc at equ^m | **0.4445** | **0.0555** | **0.02775** | $\frac{(0.0555)^2 \times 0.02775}{0.4445^2}$ = 4.3262×10^{-4} / **4.33×10^{-4} / 0.000433** **4.3×10^{-4}/ 0.00043** **mol dm^{-3}** In M1 and M2 ignore SF except 1 SF TE from expression in (i) and throughout Correct answer with no working scores (4) Allow use of fractions for intermediate values, but not for M3	**(4)**

		Comment: **1.73 × 10^{-3} mol dm^{-3} scores (3)** for use of mols instead of conc in Kc calculation **4.92 × 10^{-4} mol dm^{-3} scores (3)** for mols of NOCl at eqm calculated as 1.667 **1.97 × 10^{-3} mol dm^{-3} scores (2)** for mols of NOCl at eqm calculated as 1.667 and mols used in Kc calculation instead of conc	

Question Number	Answer	Additional Guidance	Mark
17(b)(i)	An answer that makes reference to two of the following points: (endothermic enthalpy change) • $\Delta S_{surroundings} = -\Delta H \div T$ **(1)** (entropy change of the system does not change) • so as T increases $\Delta S_{surroundings}$ becomes less negative **(1)**	Allow $\Delta S_{total} = \Delta S_{system} + (-\Delta H \div T)$ Ignore just smaller/decreases/increases	**(2)**

Question Number	Answer	Additional Guidance	Mark
17(b)(ii)	An answer that makes reference to two of the following points: • $\Delta S_{total} = R \ln K$ **(1)** • (so as T increases) ΔS_{total} increases so K increases **(1)** OR • the reaction is endothermic **(1)** • so equilibrium moves to the RHS **and** K increases **(1)**	Allow K_c for K Comment: Allow 1 mark for the complete reverse ie backward reaction is endothermic **and** the eqm moves left **and** K decreases	**(2)**

Question Number	Answer	Additional Guidance	Mark
17(b)(iii)	• reaction becomes feasible when $\Delta S_{total} = 0$ or $T = \Delta H \div \Delta S_{system}$ **(1)** • calculation of temperature in K **(1)**	<u>Example of calculation</u> Allow when $\Delta S_{total} > 0$ $T = 52200 \div 40.4 = 1292$ (K) Correct answer with no working scores (2) Ignore SF except 1SF Do not award 1293 Comment: -1292 scores (1) 1.29 scores (1)	**(2)**

(Total for Question 17 = 11 marks)

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*18</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).

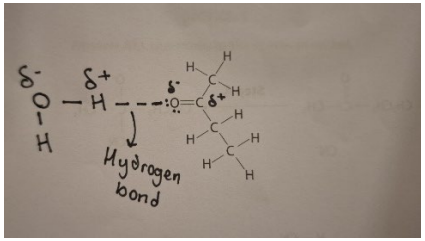
In general it would be expected that
5 or 6 indicative points would get 2 reasoning marks
3 or 4 indicative points would get 1 reasoning mark
0, 1 or 2 indicative points would get zero reasoning marks

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

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

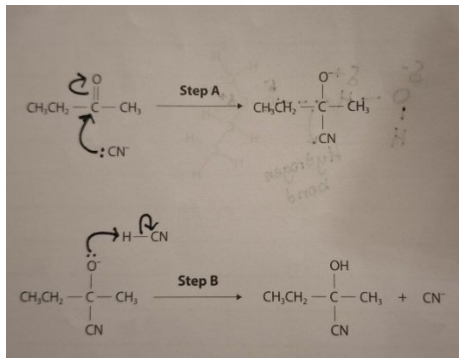
	Indicative content (Similarities) **IP1** Both react with 2,4-dintrophenylhydrazine to form a yellow/orange/red precipitate **IP2** Both can be reduced by $LiAlH_4$ (in dry ether) (Differences) **IP3** propanal is reduced to a primary alcohol but propanone to a secondary alcohol **IP4** propanal is oxidised by acidified potassium / sodium dichromate ((VI)) but propanone does not react **IP5** equation for oxidation **IP6** observation for named oxidising agent such as (orange to) green (for acidified potassium dichromate (VI))	Accept both can be reduced by $NaBH_4$ Ignore just 'react with' with no reference to reduction / reducing agent Accept propanal is reduced to propan-1-ol but propanone is reduced to propan-2-ol Allow correct structures drawn If names and structures are given then these must all be correct Ignore any equations given for reduction, even if incorrect so long the organic product Accept any names suitable oxidising agent such as Fehling's / Benedict's solution / Tollens reagent Allow H^+ / $Cr_2O_7^{2-}$ Allow acidified potassium manganate (VII) $CH_3CH_2CHO + [O] \rightarrow CH_3CH_2COOH$ Do not allow CH_3CH_2COH / C_3H_6O / $C_3H_6O_2$ Allow skeletal and displayed formula (Blue solution) to brick red precipitate (for Fehling's / Benedict's) Silver mirror / silver ppt (for Tollens') Original appearance is not required, but if given then it must be correct	

(Total for Question 18= 6 marks)

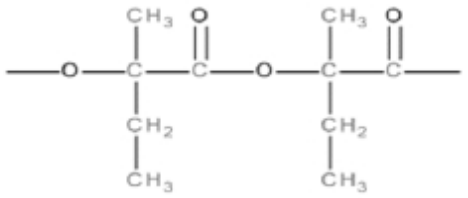
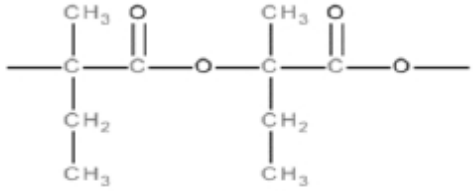
Question Number	Answer	Additional Guidance	Mark
19(a)	An answer that makes reference to the following points: • diagram showing one water molecule correctly aligned with an angle of 170 – 190° about O−H - - - O • hydrogen bond labelled anywhere on diagram • lone pair on oxygen atom lined up with hydrogen bond • one dipole on water molecule showing both δ+ and δ− • one dipole on C=O of butanone showing both δ+ and δ− All 5 bullet points scores 3 3-4 bullet points scores 2 2 bullet points scores 1	<u>Example of diagram</u>  Maximum 1 mark if the carbonyl group is not involved in the hydrogen bond	**(3)**

Question Number	Answer	Additional Guidance	Mark
19(b)(i)	An answer that makes reference to the following points: • addition **(1)** • nucleophilic **(1)**	Do not award hydrolysis / reduction / substitution	**(2)**

Question Number	Answer	Additional Guidance	Mark
19(b)(ii)	An answer that makes reference to two of the following points: • named strong acid **(1)** • (heat under) reflux **(1)**	(dilute) hydrochloric/sulfuric acid Ignore just H^+ Ignore concentrated M2 dependent on M1 or near miss such as use of a weak acid or incorrect acid formula Accept dilute sodium/potassium hydroxide **and** reflux for M1 **then** (dilute) hydrochloric/sulfuric acid	**(2)**

Question Number	Answer	Additional Guidance	Mark
19(b)(iii)	An answer that makes reference to the following points: • lone pair on C of CN^- • curly arrow from lone pair (if present) on C of CN^- • curly arrow from C=O bond to O or just beyond • lone pair on O of intermediate • curly arrow from lone pair (if present) on O of intermediate to H of HCN • curly arrow from -CN to anywhere on CN All 6 bullet points scores 3 4 or 5 bullet points scores 2 2 or 3 bullet points scores 1	<u>Example of mechanism</u>  Ignore dipoles even if incorrect Lose a bullet point for use of full charges once only TE from bp1 to bp2: if lone pair is placed on the nitrogen, curly arrow can start here.	**(3)**

Question Number	Answer	Additional Guidance	Mark
19(b)(iv)	An explanation that makes reference to three of the following points • a racemic mixture is formed **(1)** • (because) the reaction site is planar **(1)** • (and) the nucleophile / CN^- attacks (50:50 / equal probability) from above and below / either side (of the plane) **(1)**	Allow equal numbers of the (two) enantiomers / *d* and *l* isomers are formed Allow C=O bond is planar Do not award the molecule is planar Do not award CN without the minus sign Penalise reference to carbocation / intermediate once only in M2 and M3	**(3)**

Question Number	Answer	Additional Guidance	Mark
19(b)(v)	A description that makes reference to two of the following points: • ester linkage **(1)** • remaining structure **(1)**	Example of diagram  Allow  Accept displayed / structural / skeletal / hybrid formulae Allow COO for ester linkage Do not allow C-O-O- or -CO-O- for ester linkage Ignore vertical connectivity to R groups Ignore brackets and n	**(2)**

(Total for Question 19 = 15 marks)

Section C

Question Number	Answer	Additional Guidance	Mark
20(a)(i)	• equation	Example of equation $C_6H_5COOH(aq) + H_2O(l) \rightleftharpoons C_6H_5COO^-(aq) + H_3O^+(aq)$ Allow $C_6H_5COOH(aq) \rightleftharpoons C_6H_5COO^-(aq) + H^+(aq)$ Do not award → for ⇌	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	• $K_a = \frac{[C_6H_5COO^-][H^+]}{[C_6H_5COOH]}$	Accept $K_a = \frac{[C_6H_5COO^-][H_3O^+]}{[C_6H_5COOH]}$ Ignore state symbols even if incorrect	**(1)**

Question Number	Answer	Additional Guidance	Mark
20(a)(iii)	• calculation of concentration of acid **(1)** • calculation of K_a **(1)** • calculation of $[H^+]$ **(1)** • calculation of pH **(1)**	<u>Example of calculation</u> $c = 3.44 \div 122.1 = 0.028174$ (mol dm^{-3}) $K_a = 10^{-4.2} = 6.3096 \times 10^{-5}$ (mol dm^{-3}) $c = \sqrt{(6.3096 \times 10^{-5} \times 0.028174)} = 1.3333 \times 10^{-3}$ $pH = -\log_{10}(1.3333 \times 10^{-3}) = 2.875/2.88/2.9$ Ignore SF except 1 SF Correct answer with no working scores (4) Award TE throughout, however final answer must be < 7 for M4 2.87 scores (4) from rounding of intermediates 5.75 / 5.74 scores (3) from not carrying out the square root function Comment: Ignore incorrect truncation	**(4)**

Question Number	Answer	Additional Guidance	Mark
20(a)(iv)	A description that makes reference to two of the following points: • initial [acid] = eqm [acid] **(1)** • $[C_6H_5COO^-] = [H^+]$ **(1)**	Accept the ionisation of benzenecarboxylic acid is negligible Allow the ionisation of benzenecarboxylic acid is partial / incomplete Allow HA for benzenecarboxylic acid Allow dissociation for ionisation Allow [acid] is unchanged / constant Accept the $[H^+]$ (only) comes from the benzenecarboxylic acid / does not come from the ionisation of water Allow the ionisation of water is not significant Allow $[A^-] = [H^+]$ (as no H^+ from water)	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(b)(i)	An answer that makes reference to the following points: • pH value between 7.3 – 9.0 **(1)** • the solution at X contains a solution of the salt of a weak acid and a strong base (so is slightly alkaline) **(1)**	Allow the reaction is between a weak acid and a strong base / alkali	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(b)(ii)	• calculation of mols acid **(1)** • calculation of volume NaOH in cm^3 **(1)**	Example of calculation: $n = 25.0 \times 0.0015 \times 10^{-3} = 3.75 \times 10^{-5}$ (mol) $V = \frac{3.75 \times 10^{-5}}{0.002} = 0.01875\ dm^3 = 18.75 / 18.8\ (cm^3)$ Correct answer with no working scores (2) TE from M1 to M2 Ignore SF except 1SF	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(b)(iii)	• calculation of pOH 0.0020 M NaOH solution **(1)** • calculation of pH **(1)** **or** • calculation of $[H^+]$ **(1)** • calculation of pH **(1)**	Example of calculation: $pOH = -\log_{10}[OH^-] = 2.70$ $pH = pK_w - pOH = 14 - 2.70 = 11.3$ $[H^+] = 1 \times 10^{-14} \div 0.0020 = 5 \times 10^{-12}$ (mol dm^{-3}) $pH = -\log_{10}(5 \times 10^{-12}) = 11.3$ Correct answer with no working scores (2) Do not award pH as an integer TE from M1 to M2 for both methods provided final pH >7	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(c)(i)	An answer that makes reference to the following points: • the pH remains (almost) constant / line is (approximately) horizontal **(1)** • when small amounts of alkali are added **(1)**	Allow when small amounts of acid **and** alkali are added If no other mark awarded, award 1 for 'it contains a mixture of a weak acid and its salt'	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(c)(ii)	An answer that makes reference to the following points: • C_6H_5COOH / benzoic acid and $C_6H_5COO^-$ / benzoate ions are present **(1)** • in high concentrations / amounts **(1)** • when acid is added the ion / $C_6H_5COO^-$/ carboxylate is protonated removing H^+ from the solution **(1)** • when alkali is added the acid / C_6H_5COOH is deprotonated removing the OH^- from the solution **(1)**	Allow $C_6H_5COO^- + H^+ \rightarrow C_6H_5COOH$ $C_6H_5COO^- + H^+ \rightleftharpoons C_6H_5COOH$ **and** shifts right Allow the acid reacts with $C_6H_5COO^-$ / salt Allow $C_6H_5COOH + OH^- \rightarrow C_6H_5COO^- + H_2O$ Allow the alkali reacts with C_6H_5COOH / weak acid Ignore $H^+ + OH^- \rightarrow H_2O$ Penalise the use of HA / A^- once only	**(4)**

Question Number	Answer	Additional Guidance	Mark
20(d)	An answer that makes reference to the following point • enzymes are denatured/damaged at high/low pH	 Allow enzymes work best at an optimal pH / to ensure enzymes function correctly Ignore reference to 'harmful'	**(1)**

(Total for Question 20 = 21 marks)

TOTAL FOR SECTION C = 21 MARKS
TOTAL FOR PAPER = 90 MARKS