



Mark Scheme (Results)

Summer 2019

Pearson International Advanced Level
In Chemistry (WCH06) Paper 01 Chemistry
Laboratory Skills II

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Summer 2019

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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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:
 - i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
 - ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
 - iii) organise information clearly and coherently, using specialist vocabulary when appropriate

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.

Question Number	Acceptable Answers	Reject	Mark
1(a)(i)	<p>A contains Na⁺/sodium (ions) IGNORE Na</p> <p>and</p> <p>B contains Ca²⁺/calcium (ions) IGNORE Ca</p>	Ca ⁺	(1)

Question Number	Acceptable Answers	Reject	Mark
1(a)(ii)	<p>White</p> <p>IGNORE Formulae even if incorrect</p>	Colourless	(1)

Question Number	Acceptable Answers	Reject	Mark
1(a)(iii)	<p>$2\text{H}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$</p> <p>Correct species and balancing ALLOW Multiples Cancelled/crossed out spectator ions (1)</p> <p>IGNORE Additional equations as working</p> <p>State symbols Conditional on correct species (or near miss or full equation)</p> <p>ALLOW in M2 $\text{H}_2\text{CO}_3(\text{aq})$ for $\text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ (1)</p>		(2)

Question Number	Acceptable Answers	Reject	Mark
1(a)(iv)	Silver nitrate / $\text{AgNO}_3(\text{aq})$ IGNORE Nitric acid/ HNO_3 Ammonia / NH_3 Lead nitrate / $\text{Pb}(\text{NO}_3)_2(\text{aq})$	Sodium nitrate / $\text{NaNO}_3(\text{aq})$ $\text{HCl}/\text{H}_2\text{SO}_4/\text{NaOH}$	(1)

Question Number	Acceptable Answers	Reject	Mark
1(b)(i)	Manganese(II) hydroxide / $\text{Mn}(\text{OH})_2$ ALLOW $\text{Mn}(\text{H}_2\text{O})_4(\text{OH})_2$ (1) (Darkens as) oxidised (by oxygen in the air to oxides/hydroxides of manganese(III)/(IV)) ALLOW Reacts with oxygen (1) IGNORE Formulae of manganese oxides/ hydroxides provided +3/+4 Mn oxidation state Colour of manganese oxides/hydroxides	$\text{Mg}(\text{OH})_2$ / magnesium hydroxide Oxidation state higher than +4	(2)

Question Number	Acceptable Answers	Reject	Mark
1(b)(ii)	$[\text{Zn}(\text{OH})_4]^{2-}$ / $[\text{Zn}(\text{H}_2\text{O})_2(\text{OH})_4]^{2-}$ ALLOW $[\text{Zn}(\text{OH})_6]^{4-}$ $[\text{Zn}(\text{OH})_3]^-$ / $[\text{Zn}(\text{H}_2\text{O})_3(\text{OH})_3]^-$ ZnO_2^{2-} IGNORE Missing square brackets Correct charges within square brackets provided they total the charge on the complex ion State symbols even if incorrect	$\text{Zn}(\text{OH})_2$ / $[\text{Zn}(\text{OH})_2]^-$ $\text{Zn}(\text{H}_2\text{O})_4(\text{OH})_2$ $[\text{Zn}(\text{H}_2\text{O})_4]^{2+}$ / $[\text{Zn}(\text{H}_2\text{O})_6]^{2+}$	(1)

Question Number	Acceptable Answers	Reject	Mark
1(b)(iii)	<p>(E is) iron(II) nitrate / $\text{Fe}(\text{NO}_3)_2$</p> <p>ALLOW Ferrous nitrate $\text{Fe}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ (1)</p> <p>IGNORE hydrated anhydrous</p> <p>(Brown solid is) iron(III) hydroxide / $\text{Fe}(\text{OH})_3$</p> <p>ALLOW $\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3$ Hydrated iron(III) oxide / $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ $\text{FeO}(\text{OH})$ (1)</p> <p>IGNORE Just iron(III) oxide / Fe_2O_3 Just rust</p>	<p>$\text{Fe}(\text{NO}_3)_3$ Iron(III) nitrate Just iron nitrate</p> <p>$\text{Fe}(\text{OH})_2$ Iron(II) hydroxide Just iron hydroxide</p>	(2)

(Total for Question 1 = 10 marks)

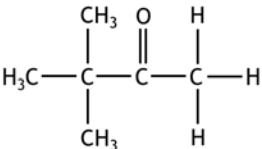
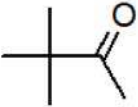
Question Number	Acceptable Answers	Reject	Mark
2(a)(i)	<p>(X is a) ketone</p> <p>ALLOW Carbonyl/C=O (1)</p> <p>IGNORE Aldehyde</p> <p>(with an) adjacent methyl (1)</p> <p>IGNORE Correct statements relating to positive or negative tests prior to final answer</p> <p>Any C₆H₁₂O structure or name if no contradiction</p> <p>Methyl ketone / methyl carbonyl / CH₃C(=)O scores (2)</p> <p>Methyl secondary alcohol / CH₃CH(OH) scores (0)</p>	<p>Alcohol</p> <p>Ethanal / CH₃CHO</p> <p>Methyl aldehyde</p> <p>Methyl alcohol / CH₃CH(OH)</p> <p>Any additional functional group</p>	(2)

Question Number	Acceptable Answers	Reject	Mark
2(a)(ii)	<p>IGNORE Structures throughout Alkane throughout</p> <p>Alkene ALLOW C=C Carbon-carbon double bond (1) IGNORE Just unsaturated/double bond</p> <p>Alcohol ALLOW Hydroxyl / hydroxy OH/-OH/C-OH (1) IGNORE Primary and/or secondary</p>	<p>Phenyl/benzene</p> <p>C=O</p> <p>Saturated</p> <p>Phenol</p> <p>Hydroxide / OH⁻</p> <p>Carboxylic acid COOH</p> <p>Tertiary</p>	(2)

Question Number	Acceptable Answers	Reject	Mark
2(a)(iii)	$C_6H_{12}O + Na \rightarrow C_6H_{11}O^{(-)}Na^{(+)} + \frac{1}{2}H_2$ ALLOW Multiples $C_6H_{11}Na^{(+)}O^{(-)}$ IGNORE State symbols, even if incorrect	O-Na $O^{(+)}Na^{(-)}$ H / H^+	(1)

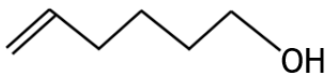
Question Number	Acceptable Answers	Reject	Mark
2(b)(i)	2 proton environments ALLOW Hydrogen/H for proton Types/kinds for environment IGNORE H^+ for proton References to symmetry References to just number of protons		(1)

Question Number	Acceptable Answers	Reject	Mark
2(b)(ii)	Each proton environment has no adjacent protons ALLOW No neighbouring protons Hydrogen/H for proton IGNORE H^+ for proton Protons are isolated Reference to n+1 rule Reference to O-H protons Reference to number of proton environments		(1)

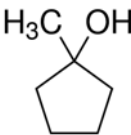
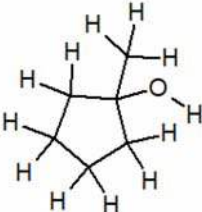
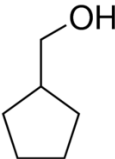
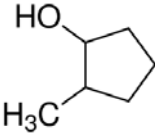

Question Number	Acceptable Answers	Reject	Mark
2(b)(iii)	<p>Allow displayed, structural or skeletal formula, or any correct combination of these</p> <p>eg</p> $(\text{CH}_3)_3\text{CCOCH}_3$   <p>IGNORE Bond lengths and bond angles Name, even if incorrect</p>	Any other answer	(1)

Question Number	Acceptable Answers	Reject	Mark
2(c)(i)	<p>Y is a 1-ene</p> <p>ALLOW The C=C bond is at the end of the chain</p> <p>OR</p> <p>One of the carbon atoms in the C=C has two hydrogens / two identical groups/atoms attached</p> <p>ALLOW Both carbon atoms of the C=C have the same group/atom attached</p> <p>IGNORE References to restricted rotation</p>	<p>...two molecules ...functional groups</p> <p>'similar' for 'same'</p>	(1)

Question Number	Acceptable Answers	Reject	Mark
2(c)(ii)	<p>No carbon/atom with four different groups attached</p> <p>ALLOW 'functional groups' or 'atoms' for groups OR No chiral carbon/centre OR No asymmetric carbon/centre OR Is a primary alcohol / not a secondary alcohol</p> <p>IGNORE Achiral/not chiral Is symmetric No effect on plane polarised light Does not have enantiomers Is not non-superimposable</p>	<p>molecules</p> <p>bonds</p>	1 exp

Question Number	Acceptable Answers	Reject	Mark
2(c)(iii)	<p>Allow displayed, structural or skeletal formula, or any correct combination of these</p> <p>eg</p> <p>CH₂CHCH₂CH₂CH₂CH₂OH</p> $ \begin{array}{c} \text{H} \quad \text{CH}_2(\text{CH}_2)_2\text{CH}_2\text{OH} \\ \quad \\ \text{C} = \text{C} \\ \quad \\ \text{H} \quad \text{H} \end{array} $  <p>IGNORE Connectivity of OH group Name, even if incorrect</p>	<p>Any other answer</p> <p>C-H-O</p>	(1)

Question Number	Acceptable Answers	Reject	Mark
2(d)(i)	Tertiary alcohol ALLOW Tertiary hydroxy(l)/OH group 3° for tertiary		(1)

Question Number	Acceptable Answers	Reject	Mark
2(d)(ii)	<p>Allow displayed, structural or skeletal formula, or any correct combination of these eg</p>   <p>Mark independently of (d)(i) except ALLOW</p>  <p>if answer to (d)(i) is primary alcohol</p>  <p>OR</p>  <p>if answer to (d)(i) is secondary alcohol</p> <p>IGNORE Connectivity of OH group Name, even if incorrect</p>		(1)

C-H-O

(Total for Question 2 = 13 marks)

Question Number	Acceptable Answers	Reject	Mark
3(a)(i)	Self-indicating ALLOW Colour changes at the end of the reaction / end-point OR Manganate(VII)/ MnO_4^- ions are purple and manganese(II)/ Mn^{2+} ions are colourless OR Colour changes as MnO_4^- reduced/converted to Mn^{2+} IGNORE Colours due to Fe^{2+} and Fe^{3+}		(1)

Question Number	Acceptable Answers	Reject	Mark
3(a)(ii)	(From) colourless to (permanent pale) pink ALLOW (pale) green to pink	(Pale) purple	(1)

Question Number	Acceptable Answers	Reject	Mark
3(b)	Mark M1 and M2 independently Titre value will not be affected/remain the same/be unchanged (1) (as titre is) difference between two readings ALLOW Both/all/two/initial and final readings taken from the top of the liquid/in the same way (1) IGNORE Error cancels out If no other mark awarded and effect on titre not stated then 'titre value is inaccurate due to increased uncertainty/parallax error (in reading from the top of the meniscus)' scores (1)		(2)

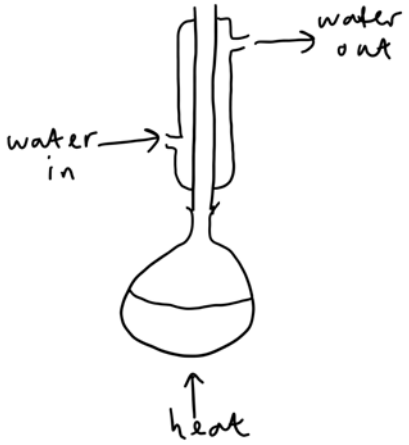
Question Number	Acceptable Answers	Reject	Mark																				
3(c)(i)	<p>First mark – three titre values correctly recorded to 2DP in table</p> <table border="1" data-bbox="461 333 1107 575"> <thead> <tr> <th data-bbox="461 333 716 394">Titration numbers</th> <th data-bbox="716 333 813 394">1</th> <th data-bbox="813 333 911 394">2</th> <th data-bbox="911 333 1008 394">3</th> <th data-bbox="1008 333 1107 394">4</th> </tr> </thead> <tbody> <tr> <td data-bbox="461 394 716 455">Burette reading (final) / cm³</td> <td data-bbox="716 394 813 455">10.85</td> <td data-bbox="813 394 911 455">21.40</td> <td data-bbox="911 394 1008 455">31.60</td> <td data-bbox="1008 394 1107 455">42.40</td> </tr> <tr> <td data-bbox="461 455 716 516">Burette reading (initial) / cm³</td> <td data-bbox="716 455 813 516">0.00</td> <td data-bbox="813 455 911 516">10.85</td> <td data-bbox="911 455 1008 516">21.40</td> <td data-bbox="1008 455 1107 516">32.10</td> </tr> <tr> <td data-bbox="461 516 716 575">Titre / cm³</td> <td data-bbox="716 516 813 575">10.85</td> <td data-bbox="813 516 911 575"><u>10.55</u></td> <td data-bbox="911 516 1008 575"><u>10.20</u></td> <td data-bbox="1008 516 1107 575"><u>10.30</u></td> </tr> </tbody> </table> <p>(1)</p> <p>Second mark – calculating mean titre from concordant results</p> <p>Mean titre = $(10.2(0) + 10.3(0))/2$ = 10.25 (cm³)</p> <p>TE on averaging of concordant results from incorrect subtraction in table</p> <p>ALLOW 3DP for mean titre if average = X.XX5 (1)</p>	Titration numbers	1	2	3	4	Burette reading (final) / cm ³	10.85	21.40	31.60	42.40	Burette reading (initial) / cm ³	0.00	10.85	21.40	32.10	Titre / cm ³	10.85	<u>10.55</u>	<u>10.20</u>	<u>10.30</u>		(2)
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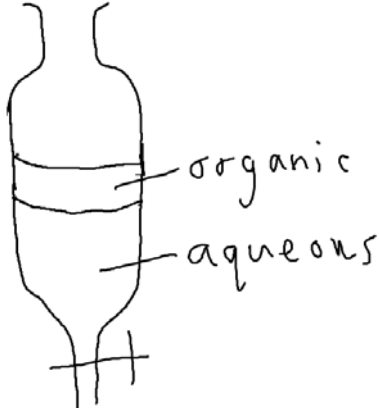
Question Number	Acceptable Answers	Reject	Mark
3(c)(ii)	<p>Correct answer with correct units to 3SF or 2SF and no working scores (5)</p> <p>Mol MnO_4^- used $= 0.00500 \times 10.25/1000$ $= 0.00005125 / 5.125 \times 10^{-5}$ TE on mean titre (1)</p> <p>Mol Fe^{2+} in 10.0 cm^3 $= 0.00005125 \times 5$ $= 0.00025625 / 2.5625 \times 10^{-4}$ TE on mol MnO_4^- used (1)</p> <p>Mol Fe^{2+} in 100.0 cm^3 $= 0.00025625 \times 100.0/10.0$ $= 0.0025625 / 2.5625 \times 10^{-3}$ TE on mol Fe^{2+} in 10.0 cm^3 (1)</p> <p>Mass $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in 100.0 cm^3/two tablets $= 0.0025625 \times 277.9$ $= 0.712119 \text{ (g)}$ TE on mol Fe^{2+} in 100.0 cm^3 (1)</p> <p>Mass $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in one tablet to 3SF/2SF $= 0.712119/2$ $= 0.356 \text{ g} / 356 \text{ mg}$ TE on mass $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in 100.0 cm^3/two tablets TE on $M_r \text{ FeSO}_4 \cdot 7\text{H}_2\text{O}$ (1)</p>	Incorrect/ missing units	(5)

Question Number	Acceptable Answers	Reject	Mark
3(d)	<p>First mark – % uncertainty in mean titre</p> <p>$(0.05 \times 2)/10.25 \times 100 = 0.9756/0.976/0.98/1.0/1\%$ TE on mean titre from (c)(i) (1)</p> <p>Second mark – % uncertainty in pipette</p> <p>$0.06/10.0 \times 100 = 0.6\%$ (1) (so burette has greater percentage uncertainty)</p> <p>Both uncertainties calculated correctly but labelled incorrectly scores (1)</p> <p>± 0.05 for pipette gives % uncertainty 0.5% and ± 0.06 for burette gives % uncertainty 1.17% scores (1)</p> <p>mean titre for pipette volume (with TE) gives % uncertainty = $0.06/(\text{mean titre}) \times 100$ and 10 cm^3 for burette volume gives % uncertainty = 1% scores (1)</p>		(2)

(Total for Question 3 = 13 marks)

Question Number	Acceptable Answers	Reject	Mark
4(a)	<p>(Concentrated sulfuric acid) Catalyst</p> <p>ALLOW To speed up the reaction To shift the equilibrium to the right (1)</p> <p>IGNORE To initiate reaction To provide H⁺ As a solvent</p> <p>(Anti-bumping granules) For smooth boiling / heating ALLOW 'uniform/even/gentle' for 'smooth' To promote formation of small bubbles To provide nucleation sites</p> <p>OR</p> <p>To prevent superheating / violent/flash boiling ALLOW 'vigorous/uneven/localised/sudden' for 'violent/flash' To prevent formation of large bubbles (1)</p> <p>IGNORE To prevent bumping To prevent splashing/spitting/spillage</p>	<p>Just gentle heating</p> <p>Explosion</p>	(2)

Question Number	Acceptable Answers	Reject	Mark
4(b)	 <p>First mark Heat/arrow (may be directed to any part of the liquid in the flask) / heating mantle / electric heater</p> <p>and</p> <p>Round-bottom/pear-shaped flask</p> <p>and</p> <p>Vertical condenser/tube (1)</p> <p>IGNORE No reaction mixture in flask</p> <p>Second mark Condenser jacket and correct water direction (water in must be below water out) ALLOW Correct unlabelled arrows or just water in/out (1)</p>	<p>Water bath</p> <p>Sealed apparatus or accidental lines sealing apparatus unless qualified</p> <p>Gaps at apparatus joints</p> <p>Conical flask</p> <p>Lack of joint between flask and condenser</p> <p>Thermometer in condenser</p>	(2)

Question Number	Acceptable Answers	Reject	Mark
4(c)	 <p>First mark Diagram of separating funnel (with or without stopper/bung)</p> <p>ALLOW Any shape separating funnel with tap at the bottom (no label required) if capable of being sealed with a bung (1)</p> <p>Second mark Aqueous and organic layers labelled in correct order</p> <p>ALLOW Just one labelled layer if two layers shown</p> <p>3-methylbutyl ethanoate/ester for organic layer</p> <p>Water/ethanoic acid for aqueous layer (1)</p> <p>IGNORE 3-methylbutan-1-ol/ alcohol/ product for organic layer</p> <p>IGNORE 3-methylbutan-1-ol/alcohol/ reactant for aqueous layer</p>	<p>Sealed apparatus (if stopper/bung unclear)</p> <p>Burette</p> <p>More than two layers</p>	(2)

Question Number	Acceptable Answers	Reject	Mark
4(d)	<p>To react with/neutralise any (remaining sulfuric) acid</p> <p>ALLOW To remove the (sulfuric/ethanoic) acid / H⁺ To neutralise the organic layer (1)</p> <p>(Aqueous layer) turns damp red litmus blue</p> <p>ALLOW Test with (red) litmus paper Test with universal indicator paper Remove sample and test with any named indicator IGNORE Just test with any named indicator</p> <p>ALLOW (Confirm alkalinity) with pH meter</p> <p>ALLOW Add sodium hydrogencarbonate and no effervescence is observed (1)</p>	<p>Mention of NaOH</p> <p>HCl (or other acids)</p> <p>Addition of any named indicator to the funnel</p>	(2)

Question Number	Acceptable Answers	Reject	Mark
4(e)	<p>To avoid contamination (of the distillate) with 3-methylbutan-1-ol / unreacted alcohol (1) IGNORE Ethanoic acid Water</p> <p>(Because) the boiling temperature of 3-methylbutan-1-ol is lower (than that of 3-methylbutyl ethanoate) ALLOW 131°C for lower</p> <p>OR</p> <p>(The distillate) would contain a lower yield of 3-methylbutyl ethanoate as its boiling temperature is 142°C/higher than 140°C (1) IGNORE 3-methylbutyl ethanoate will not be collected below 140°C</p> <p>If no other mark awarded, 'to obtain a pure product' or 'to avoid contamination with impurities' scores (1)</p>		(2)

Question Number	Acceptable Answers	Reject	Mark
4(f)(i)	<p>Correct answer with no working scores (3)</p> <p>First mark – calculating mass of 3-methylbutan-1-ol</p> <p>Mass 3-methylbutan-1-ol $= 0.81 \times 7.5 (= 6.075 \text{ (g)})$ (1)</p> <p>Second mark – calculating moles of 3-methylbutan-1-ol</p> <p>Moles 3-methylbutan-1-ol $= 6.075/88.0 (= 0.069034)$ TE on mass (1)</p> <p>Third mark – calculating moles / theoretical mass of product and % yield</p> <p>EITHER</p> <p>Moles 3-methylbutyl ethanoate $= 4.75/130.0 = 0.036538$ and $\% \text{ yield} = 0.036538/0.069034 \times 100$ $= 52.928$ $= 53$ TE on moles 3-methylbutan-1-ol</p> <p>OR</p> <p>Theoretical mass 3-methylbutyl ethanoate $= 0.069034 \times 130.0$ $= 8.9744 \text{ (g)}$ TE on moles 3-methylbutan-1-ol and $\% \text{ yield} = 4.75/8.9744 \times 100$ $= 52.928$ $= 53$ (1)</p> <p>IGNORE SF except 1 SF throughout</p>	<p>>100%</p> <p>>100%</p>	(3)

Question Number	Acceptable Answers	Reject	Mark
4(f)(ii)	<p>(The reaction/esterification is) equilibrium/reversible</p> <p>ALLOW (The reaction) does not go to completion The ester product is (partially) hydrolysed</p> <p>IGNORE Any reference to side reactions/additional products/impurities</p> <p>IGNORE Any correct reason relating to the method of preparation/transfer losses</p>	<p>by NaHCO₃</p> <p>Water is a by-product</p>	(1)

(Total for Question 4 = 14 marks)

TOTAL FOR PAPER = 50 MARKS

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