

Interactive Example Candidate Responses

Paper 22 (May/June 2016), Question 4

Cambridge International AS & A Level Chemistry 9701

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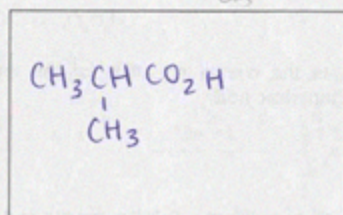
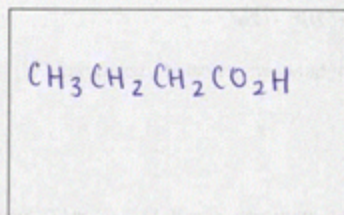
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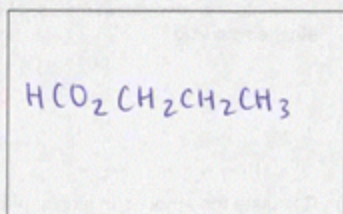
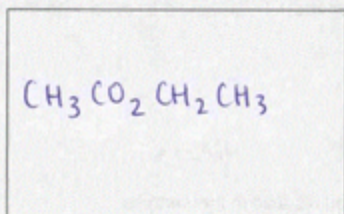
4 This question is about molecules with molecular formula $C_4H_8O_2$.

(a) Give the structural formulae of the pair of chain isomers with the formula $C_4H_8O_2$ that are carboxylic acids.



[2]

(b) (i) Give the structural formulae of a pair of positional isomers with the formula $C_4H_8O_2$ that are esters.



[2]

(ii) Give the reagents and conditions needed to produce one of your esters in (i).

one at Alcohol and carboxylic acid. Heat both of them under reflux with concentrated sulfuric acid.

[2]

Your
Mark

4(a)

4(b)(i)

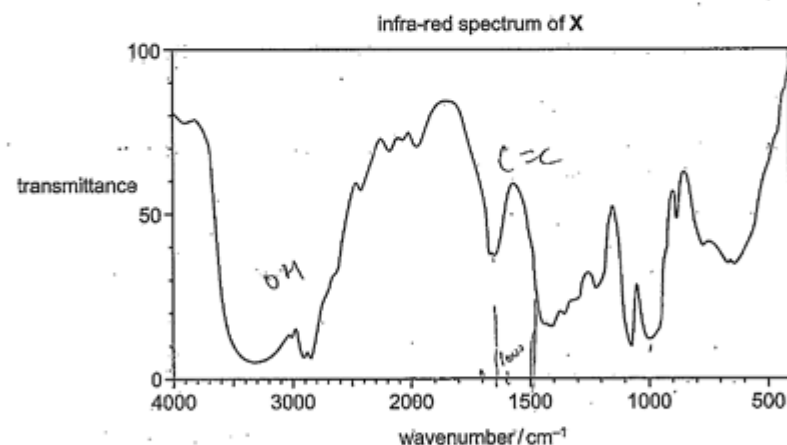
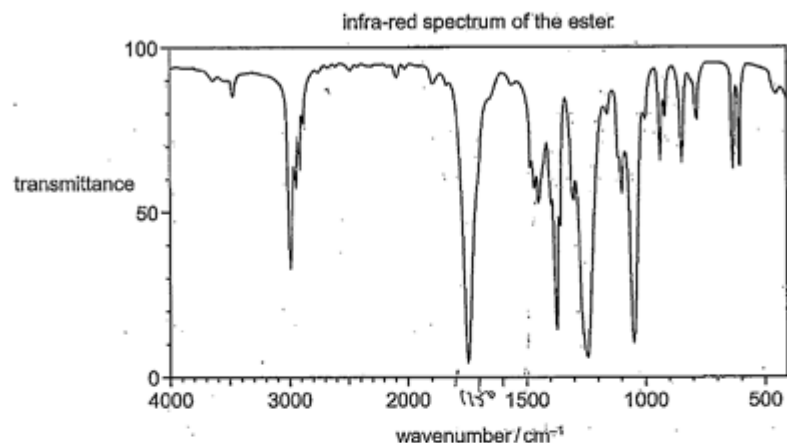
4(b)(ii)

4(c)

Q4	Mark scheme	
(a)	$CH_3CH_2CH_2COOH$ $(CH_3)_2CHCOOH$ / $CH_3CH(CH_3)COOH$	[1] [1] [2]
(b)(i)	Two from 1. $CH_3CH_2COOCH_3$ 2. $CH_3COOCH_2CH_3$ 3. $HCOOCH_2CH_2CH_3$	[max 2]
(b)(ii)	incorrect acid + alcohol for either ester 1. methanol + propanoic acid 2. ethanol + ethanoic acid 3. propan-1-ol + methanoic acid (conc) H_2SO_4 / (conc) H_3PO_4 AND heat / warm / reflux;	[1] [2]
(c)	Peak at 1710–1750 (for ester) due to $C(=O)$ Peak at 1500–1680 (for X) due to $C(=C)$ / alkene Peak at 3200–3650 (for X) due to (alcohol) $O(-)H$	[1] [1] [1] [3]
		[Total: 9]

(c) The infra-red spectra of one of the esters and of another isomer, X, are shown.

X decolourises bromine water and is not an ester or an acid.



Explain the differences between these two spectra, with particular reference to the peaks with wavenumbers above 1500 cm⁻¹.

In ester's spectrum, there is one sharp and strong peak at 1750 cm⁻¹. It means there is -C=O group.

In X's spectrum, there is one weak peak at approximately at 1650 cm⁻¹ and one broad peak between 3200-3600 cm⁻¹.

That means there is C=C and OH group in X.

[Total: 9]

Your
Mark

4(a)

4(b)(i)

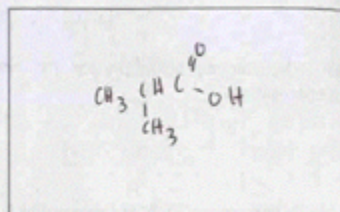
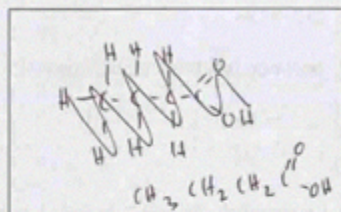
4(b)(ii)

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Q4	Mark scheme	
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(b)(ii)	incorrect acid + alcohol for either ester 1. methanol + propanoic acid 2. ethanol + ethanoic acid 3. propan-1-ol + methanoic acid (conc)H ₂ SO ₄ / (conc)H ₃ PO ₄ AND heat / warm / reflux;	[1] [2]
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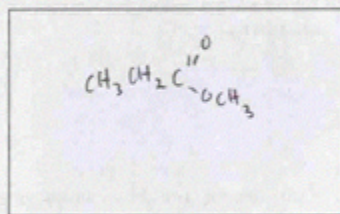
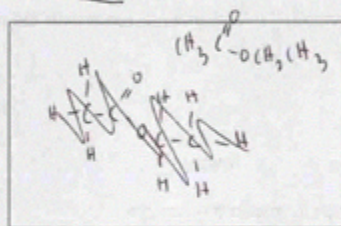
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- (a) Give the structural formulae of the pair of **chain** isomers with the formula $C_4H_8O_2$ that are carboxylic acids.



[2]

- (b) (i) Give the structural formulae of a pair of **positional** isomers with the formula $C_4H_8O_2$ that are esters.



[2]

- (ii) Give the reagents and conditions needed to produce one of your esters in (i).

Reagents: Ethanol and Ethanoic acid, heat or reflux.

[2]

Your
Mark

4(a)

4(b)(i)

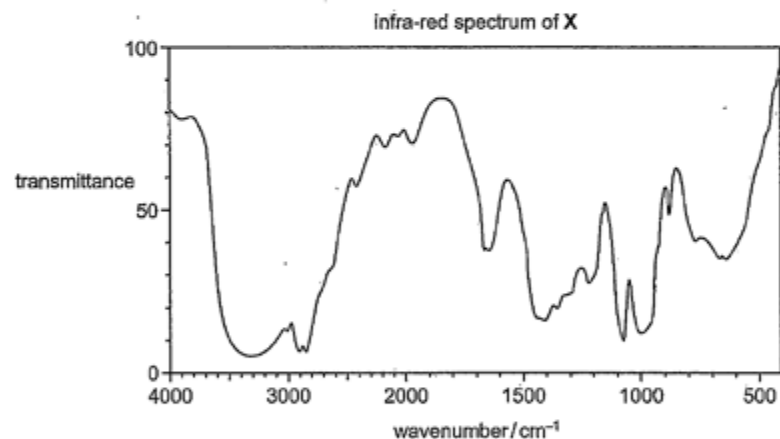
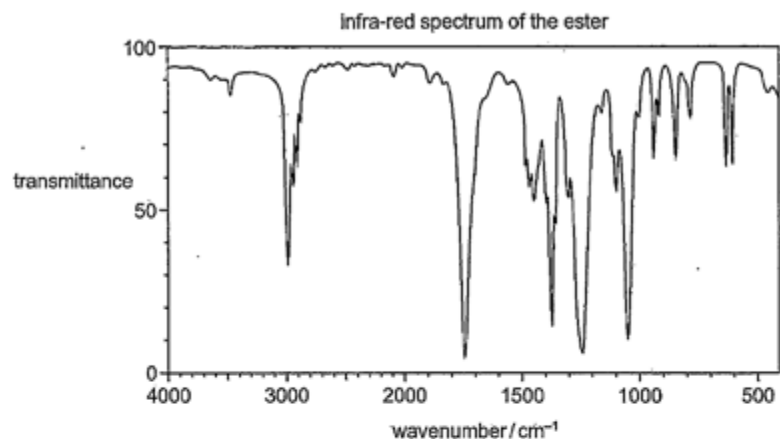
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(c) The infra-red spectra of one of the esters and of another isomer, X, are shown.

X decolourises bromine water and is not an ester or an acid.



Explain the differences between these two spectra, with particular reference to the peaks with wavenumbers above 1500 cm⁻¹.

The shape of peak on infra-red spectrum of ester is weak while the shape of peak on infra-red spectrum of X is strong and broad between wavenumbers 3200-3600 cm⁻¹. The shape of peak on infra-red spectrum of ester is weak while shape of peak on infra-red spectrum of X is strong and broad between wave numbers 1600-1700 cm⁻¹ which shows X contain an alkene.

[Total: 9]

Your
Mark

4(a)

4(b)(i)

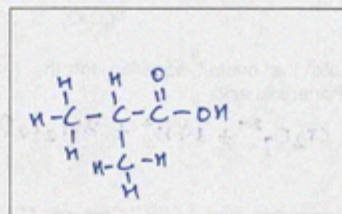
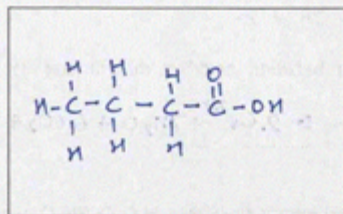
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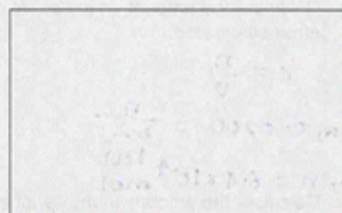
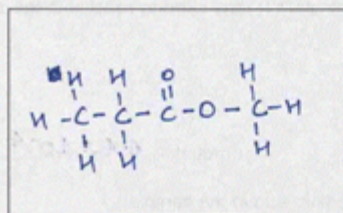
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[2]

- (b) (i) Give the structural formulae of a pair of **positional** isomers with the formula $C_4H_8O_2$ that are esters.



[2]

- (ii) Give the reagents and conditions needed to produce one of your esters in (i).

when carboxylic acid is added to ethanol in warm condition it gives ester.

condition: 70°C / warm

Reagent: Alcohol

[2]

Your
Mark

4(a)

4(b)(i)

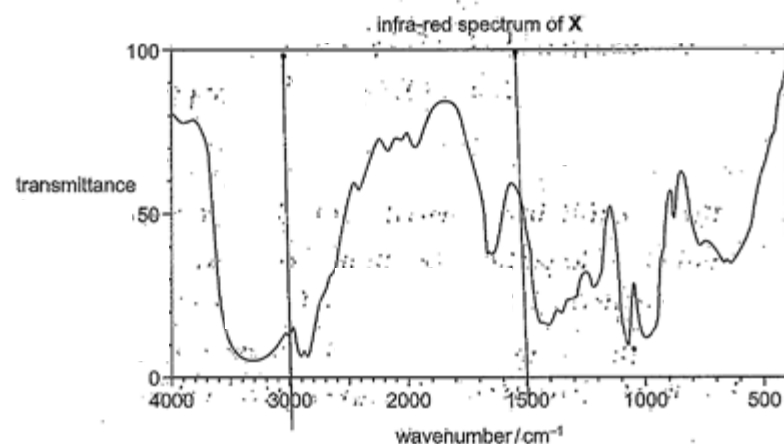
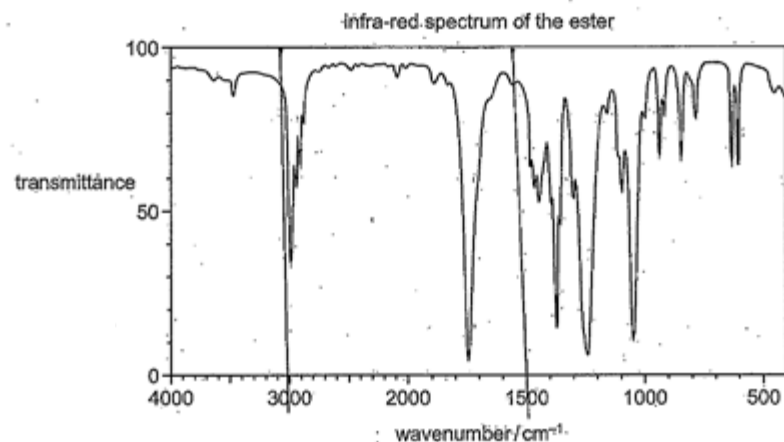
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X decolourises bromine water and is not an ester or an acid.



Explain the differences between these two spectra, with particular reference to the peaks with wavenumbers above 1500 cm⁻¹.

There is a peak at around 1720, which is strong shows that there is ester group. Similarly a weak peak at the X shows that that is an aromatic compound or alkene. There is a double bond in second figure. Both the compounds contain alkanes group.

[Total: 9]

Your
Mark

4(a)

4(b)(i)

4(b)(ii)

4(c)

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