A Level OCR Chemistry

Chapter 14 – answers

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
Spec reference</th></tr>
<tr><td>1(a)</td><td>Aldehyde
There is a peak at 1750 cm^{-1} for C=O and no broad peak between 2500 and 3300 cm^{-1} for OH

Carboxylic acid
It has the C=O peak at 1750 cm^{-1} and there is a broad peak between 2500-3300 for OH of carboxylic acid

Alcohol
There is a peak at 3200-3600 cm^{-1} and there is no peak at 1750 cm^{-1}</td><td>The unit cm^{-1} is not essential

Allow: no peak at 3200-3600 cm^{-1}</td><td>1
1

1
1

1
1</td><td>AO1
4.2.4c</td></tr>
<tr><td>1(b)</td><td>Reflux
Excess acidified dichromate</td><td>Not distil</td><td>1
1</td><td>AO1
4.2.1c</td></tr>
<tr><td>1(c)</td><td>The peak between 3200 and 3600 cm^{-1} reduces/disappears and a (sharp) peak at 1630-1820 cm^{-1} appears
As the alcohol is converted into an aldehyde
Then a broad peak appears between 2500-3300
As the aldehyde is converted to a carboxylic acid</td><td>

Allow as CH_2OH changes to CHO

Allow as CHO changes to COOH</td><td>1
1
1
1
1</td><td>AO2
4.2.4c</td></tr>
<tr><td>2(a)</td><td><table><tr><th></th><th>Carbon</th><th>Hydrogen</th><th>Oxygen</th></tr><tr><td>Number of moles</td><td>62.1/12</td><td>10.3/1</td><td>27.6/16</td></tr><tr><td>Relative number of atoms</td><td>5.18/1.72 = 3</td><td>10.3/1.72 = 6</td><td>1.73/1.72 = 1</td></tr></table>The empirical formula = C_3H_6O</td><td>The layout of the solution is not essential</td><td>1

1</td><td>AO1
2.1.3b</td></tr>
<tr><td>2(b)</td><td>-COOH / carboxyl
There is a sharp peak at 1630-1820 cm^{-1} for C=O
and a broad peak at 2500-3300 cm^{-1} for OH in COOH group</td><td>If they just give the formula or name it then just 1 mark</td><td>
1
1</td><td>AO2
4.2.4c</td></tr>
</table>

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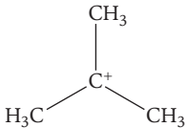
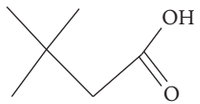
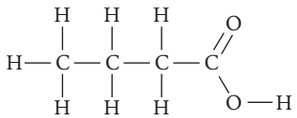
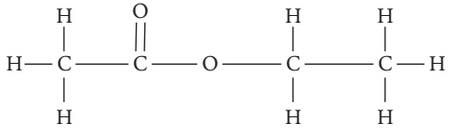
2(c)	The molecular mass = 116 because the molecular ion peak is at 116 The empirical formula (C_3H_6O) mass = 36 + 6 + 16 = 58. Therefore: Molecular formula = 2 × Empirical formula Molecular formula = $C_6H_{12}O_2$	Accept M^+ peak	1 1	AO2 4.2.4f 4.2.4g
2(d)(i)	The mass of carbocation =57 i.e. $C_4H_9^+$ Therefore, carbocation is  For fragment where *m/z* = 59: the compound is a carboxylic acid and contains the COOH group which has mass of 45. Therefore the remainder of the carbocation has mass of 14 i.e. CH_2 Carbocation is $^+CH_2COOH$	 Accept $(CH_3)_3C^+$ owtte	1 1 1 1	AO3 4.2.4g 4.2.4h
2(d)(ii)	A is $(CH_3)_3CCH_2COOH$ 		1	AO3 4.2.4h
3(a)(i)	Butanoic acid  Ethyl ethanoate 	Bond angles are not important in these	1 1	AO1 6.1.3c

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<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
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<tr><td>3(a)(ii)</td><td>They both have a peak at 1750cm^{-1} because of the C=O group
The butanoic acid has a broad peak between 2500 and 3300 cm^{-1} because of its OH group. Ethyl ethanoate has no such peak (has no -OH group).</td><td></td><td>1
1</td><td>AO2
4.2.4c</td></tr>
<tr><td>3(b)</td><td>Reflux ethanol with excess acidified (potassium) dichromate solution
to give ethanoic acid.
$CH_3CH_2OH + 2[O] \rightarrow CH_3COOH + H_2O$
Reflux the ethanoic acid with ethanol
In the presence of an acid catalyst
$CH_3CH_2OH + CH_3COOH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$</td><td>As long as they don't say all of the ethanol

Heat will be sufficient instead of reflux
Alternatively either HCl or H_2SO_4 will do
The reversible arrows are not essential.</td><td>1
1
1
1
1</td><td>AO2
4.2.1c
6.1.3c</td></tr>
<tr><td>4(a)</td><td><table><tr><th></th><th>Carbon</th><th>Hydrogen</th><th>Oxygen</th></tr><tr><td>No. of moles</td><td>68.2/12</td><td>13.63/1</td><td>18.2/16</td></tr><tr><td>Relative number of atoms</td><td>5.68/1.14 = 5</td><td>13.63/1.14 = 12</td><td>1.14/1.14 = 1</td></tr></table>Empirical formula = $C_5H_{12}O$
Molecular mass/empirical formula mass = 88/88 = 1
Molecular formula = empirical formula = $C_5H_{12}O$</td><td></td><td>1

1

1</td><td>AO1
2.1.3b
4.2.4f</td></tr>
<tr><td>4(b)(i)</td><td>The functional group is an alcohol because of the broad absorption between 3200 and 3600 cm^{-1}</td><td>'Alcohol' is enough for the mark.
Allow OH/hydroxyl
NOT hydroxide</td><td>1</td><td>AO1
4.2.4d; 4.2.4h</td></tr>
</table>

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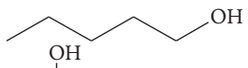
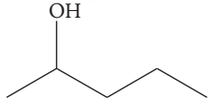
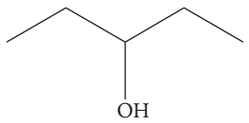
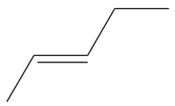
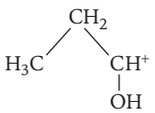
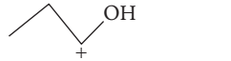
4(b)(ii)	 pentan-1-ol  pentan-2-ol  pentan-3-ol	Name and formula required. Do not accept any branched compounds	3	AO2 4.1.1b 4.1.1e
4(c)(i)	 E-pent-2-ene  Z-pent-2-ene	The isomers can be other way round each time	1 1	AO3 4.1.3c 4.1.1b and e
4(c)(ii)	Pentan-3-ol Pentan-1-ol will give just 1 product pent-1-ene Pentan-2-ol will give 3 products: pent-1-ene and the 2 *E*/*Z* isomers of pent-2-ene		1 1 1	AO3 4.2.1d 4.1.3c
4(d)		Variations are allowed but must have a 1+ charge e.g. 	1	AO3 4.2.4g
5(a)	COOH/carboxylic acid/carboxyl Has broad peak for -OH (2500-3300 cm^{-1}) and C=O (1700 cm^{-1})	Not carboxylate	1 1	AO1 4.2.4c

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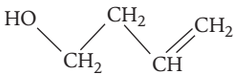
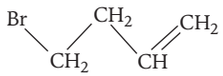
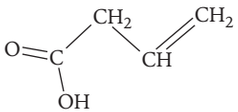
5(b)	In C – bromo group – pale cream ppt etc. with silver nitrate D is a primary alcohol because it gave a carboxylic acid when fully oxidised C, D (and E) contain C=C bond because they decolourised bromine water,	Reasons also required for each mark.	1 1 1	AO2 4.1.3c; 4.1.3f; 4.2.1a; 4.2.2a
5(c)	 D  C  E D must have the CH_2OH group in order to give -COOH in E This means that C must be a primary haloalkane C is unbranched and does not have E/Z isomers.	Allow variations on these e.g. $HOCH_2CH_2CH=CH_2$ D $BrCH_2CH_2CH=CH_2$ C $HOOCCH_2CH=CH_2$ E	1 1 1 1	AO3 4.1.3c; 4.1.3f; 4.2.1a; 4.2.2a
5(d)	$H_2C=CHCH_2CH_2Br + Br_2 \rightarrow CH_2BrCHBrCH_2CH_2Br$		1	AO2 4.2.2a; 4.2.1c
6(a)	C_6H_{12} some evidence of dividing by 12 to determine number of carbons but aware that there must be some hydrogens		1 1	AO2 2.1.3b

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Question	Answers	Extra information	Mark	AO Spec reference
6(b)(i)	G is an aldehyde Because it can be oxidised to a carboxylic acid The infrared spectra show that the product of oxidation is a carboxylic acid (peaks at 2500-3300 and 1750 cm^{-1}) It is ethanal Because its molecular ion peak is at $m/z = 44$ (mass of C_2H_4O)		1 1 1 1	AO3 4.2.4c; 6.1.2a
6(b)(ii)	H is a ketone Its infrared spectrum does not change after refluxing with acidified dichromate. It is butan-2-one This fits with M_r of 72 (C_4H_8O)	Ketones cannot be oxidised further using acidified dichromate	1 1 1 1	AO3 4.2.4c; 6.1.2a
6(c)	$CH_3CH=C(CH_3)CH_2CH_3$		1	AO3 4.1.3c

Skills box answers:

a) 6×10^9
b) 8×10^{11}
c) 6.025×10^9
d) 1.62×10^5
e) 2.18×10^{71}