A Level AQA Chemistry

Chapter 18 – answers

Question	Answers	Extra information	Mark	AO Spec reference
01.1	Figure 1 is the aldehyde –There is a peak at 1750 cm^{-1} for C═O And no broad peak between 2500 and 3300 cm^{-1} for OH Figure 2 is the carboxylic acid – it has the C═O peak at 1750 cm^{-1}. There is a broad peak between 2500–3300 for OH of carboxylic acid Figure 3 is the alcohol There is a peak at 3200–3600 cm^{-1} Or there is no peak at 1750 cm^{-1}.	The unit cm^{-1} is not essential Allow no peak at 3200–3600 cm^{-1} Ignore reference to C—H bonds	1 1 1 1 1 1	AO1 3.3.6.3
01.2	Reflux Excess acidified potassium dichromate	Reject dichromate on its own as a reagent was asked for	1 1	AO1 3.3.5.2
01.3	The peak between 3200 and 3600 cm^{-1} reduces/disappears (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	Allow as CH_2OH changes to CHO Allow as CHO changes to COOH	1 1 1 1 1	AO2 3.3.6.3
02.1	<table><tr><th></th><th>Carbon</th><th>Hydrogen</th><th>Oxygen</th></tr><tr><td>No. of moles</td><td>$\frac{62.1}{12}$</td><td>$\frac{10.3}{1}$</td><td>$\frac{27.6}{16}$</td></tr><tr><td>Relative number of atoms</td><td>$\frac{5.18}{1.72} = 3$</td><td>$\frac{10.3}{1.72} = 6$</td><td>$\frac{1.73}{1.72} = 1$</td></tr></table> The empirical formula = C_3H_6O		1 1	AO1 3.1.2.4
02.2	-COOH / carboxyl / carboxylic acid 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	If they just give the formula or name it then just 1 mark	1 1	AO2 3.3.6.3

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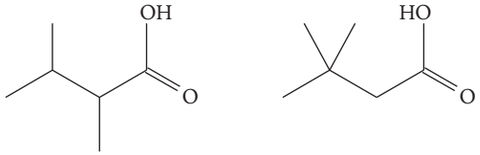
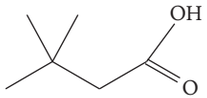
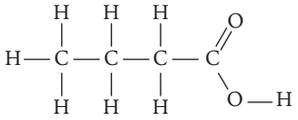
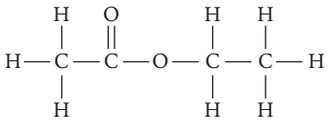
02.3	The molecular mass = 116 because the molecular ion peak is at 116 The empirical formula (C_3H_6O) mass = 36 + 6 + 16 = 58. Therefore, molecular formula = 2 × Empirical formula Molecular formula = $C_6H_{12}O_2$	Accept M^+ peak	1 1	AO2 3.3.6.2 3.1.2.4
02.4		1 mark for each	1 + 1	AO3 3.3.1.3
02.5	A is $(CH_3)_3CCH_2COOH$ The other isomer has a chiral carbon 		1 1	AO3 3.3.7
03.1	 Butanoic acid  Ethyl ethanoate	Bond angles are not important in these displayed formulae	1 1	AO1 3.3.9.1;

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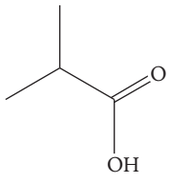
<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
Spec reference</th></tr>
<tr><td>03.2</td><td>They both have a peak at 1750 cm^{-1} because of the C=O group
The butanoic acid has a broad peak between 2500 and 3300 cm^{-1} because of its OH group. Ethyl ethanoate has no such peak (has no -OH group).</td><td></td><td>1
1</td><td>AO2
3.3.6.3</td></tr>
<tr><td>03.3</td><td> 
</td><td>Allow CH_3 groups</td><td>1</td><td>AO2
3.3.1.3</td></tr>
<tr><td>03.4</td><td>Add (solid) sodium hydrogencarbonate
If there is effervescence then the substance is the acid
$CH_3CH_2CH_2COOH + NaHCO_3 \rightarrow CH_3CH_2CH_2COO^-Na^+ + H_2O + CO_2$</td><td>Allow any carbonate or hydrogen carbonate
Or gas produced turns limewater cloudy</td><td>1
1
1</td><td>AO1
3.3.9.1</td></tr>
<tr><td>03.5</td><td>The intermolecular forces in butanoic acid include hydrogen bonds
These are stronger than the permanent dipole forces between the ethyl ethanoate molecules</td><td></td><td>1
1</td><td>AO2
3.3.9.1; 3.1.3.7</td></tr>
<tr><td>04.1</td><td><table><tr><td></td><td>Carbon</td><td>Hydrogen</td><td>Oxygen</td></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>

It must be clear, using m/z data, that em formula = mole formula.</td><td>

1
1

1</td><td>AO1
3.1.2.4</td></tr>
<tr><td>04.2</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
3.3.6.3</td></tr>
</table>

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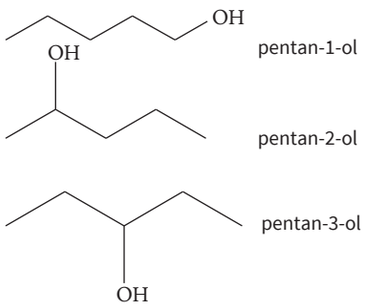
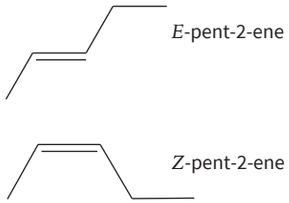
04.3	 pentan-1-ol pentan-2-ol pentan-3-ol	Name and formula required. Do not accept any branched compounds	1 1 1	AO2 3.3.1.3
04.4	 *E*-pent-2-ene *Z*-pent-2-ene	The isomers can be other way round each time	1 1	AO3 3.3.5.3 3.3.1.3
04.5	Pentan-3-ol Pentan-1-ol will give just 1 product - pent-1-ene Pentan-2-ol will give 3 products: pent-1-ene and the 2 *E-Z* isomers of pent-2-ene		1 1 1	AO3 3.3.5.3
05.1	-COOH/carboxylic acid/carboxyl Has broad peak for -OH (2500–3300 cm^{-1}) and C═O (1700 cm^{-1})	Not carboxylate	1 1	AO1 3.3.6.3
05.2	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 3.2.3.1; 3.3.3.1; 3.3.5.2; 3.3.4.2

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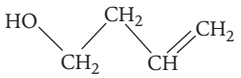
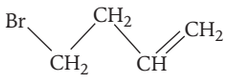
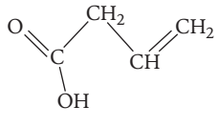
05.3	 **D**  **C**  **E** **D** must have the CH_2OH group in order to give -COOH in **E** This means that **C** must be a primary haloalkane	Allow variations on these e.g. $HOCH_2CH_2CH=CH_2$ **D** $BrCH_2CH_2CH=CH_2$ **C** $HOOCCH_2CH=CH_2$ **E**	1 1 1 1	AO3 3.2.3.1; 3.3.3.1; 3.3.5.2; 3.3.4.2
05.4	$H_2C=CHCH_2CH_2Br + Br_2 \rightarrow CH_2BrCHBrCH_2CH_2Br$		1	AO2 3.3.4.2
06.1	C_6H_{12} $6 \times 12 + 12 \times 1 = 84$ / M_r = molecular ion peak	Allow 84/12 working, but must be clear that some Hs needed etc.	1 1	AO2 3.1.2.4
06.2	**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 3.3.6.3; 3.3.8

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06.3	**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)		1 1 1 1	AO3 3.3.6.3; 3.3.8
06.4	$CH_3CH{=}C(CH_3)CH_2CH_3$		1	AO3 3.3.1.3; 3.3.4.1;

Skills box answers:

1. Cyclohexene.
   $C_6H_{10}(l) + Br_2(aq) \rightarrow C_6H_{10}Br_2(l)$
2. Cyclohexanecarboxylic acid
   $2C_6H_{11}COOH(l) + Na_2CO_3(aq) \rightarrow 2Na(C_6H_{11}COO)(aq) + H_2O(l) + CO_2(g)$
3. a. Cyclohexanone and cyclohexanol are flammable and should be kept away from naked flames.
   b. Fill a beaker with hot water / use a water bath. Place boiling tubes in water bath and leave to a few minutes.