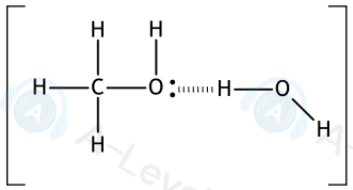
Question Number	Answer	Mark
4	**The only correct answer is D** ($CH_3(CH_2)_7CH_3$) ***A*** *is not correct because* $(CH_3)_4C$ *has fewer electrons and a branched carbon chain* ***B*** *is not correct because* $CH_3CH_2CH_2CH_2CH_3$ *has fewer electrons* ***C*** *is not correct because* $(C_2H_5)_4C$ *has a branched carbon chain*	**(1)**

Question Number	Answer
2(a)	**The only correct answer is B** (801) ***A*** *is incorrect because only one oxygen molecule has been included* ***C*** *is incorrect because only two O-H bonds have been included and only one oxygen molecule has been included* ***D*** *is incorrect because only two O-H bonds have been included*

Question Number	Answer
(b)	**The only correct answer is B** (+40) ***A*** *is incorrect because this is the value for the enthalpy change of condensation* ***C*** *is incorrect because this is the value for the enthalpy change of condensation for two moles of water* ***D*** *is incorrect because this is the value for the enthalpy change of vaporisation for two moles of water*

Question Number	Answer	Mark
8	**The only correct answer is B** ($BaCl_2$ and Ag_2SO_4) ***A*** *is not correct because in* ***B*** $BaSO_4(s)$ *is formed as well as* $AgCl(s)$ ***C*** *is not correct because no solid would form* ***D*** *is not correct because in* ***B*** $AgCl(s)$ *is formed as well as* $BaSO_4(s)$	**(1)**

Question number	Answer	Mark
7	**The only correct answer is A**  **B** *is incorrect because the O-----H─O bond angle should be 180°* **C** *is incorrect because the hydrogen atoms bonded to carbon atoms cannot form hydrogen bonds* **D** *is incorrect because the hydrogen atoms bonded to carbon atoms cannot form hydrogen bonds*	**(1)**

Question Number	Answer
11	**The only correct answer is A** (hexane) ***B*** *is not correct because pentane has a lower boiling temperature as it has fewer electrons* ***C*** *is not correct because 2-methylpentane has a lower boiling temperature as it is branched* ***D*** *is not correct because 2,3-dimethylbutane has a lower boiling temperature as it is branched*

5	**The only correct answer is D** (calcium > strontium > barium) ***A*** *is incorrect because barium sulfate is the least soluble / magnesium sulfate is the most soluble* ***B*** *is incorrect because magnesium sulfate is more soluble than calcium and strontium sulfates* ***C*** *is incorrect because calcium sulfate is more soluble than barium sulfate*

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th></tr>
<tr><td>*20</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).</td></tr>
</table>

	Indicative content	**Comment**: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning Allow use of molecular formulae throughout Ignore C–H absorptions	
	IP1 O–H bond (broad) absorption at ~3400 (cm^{-1})	Allow ranges between 3800-3000(cm^{-1}) Allow due to hydroxyl/alcohol	
	IP2 C=O absorption at 1740-1700(cm^{-1}) so cannot be butan-1-ol	Accept so can only be 1-hydroxypropanone or propenoic acid Ignore references to aldehydes	
	IP3 M^+ has an m/z value of 74 so could be 1-hydroxypropanone **or** butan-1-ol **(**propenoic acid has a M^+ value of 72)		
	IP4 base / most abundant peak has an m/z value of 43 so could be $CH_3CO^{(+)}$ / $C_3H_7^{(+)}$	Allow $CCH_2OH^{(+)}$ Ignore other proposed base peaks Do not award negatively charged fragments	
	IP5 no C=C absorption on IR spectra at 1669-1645(cm^{-1}) **or** O–H peak absorbance too high for acid (so not propenoic acid)	Allow propenoic acid would have a(n additional) peak at 1669-1645(cm^{-1}) Allow a range from 3300-2500(cm^{-1})	
	IP6 so the substance is 1-hydroxypropanone, (not propenoic acid or butan-1-ol)	Allow a correct structure	

(Total for Question 20 = 6 marks)

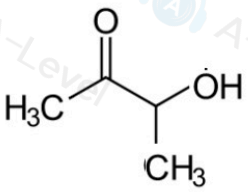
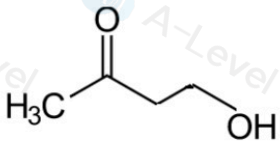
TOTAL FOR SECTION B = 40 MARKS

Question Number	Answer		Additional Guidance	Mark
20(a)(i)	• calculation of percentage of oxygen	(1)	Example of calculation 100 – 54.5 – 9.1 = 36.4 (%)	(3)
	• calculation of **moles** of C, H and O in 100 g	(1)	C = 54.5/12 = 4.5417 H = 9.1/1 = 9.1 O = 36.4/16 = 2.275	
	• (divide by the lowest number to get the ratio) **and** correct empirical formula	(1)	O: 2.275/2.275 = 1 H: 9.1/2.275 = 4 C: 4.5417/2.275 = 1.9964 C_2H_4O	

Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	• C_2H_4O = 44 $88 \div 44 = 2$ **and** molecular formula = $C_4H_8O_2$	Allow any suitable use of 44 e.g. $2 \times 44 = 88$ Allow $88 \div (2 \times 12 + 4 + 16)$ No TE from (a)(i)	(1)

Question Number	Answer		Additional Guidance	Mark
20(b)(i)	An answer that makes reference to the following points:			(3)
	• (acetoin reacted with PCl_5) so must) contain an OH group	(1)	Allow contains and alcohol or a carboxylic acid Ignore hydroxyl group Do not award it just alcohol or carboxylic acid are stated on their own	
	• (acetoin did not react with sodium hydrogencarbonate so) it is not a carboxylic acid / it is an alcohol	(1)	Allow not COOH Allow not a tertiary alcohol	
	• (acetoin reacted with potassium dichromate(VI) solution so must) contain a 1° or 2° alcohol	(1)	Allow an alcohol that can be oxidised	

Question Number	Answer			Additional Guidance	Mark
20(b)(ii)		Bond	Wavenumber range / cm^{-1}	Both bond and wavenumber range required for each mark	(3)
	Absorption present in acetoin but not in an aldehyde	C=O	1720-1700	Do not award 1700 – 1680	(1)
	One absorption present in an aldehyde but not in acetoin	C=O Or C-H	1740-1720 2900-2820 or 2775-2700	Allow boxes 2 and 3 to both contain the C-H bond but different wave numbers	(1)
	Another absorption present in an aldehyde but not in acetoin	C-H	2900-2820 or 2775-2700	The full range is required as they are quoting from the data book. Ranges can be reversed d e.g. 1700-1720	(1)

Question Number	Answer		Additional Guidance	Mark
20(b)(iii)	An answer that makes reference to the following points:			(3)
	• (peak at 45) CH_3CHOH^+/ $CH_2CH_2OH^+$/$C_2H_4OH^+$/$C_2H_5O^+$	(1)	Allow displayed/ skeletal/ molecular Do not award $CH_3CH_2O^+$	
	• (peak at 43) CH_3CO^+/ $C_2H_3O^+$	(1)	Do not award $C_3H_7^+$ Do not award CH_2COH^+/ CH_2CHO^+ Penalise missing + once only	
	• a structure consistent with these peaks  	(1)	Penalise wrong connectivity to the OH- only when horizontal and only once.	

(Total for Question 20 = 13 marks)