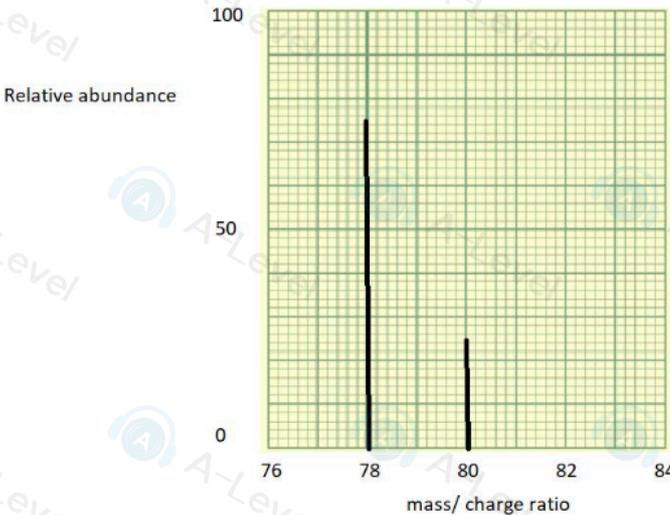


Question Number	Answer	Mark
19	<p><b>The only correct answer is C</b> (further substitution products are formed)</p> <p><i>A is not correct because this is not true</i>  <i>B is not correct because ultraviolet radiation is used in industrial reactions</i>  <i>D is not correct because termination products are formed in low concentrations</i></p>	(1)

Question Number	Answer	Mark
18	<p><b>The only correct answer is D</b> (<math>C_3H_7^\bullet + HCl \rightarrow C_3H_7Cl + H^\bullet</math>)</p> <p><i>A is not correct because this is a termination step in the reaction</i>  <i>B is not correct because this is a termination step in the reaction</i>  <i>C is not correct because this is a propagation step in the reaction</i></p>	(1)

Question Number	Answer	Mark
14	<p><b>The only correct answer is A</b> (<math>R-O-O-R \rightarrow 2R-O^\bullet</math>)</p> <p><i>B is incorrect because in this step a radical and a molecule form a radical so this is a propagation step</i>  <i>C is incorrect because in this step two radicals from a molecule, so this is a termination step</i>  <i>D is incorrect because in this step a radical and a molecule form a radical so this is a propagation step</i></p>	(1)

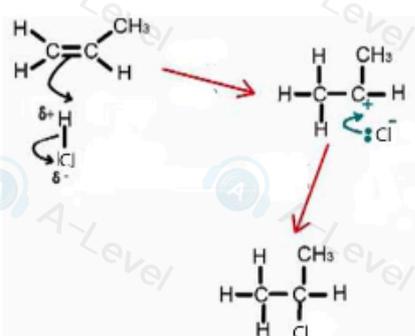
Question Number	Answer	Mark
15	<p><b>The only correct answer is C</b> (<math>CH_3^\bullet + H^\bullet \rightarrow CH_4</math>)</p> <p><i>A is incorrect because methyl free radicals are present</i>  <i>B is incorrect because the chlorine free radical and the methyl free radical are present</i>  <i>D is incorrect because chlorine free radicals are present</i></p>	(1) <b>Computer</b>

Question Number	Answer	Additional Guidance	Mark
19(a)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>two peaks at 78 and 80</li> <li>peak at 78, 3 x higher than peak at 80</li> </ul> 	<p>(1) If there are more than 2 peaks score 0</p> <p>(1) Allow within 1 small square</p> <p>If the peaks are wrong but the lower mass/ charge one is 3x higher than the other, M2 can be scored as a TE.</p> <p>Ignore any labels on the peaks</p>	(2)

Question Number	Answer	Additional Guidance	Mark
19(b)(i)	<p>An answer that makes reference to the following points:</p>  <ul style="list-style-type: none"> <li>diagram showing curly half-arrows forming 2 free radicals (1)</li> <li>uv (radiation / light) or sunlight (1)</li> </ul>	<p>Both arrows can come from the same side of the bond</p> <p>Ignore just light</p>	(2)

Question Number	Answer	Additional Guidance	Mark
19(b)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>homolytic: each atom gets one electron/ the electron pair splits evenly (1)</li> <li>free radical: species with an unpaired electron (1)</li> </ul>	<p>Allow equal splitting of the electrons (in the bond)</p> <p>Allow atom/ element</p> <p>Allow lone electron</p> <p>Ignore free electron</p>	(2)

Question Number	Answer	Additional Guidance	Mark
19(b)(iii)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>multiple substitutions can occur/ more than one (organic) product</li> </ul>	<p>Allow more products formed//more waste products            Allow termination products            Allow side products/reactions            Allow further reactions</p> <p>Ignore chain reaction            Ignore poor yield/atom economy            Ignore forms impurities            Ignore references to HCl being formed/toxic</p>	(1)

Question Number	Answer	Additional Guidance	Mark
19(c)(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>1 dipole on H-Cl</li> <li>2 curly arrow from H-Cl bond to Cl<math>\delta^-</math></li> <li>3 curly arrow from double bond to H(<math>\delta^+</math>)</li> <li>4 correct carbocation intermediate</li> <li>5 curly arrow from lone pair on Cl</li> <li>6 arrow to C<math>^+</math> on intermediate</li> <li>7 charge on chloride ion</li> </ul> <p>All 7 marking points score 4 marks, 5/6 points score 3 marks, 3/4 points score 2, 2 points score 1 mark</p>	 <p>Arrows must start from the covalent bond or lone pair            From the H-Cl bond it must go to the Cl or beyond.            From the C=C bond it must go to the H or in the space.            From the lone pair on the Cl it must go to the C<math>^+</math> on the intermediate.            If wrong alkene used just penalise 1 marking point.            If primary carbocation is formed just penalise marking point 4            If half curly arrows used penalise 1 marking point            If HBr/HI used penalise 1 marking point</p>	(4)

Question Number	Answer	Additional Guidance	Mark
19(c)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• (the formation of 1-chloropropane goes via a) primary carbocation</li> <li>• (which is) less stable than the secondary carbocation (formed when of 2-chloropropane is produced)</li> </ul>	<p>(1) Do not award 1-chloropropane is a primary carbocation or 2-chloropropane is a secondary carbocation but only penalise once,</p> <p>(1) Allow the correct comparison between a tertiary and primary or secondary carbocation for 1 mark Allow reverse argument</p>	(2)

(Total for Question 19 = 13 marks)

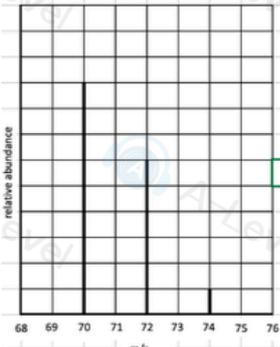
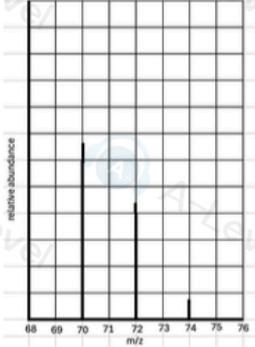
Question Number	Answer	Additional Guidance	Mark
22(a)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li>free-radical substitution reaction</li> </ul>		(1)

Question Number	Answer	Additional Guidance	Mark
22(b)(i)	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>a balanced equation</li> <li>a pair of single headed arrows (fish hooks) on the <math>\text{Cl}-\text{Cl}</math> bond in the reactant</li> </ul>	<p>(1) <math>\text{Cl}-\text{Cl} \longrightarrow 2\text{Cl}\cdot</math> Do not award charges</p> <p>(1) <math>\text{Cl} \begin{array}{c} \curvearrowright \\ \curvearrowleft \end{array} \text{Cl} \longrightarrow 2\text{Cl}\cdot</math> Allow <math>\text{Cl} \begin{array}{c} \curvearrowleft \\ \curvearrowright \end{array} \text{Cl} \longrightarrow 2\text{Cl}\cdot</math></p>	(2)

Question Number	Answer	Additional Guidance	Mark
22(b)(ii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>first propagation</li> <li>second propagation</li> </ul>	<p>The radical could be anywhere on the organic materials</p> <p>(1) <math>\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 + \text{Cl}\cdot \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\cdot + \text{HCl}</math> Allow <math>\text{C}_4\text{H}_{10} + \text{Cl}\cdot \rightarrow \text{C}_4\text{H}_9\cdot + \text{HCl}</math></p> <p>(1) <math>\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl} + \text{Cl}\cdot</math> Allow <math>\text{C}_4\text{H}_9\cdot + \text{Cl}_2 \rightarrow \text{C}_4\text{H}_9\text{Cl} + \text{Cl}\cdot</math></p> <p>Penalise use of incorrect alkane once only</p>	(2)

Question Number	Answer	Additional Guidance	Mark
22(b)(iii)	An answer that makes reference to the following point: <ul style="list-style-type: none"> <li>termination step fusion of two butyl radicals</li> </ul>	<p><math>\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\cdot + \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\cdot \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3</math></p> <p>Allow <math>\text{C}_4\text{H}_9\cdot + \text{C}_4\text{H}_9\cdot \rightarrow \text{C}_8\text{H}_{18}</math></p> <p>Do not award if charges are shown</p>	(1)

Question Number	Answer	Additional Guidance	Mark
22(c)	<p>Method</p> <ul style="list-style-type: none"> <li>calculation of moles of butane</li> <li>calculation of theoretical mass of trichlorobutane</li> <li>% yield</li> </ul> <p>Alternative method</p> <ul style="list-style-type: none"> <li>calculation of moles of butane</li> <li>calculation of actual moles of trichlorobutane</li> <li>% yield <math>((M_2/M_1) \times 100)</math></li> </ul>	<p><u>Example of calculation</u></p> <p>(1) <math>10/58 = 0.17241</math> mol butane</p> <p>(1) mol trichlorobutane <math>0.17241 \times 161.5 = 27.844(\text{g})</math></p> <p>(1) <math>1/27.844 \times 100 = 3.591\%</math></p> <p>(1) <math>10/58 = 0.17241</math> mol butane</p> <p>(1) <math>1/161.5 = 6.19195 \times 10^{-3}</math></p> <p>(1) <math>[6.19195 \times 10^{-3} / 0.17241] \times 100 = 3.591\%</math></p> <p>TE throughout, but final answer must be less than 100% Correct answer with some working scores 3 Ignore SF except for 1 SF</p>	(3)

Question Number	Answer	Additional Guidance	Mark
22(d)	<p>An answer that makes reference to the following points:</p>  <ul style="list-style-type: none"> <li>3 lines drawn at 70, 72, 74</li> <li>ratio 9 (at 70):6 (at 72):1 (at 74)</li> </ul>	 <p>(1)</p> <p>(1) Accept 56.25% (5.6 squares) : 37.5% (3.8 squares) : 6.25% (0.6 squares) assuming 1 square is 10%</p>	(2)

(Total for Question 22 = 11 marks)