



# Mark Scheme (Results)

October 2022

Pearson Edexcel International Advanced  
Subsidiary Level  
In Chemistry (WCH11)  
Paper 01: Structure, Bonding and Introduction  
to Organic Chemistry

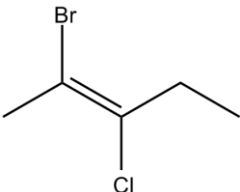
**Section A (multiple choice)**

Question Number	Correct Answer	Mark
<b>1</b>	<p><b>The only correct answer is A</b> (iron and copper(II) sulfate solution)</p> <p><i>B is incorrect because the reaction is a precipitation</i></p> <p><i>C is incorrect because the reaction is a neutralisation</i></p> <p><i>D is incorrect because there is no reaction</i></p>	<b>1</b>

Question Number	Correct Answer	Mark
<b>2</b>	<p><b>The only correct answer is D</b> (silver nitrate solution and potassium bromide solution)</p> <p><i>A is incorrect because the reaction is a neutralisation</i></p> <p><i>B is incorrect because there is no reaction</i></p> <p><i>C is incorrect because the reaction is a displacement</i></p>	<b>1</b>

Question Number	Correct Answer	Mark
<b>3</b>	<p><b>The only correct answer is C</b> (7,8,10)</p> <p><i>A is incorrect because this is the number of protons, electrons and neutrons in the <math>^{15}_7\text{N}</math> atom</i></p> <p><i>B is incorrect because this is the number of protons, electrons and neutrons in the <math>^{15}_7\text{N}^{3+}</math> ion</i></p> <p><i>D is incorrect because it the numbers of protons and neutrons have been reversed</i></p>	<b>1</b>

Question Number	Correct Answer	Mark
4	<p>The only correct answer is D (9)</p> <p><i>A is incorrect because it is the number of occupied quantum shells</i></p> <p><i>B is incorrect because it is the number of occupied subshells</i></p> <p><i>C is incorrect because the electrons in the 3p subshell have been paired before each orbital is occupied</i></p>	1

Question Number	Correct Answer	Mark
5	<p>The only correct answer is A</p>  <p><i>B is incorrect because it is Z-2-bromo-3-chloropent-2-ene</i></p> <p><i>C is incorrect because it is E-3-bromo-2-chloropent-2-ene</i></p> <p><i>D is incorrect because it is E-4-bromo-3-chloropent-2-ene</i></p>	1

Question Number	Correct Answer	Mark
6(a)	<p>The only correct answer is C (it is toxic at low concentrations)</p> <p><i>A is incorrect because CO does not form an acid in the atmosphere</i></p> <p><i>B is incorrect because CO does not strongly absorb infrared radiation</i></p> <p><i>D is incorrect because CO is not the main cause of ozone layer depletion</i></p>	1

Question Number	Correct Answer	Mark
6(b)	<p><b>The only correct answer is D (120)</b></p> <p><i>A is incorrect because it is the volume of butane that has not reacted</i></p> <p><i>B is incorrect because it is the total volume of reactants</i></p> <p><i>C is incorrect because it is the total volume of products</i></p>	1

Question Number	Correct Answer	Mark
7(a)	<p><b>The only correct answer is A (to break the Br-Br bond only)</b></p> <p><i>B is incorrect because the energy of ultraviolet radiation is insufficient to break a C–H bond</i></p> <p><i>C is incorrect because the energy of ultraviolet radiation is insufficient to break a C–C bond</i></p> <p><i>D is incorrect because the energy of ultraviolet radiation is insufficient to break a C–H bond</i></p>	1

Question Number	Correct Answer	Mark
7(b)	<p><b>The only correct answer is D (propagation, homolytic)</b></p> <p><i>A is incorrect because initiation would not have a free radical reactant and heterolytic bond breaking would form ions</i></p> <p><i>B is incorrect because initiation would not have a free radical reactant</i></p> <p><i>C is incorrect because heterolytic bond breaking would form ions</i></p>	1

Question Number	Correct Answer	Mark
7(c)	<p><b>The only correct answer is B</b> (<math>\text{C}_8\text{H}_{18} + \text{Br}_2 \rightarrow \text{C}_8\text{H}_{17}\text{Br} + \text{HBr}</math>)</p> <p><i>A is incorrect because hydrogen is not formed in the reaction</i></p> <p><i>C is incorrect because the carbon chain does not break in the reaction</i></p> <p><i>D is incorrect because the carbon chain does not break in the reaction and a C=C double bond does not form</i></p>	1

Question Number	Correct Answer	Mark
8	<p><b>The only correct answer is D</b> (<math>\text{CH}_2\text{Cl}_2</math>)</p> <p><i>A is incorrect because <math>\text{C}_5\text{H}_{12}</math> is non-polar</i></p> <p><i>B is incorrect because although <math>\text{CCl}_4</math> has polar bonds it does not have a dipole moment</i></p> <p><i>C is incorrect because although <math>\text{BCl}_3</math> has polar bonds it does not have a dipole moment</i></p>	1

Question Number	Correct Answer	Mark
9	<p><b>The only correct answer is D</b> (54.2)</p> <p><i>A is incorrect because the volume has been divided by the density rather than multiplied</i></p> <p><i>B is incorrect because the volume has been divided by the density, then divided by the atomic number</i></p> <p><i>C is incorrect because the volume has been divided by the relative atomic mass</i></p>	1

Question Number	Correct Answer	Mark
10(a)	<p><b>The only correct answer is B (region Q)</b></p> <p><i>A is incorrect because region P denotes where ionisation takes place</i></p> <p><i>C is incorrect because region R denotes where deflection takes place</i></p> <p><i>D is incorrect because region S denotes where detection takes place</i></p>	1

Question Number	Correct Answer	Mark
10(b)	<p><b>The only correct answer is B (<math>^{54}\text{Fe}^{2+}</math>)</b></p> <p><i>A is incorrect because it has the same mass but a smaller charge than <math>^{54}\text{Fe}^{2+}</math></i></p> <p><i>C is incorrect because it has a larger mass and a smaller charge than <math>^{54}\text{Fe}^{2+}</math></i></p> <p><i>D is incorrect because it has a larger mass than <math>^{54}\text{Fe}^{2+}</math></i></p>	1

Question Number	Correct Answer	Mark
10(c)	<p><b>The only correct answer is C (3)</b></p> <p><i>A is incorrect because it assumes that all chlorine molecular ions have the same mass</i></p> <p><i>B is incorrect because it assumes that all chlorine molecules only form between atoms of the same mass</i></p> <p><i>D is incorrect because it assumes that <math>^{35}\text{Cl} - ^{37}\text{Cl}</math> and <math>^{37}\text{Cl} - ^{35}\text{Cl}</math> are not identical</i></p>	1

Question Number	Correct Answer	Mark
11(a)	<p><b>The only correct answer is B</b> (element V)</p> <p><i>A is incorrect because in element U each p orbital contains a single electron</i></p> <p><i>C is incorrect because in element W two p orbitals contain electron pairs</i></p> <p><i>D is incorrect because in element X three p orbitals contain electron pairs</i></p>	1

Question Number	Correct Answer	Mark
11(b)	<p><b>The only correct answer is B</b> (element X)</p> <p><i>A is incorrect because element S is in Group 3</i></p> <p><i>C is incorrect because element Y is in Group 1</i></p> <p><i>D is incorrect because element Z is in Group 2</i></p>	1

Question Number	Correct Answer	Mark
11(c)	<p><b>The only correct answer is D</b> (element Y)</p> <p><i>A is incorrect because in element S the second electron is not removed from an inner shell</i></p> <p><i>B is incorrect because in element T the second electron is not removed from an inner shell</i></p> <p><i>C is incorrect because in element X the second electron is not removed from an inner shell</i></p>	1

Question Number	Correct Answer	Mark
12	<p><b>The only correct answer is C (0.0654)</b></p> <p><i>A is incorrect because this is the moles of hydrated copper(II) sulfate used</i></p> <p><i>B is incorrect because this is the moles of anhydrous copper(II) sulfate used</i></p> <p><i>D is incorrect because the 5H<sub>2</sub>O are not included in the molar mass</i></p>	1

Question Number	Correct Answer	Mark
13	<p><b>The only correct answer is A (5.65)</b></p> <p><i>B is incorrect because the yield of 95% has not been used</i></p> <p><i>C is incorrect because the 2:1 ratio in the equation has not been used</i></p> <p><i>D is incorrect because the yield of 95% and the 2:1 ratio in the equation have not been used</i></p>	1

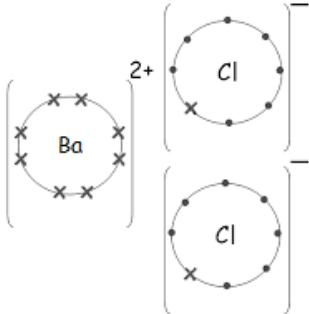
**Total for Section A = 20 marks**



## Section B

Question Number	Correct Answers	Additional Guidance	Mark
14(a)(i)	$\text{Ba}^{2+}(\text{g}) \rightarrow \text{Ba}^{3+}(\text{g}) + \text{e}^{-}$ <p>OR</p> $\text{Ba}^{2+}(\text{g}) - \text{e}^{-} \rightarrow \text{Ba}^{3+}(\text{g})$	<p>Allow <math>\text{e}^{-}(\text{g})</math> / <math>1\text{e}^{-}</math></p> <p>Do not award multiples</p> <p>Allow ions shown as <math>\text{Ba}^{+2}(\text{g})</math> and <math>\text{Ba}^{+3}(\text{g})</math></p> <p>Allow <math>\text{Ba}^{++}</math> / <math>\text{Ba}^{+++}</math></p> <p>Comment – allow lower case ‘ba<sup>2+</sup>’ etc</p>	1

Question Number	Correct Answers	Additional Guidance	Mark
14(a)(ii)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>there is a <b>large</b> increase (in ionisation energy)</li> </ul> <p><b>and</b></p> <ul style="list-style-type: none"> <li>between the 2<sup>nd</sup> and 3<sup>rd</sup> ionisations</li> </ul>	<p>Note – there must be some indication of a significant increase</p> <p>Allow just there is a jump</p> <p>Allow ‘after 2 electrons are removed’ / between the 2<sup>nd</sup> and 3<sup>rd</sup> electrons</p> <p>Ignore comments related to first ionisation energy</p>	1

Question Number	Acceptable Answers	Additional Guidance	Mark
14(b)(i)	<p>An answer that makes reference to one of the following points:</p> <ul style="list-style-type: none"> <li>barium ion shown correctly</li> <li>one chloride ion shown correctly <b>and</b> an indication of two chloride ions present</li> </ul> <p>example of dot-and-cross diagram</p> 	<p>(1) Allow barium ion with no electrons shown Allow lower case 'ba' Ignore any inner shells shown for Ba<sup>2+</sup></p> <p>(1) If inner shells shown for Cl<sup>-</sup> they must be correct</p> <p>Allow all dots or all crosses</p> <p>Ignore absence of square brackets</p> <p>Ignore any working</p> <p>Do not award covalent diagrams</p> <p>Comment If all charges are omitted, we assume the bonding is covalent so scores zero</p>	2

Question Number	Acceptable Answers	Additional Guidance	Mark
14(b)(ii)	<ul style="list-style-type: none"> <li>calculation of moles of barium chloride (1)</li> <li>calculation of mass of barium chloride to 2 or 3 SF (1)</li> </ul>	<p><u>Example of calculation</u></p> <p><math>0.200 \times (150 \div 1000) = 0.03 \text{ (mol)}</math> Ignore units in M1 even if incorrect</p> <p><math>0.03 \times 208.3 = 6.249</math>  <math>= 6.2 / 6.25 \text{ (g)}</math>  Do not award 6.3</p> <p>Ignore absence of units but if given must be correct in M2</p> <p>Correct answer with no working scores 2 marks</p> <p>Allow <math>0.03 \times 208 = 6.24 / 6.2</math> for M2</p> <p>Allow TE from M1 to M2</p>	2

Question Number	Acceptable Answers	Additional Guidance	Mark
14(b)(iii)	$2\text{H}^+ + \text{CO}_3^{2-} \rightarrow \text{H}_2\text{O} + \text{CO}_2$	<p>Accept <math>2\text{H}_3\text{O}^+ + \text{CO}_3^{2-} \rightarrow 3\text{H}_2\text{O} + \text{CO}_2</math></p> <p>Allow <math>\text{H}_2\text{CO}_3</math> Allow multiples Ignore state symbols even if incorrect Do not award uncanceled chloride ions</p>	1

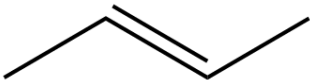
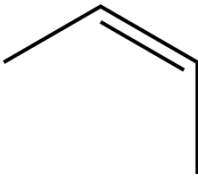
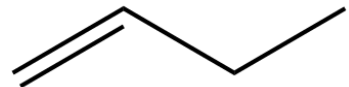
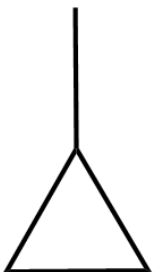
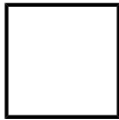
Question Number	Acceptable Answers	Additional Guidance	Mark
14(c)	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> <li>(the) ions are not free to move (and carry charge) / (the) ions are in a fixed position (so cannot carry charge)</li> </ul>	<p>Do not award 'electrons are not free to move'</p> <p>Do not award if any statement that BaCl<sub>2</sub> is covalent</p>	1

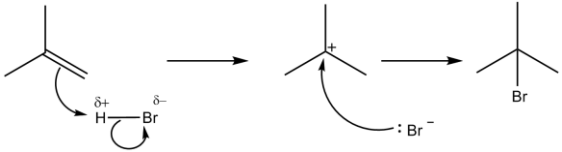
**Total for Question 14 = 8 marks**

Question Number	Acceptable Answers	Additional Guidance	Mark
15(a)(i)	<ul style="list-style-type: none"> <li>2,2,4-trimethylpentane</li> </ul>	Ignore any incorrect or absent commas, hyphens etc Allow 2,2-dimethyl-4-methylpentane Note : ignore minor misspelling of methyl e.g. 'methly'	1

Question Number	Acceptable Answers	Additional Guidance	Mark
15(a)(ii)	<ul style="list-style-type: none"> <li>reforming</li> </ul>	Allow reformation / reform  Do not award cracking / fractional distillation Ignore rearrangement / isomerisation	1

Question Number	Acceptable Answers	Additional Guidance	Mark
15(a)(iii)	<ul style="list-style-type: none"> <li>prevents knocking / prevents pre-ignition / prevents pinking</li> </ul>	Allow smoother combustion / smoother burning / increases octane number / improves octane number / increases RON  IGNORE increases the volatility of a fuel / ignites more easily / is a better fuel / burns more cleanly / has a lower boiling temperature / is a safer fuel / burns more efficiently	1

Question Number	Acceptable Answers	Additional Guidance	Mark
15(b)	<div data-bbox="533 268 1205 363"> <ul style="list-style-type: none"> <li>•  (1)</li> </ul> </div> <div data-bbox="533 403 1205 595"> <ul style="list-style-type: none"> <li>•  (1)</li> </ul> </div> <div data-bbox="533 667 1205 770"> <ul style="list-style-type: none"> <li>•  (1)</li> </ul> </div> <div data-bbox="533 810 1205 1098"> <ul style="list-style-type: none"> <li>•  or  (1)</li> </ul> </div>	<p>Penalise use of displayed or structural formulae once only</p> <p>If displayed / semi-displayed formulae used ignore connectivity of CH<sub>3</sub> groups</p> <p>Ignore names even if incorrect</p>	4

Question Number	Acceptable Answers	Additional Guidance	Mark
15(c)(i)	<ul style="list-style-type: none"> <li>dipole on hydrogen bromide molecule <b>and</b> structure of final product (1)</li> <li>curly arrow from C=C to H and curly arrow from H-Br bond to, or just beyond, Br (1)</li> <li>carbocation intermediate (1)</li> <li>lone pair on Br<sup>-</sup> and curly arrow from lone pair to positive charge (1)</li> </ul>	 <p>Allow any combination of displayed, structural or skeletal formulae</p> <p>Allow + on bracket around the structure Do not award <math>\delta+</math> on intermediate</p> <p>Do not award <math>\delta-</math> on Br in M4</p> <p>Penalise use of half-arrows once only</p> <p>If minor product is shown then do not award M1</p> <p>NOTE – incorrect starting alkene can score M2 and M4 only</p>	4

Question Number	Acceptable Answers	Additional Guidance	Mark
15(c)(ii)	<ul style="list-style-type: none"> <li>the <b>tertiary</b> carbocation is (more) stable (than the primary carbocation)</li> </ul>	<p>Accept the 3° carbocation is more stable (than the 1° carbocation)</p> <p>Allow a description of a 3° carbocation e.g. '3 methyl groups attached to the positive C'</p> <p>Ignore explanations of stability even if incorrect / Ignore references to Markovnikov's law</p>	1

Question Number	Acceptable Answers	Additional Guidance	Mark															
15(d)(i)	<ul style="list-style-type: none"><li>expression for calculation of moles of C and H (1)</li><li>deduction of empirical formula (1)</li></ul>	<p><u>Example of calculation</u></p> <table><tr><td>Element</td><td>C</td><td>H</td></tr><tr><td>Expression to calculate moles</td><td>92.3 / 12</td><td>7.7 / 1</td></tr><tr><td>Moles (mol)</td><td>=7.7 (mol)</td><td>= 7.7 (mol)</td></tr><tr><td>Ratio</td><td>1</td><td>1</td></tr><tr><td colspan="3">Empirical formula = CH / HC</td></tr></table> <p>No TE from M1 to M2</p>	Element	C	H	Expression to calculate moles	92.3 / 12	7.7 / 1	Moles (mol)	=7.7 (mol)	= 7.7 (mol)	Ratio	1	1	Empirical formula = CH / HC			2
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Question Number	Acceptable Answers	Additional Guidance	Mark
15(d)(ii)	<ul style="list-style-type: none"> <li>conversion of volume to m<sup>3</sup> (1)</li> <li>conversion of temperature to K and pressure to Pa (1)</li> <li>rearrangement of ideal gas equation and calculation of <math>n</math> (1)</li> <li>calculation of molar mass (1)</li> </ul>	<p><u>Example of calculation</u></p> <p>98 x 10<sup>-6</sup> (m<sup>3</sup>) – if <math>V</math> in dm<sup>3</sup> then pressure must be in kPa</p> <p>358 (K) and 104 000 (Pa)</p> <p><math>n = pV \div RT = (104\,000 \times 98 \times 10^{-6}) \div (8.31 \times 358)</math>  <math>= 3.4259 \times 10^{-3}</math> (mol)</p> <p>Molar mass = <math>(0.267) \div (3.4259 \times 10^{-3}) = 77.9 / 78</math> (g mol<sup>-1</sup>)</p> <p>Comment  Do not penalise grams given as units for molar mass</p> <p>Allow TE throughout</p> <p>M1 and M2 could be subsumed within M3</p> <p>Answer of 78 with no working scores M4 only</p>	4

Question Number	Acceptable Answers	Additional Guidance	Mark
15(d)(iii)	C <sub>6</sub> H <sub>6</sub>	<p>Standalone mark</p> <p>No TE from di and dii</p>	1

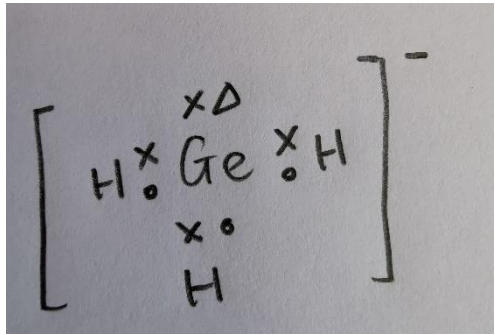
**Total for Question 15 = 19 marks**

Question Number	Acceptable Answers	Additional Guidance	Mark
16(a)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• <b>atoms</b> (of the same element) with the same number of protons / <b>atoms</b> with same atomic number / <b>atoms</b> with same proton number (1)</li> <li>• with a different number of neutrons / neutron number / mass number (1)</li> </ul>	<p>NOTE answers with no reference to atoms can score 1 max for correct statements about the number of protons and neutrons or atomic number and mass number</p> <p>e.g. ‘elements with same number of protons but different number of neutrons’ scores 1 mark</p> <p>e.g. ‘isotopes have the same atomic number and different mass number’ scores 1 mark</p> <p>Ignore references to same number of electrons</p> <p>Ignore references to relative atomic mass</p>	2

Question Number	Acceptable Answers	Additional Guidance	Mark
16(b)	<ul style="list-style-type: none"> <li>numerator of weighted mean expression (1)</li> <li>calculation of relative atomic mass (1)</li> </ul>	<p><u>Example of calculation</u></p> $(70 \times 20.6) + (72 \times 27.4) + (73 \times 7.7) + (74 \times 36.7) + (76 \times 7.6)$ $\frac{(70 \times 20.6) + (72 \times 27.4) + (73 \times 7.7) + (74 \times 36.7) + (76 \times 7.6)}{100}$ $= 72.703 / 72.70 / 72.7$ <p>TE on one transcription error          Final answer must be to at least 1 decimal place          Correct answer with no working scores 2          Ignore units</p>	2

Question Number	Acceptable Answers	Additional Guidance	Mark
16(c)	<ul style="list-style-type: none"> <li><math>1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^2</math></li> </ul>	<p>Allow [Ar] <math>3d^{10} 4s^2 4p^2</math>          Allow <math>4s^2</math> immediately before <math>3d^{10}</math>          Allow <math>3p_x^2 3p_y^2 3p_z^2</math>          Allow numbers of electrons not shown as superscripts          Allow upper case letters for 'S', 'P' and 'D'</p>	1

Question Number	Acceptable Answers	Additional Guidance	Mark
16(d)(i)	<ul style="list-style-type: none"> <li>calculation of <math>\sum M_r</math> (all reactants) / <math>\sum M_r</math> (all products) (1)</li> <li>calculation of atom economy as a percentage (1)</li> </ul>	<p><u>Example of calculation</u></p> $46+72.6+48+23+10.8+4+18 = 222.4$ $/ 72.6+4+80+23+10.8+32 = 222.4$ $(76.6 \div 222.4) \times 100 = 34.442\%$ <p>Allow TE in M2 from M1 provided atom economy is less than 100%</p> <p>Allow use of <math>A_r = 72.7</math> for Ge calculated in (b) which gives the answer 34.472%</p> <p>Ignore SF except 1 SF</p>	2

Question Number	Acceptable Answers	Additional Guidance	Mark
16(d)(ii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>3 bond pairs between Ge atom and <b>three</b> H atoms (1)</li> <li>lone pair on Ge atom (and charge on ion) (1)</li> </ul>	 <p>Allow any combination of dots and / or crosses</p> <p>Ignore missing charge on ion</p> <p>Ignore lines showing covalent bonds</p>	2

Question Number	Acceptable Answers	Additional Guidance	Mark
<b>16(d)(iii)</b>	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>trigonal pyramid(al) (1)</li> <li>angle between 106 and 108° (1)</li> </ul>	<p>Allow pyramidal</p> <p>Comment – the correct shape and angle are standalone marks. However allow trigonal planar and 120° for 2 marks if (d)(ii) shows only 3 bond pairs.</p>	<b>2</b>

Question Number	Acceptable Answers	Additional Guidance	Mark
16(d)(iv)	<ul style="list-style-type: none"> <li>calculation of maximum mass of germane in laboratory in mg (1)</li> <li>conversion of mass from mg to g (1)</li> <li>calculation of moles of germane (1)</li> <li>calculation of maximum number of germane molecules in laboratory (1)</li> </ul> <p>NOTE – do not award M1 and M2 if there is evidence that candidates believe the values 147.84 / 0.14784 are moles. Such answers are likely to only be able to access M4</p>	<p><u>Example of calculation</u></p> $0.640 \times 231 = 147.84 \text{ (mg)}$ $147.84 \div 1000 = 0.14784 \text{ (g)}$ <p>Allow TE from M1 to M2</p> $= 0.14784 \div 76.6 = 1.9300 \times 10^{-3} \text{ (mol)}$ <p>Allow TE from M2 to M3</p> $1.9300 \times 10^{-3} \times 6.02 \times 10^{23}$ $= 1.1619 \times 10^{21} \text{ (molecules)}$ <p>Allow TE from M3 to M4  Allow use of 76.7 for 76.6 giving  <math>1.1604 \times 10^{21}</math>  Correct answer with no working scores 4 marks  Ignore SF except 1 SF</p>	4

Question Number	Acceptable Answers	Additional Guidance	Mark
16(e)(i)	<ul style="list-style-type: none"> <li>calculation of moles of carbon dioxide</li> </ul>	$(335.5 \div 24000)$ $= 0.013979 / 1.3979 \times 10^{-2} \text{ (mol)}$ Ignore SF except 1 SF	1

Question Number	Acceptable Answers	Additional Guidance	Mark
16(e)(ii)	<ul style="list-style-type: none"> <li>answer to (i) <math>\times 2</math></li> </ul>	$(0.013979 \times 2)$ $= 0.027958 / 2.7958 \times 10^{-2} \text{ (mol)}$ Ignore SF except 1 SF Allow TE from (i)	1

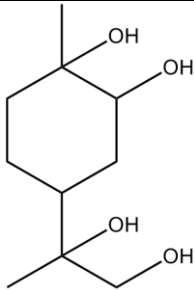
Question Number	Acceptable Answers	Additional Guidance	Mark	
16(e)(iii)	<ul style="list-style-type: none"> <li>answer to (ii) <math>\div 4</math></li> </ul>	$(0.027958 \div 4)$ $= 0.0069896 / 6.9896 \times 10^{-3} \text{ (mol)}$ Ignore SF except 1 SF Allow TE from (ii)	1	

Question Number	Acceptable Answers	Additional Guidance	Mark
16(e)(iv)	<ul style="list-style-type: none"> <li><math>1.50 \div (\text{answer to (iii)})</math> (1)</li> <li>identification of X (1)</li> </ul>	$1.50 \div 6.9897 \times 10^{-3} = 214.6 \text{ (g mol}^{-1}\text{)}$ $214.6 - 72.6 = 142.01$ $142.01 \div 4 = 35.501$ ; so X = Cl Allow TE from (iii) Must be some correct working to score M2	2

**Total for Question 16 = 20 marks**

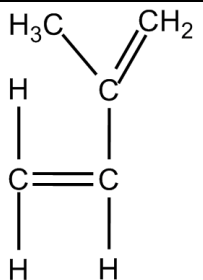
Question Number	Acceptable Answers	Additional Guidance	Mark
17(a)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• C<sub>10</sub> (1)</li> <li>• H<sub>16</sub> (1)</li> </ul>	<p>Allow in either order</p> <p>Allow numerical values not shown as subscripts e.g. C10H16 scores both marks</p>	2

Question Number	Acceptable Answers	Additional Guidance	Mark
17(b)(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• from purple to colourless</li> </ul>	<p>Do not award other colours</p> <p>Allow (pale) pink to colourless</p> <p>Ignore references to clear</p> <p>Ignore adjectives before purple e.g. deep purple</p>	1

Question Number	Acceptable Answers	Additional Guidance	Mark
17(b)(ii)		<p>Allow displayed formula</p> <p>Ignore connectivity of OH group unless bond shown horizontally, and H connected directly to bond</p> <p>Ignore orientation of OH group</p>	1



Question Number	Acceptable Answers	Additional Guidance	Mark
17(b)(iii)	<ul style="list-style-type: none"> <li>oxidation</li> </ul>	Allow electrophilic addition	1

Question Number	Acceptable Answers	Additional Guidance	Mark
17(c)		<p>Allow skeletal, structural or displayed or any combination</p> <p>Ignore 'n' before or after structure</p> <p>Ignore connectivity of CH<sub>3</sub> and CH<sub>2</sub> groups</p>	1

Question Number	Acceptable Answers	Additional Guidance	Mark
17(d)	<p>An answer that makes reference to any <b>two</b> of the following points:</p> <ul style="list-style-type: none"> <li>• (help develop) biodegradable polymers / polymers from plant material / (polymers that can be) re-used / (polymers that can be easily) recycled (1)</li> <li>• remove (toxic) gases produced by incineration (of polymers) (1)</li> <li>• (develop processes to) convert polymers back into feedstock (for use in chemical industry) (1)</li> <li>• use of IR (spectroscopy) to separate polymers (for recycling) (1)</li> </ul>	<p>Allow the term 'plastic' for polymers</p> <p>Ignore biopolymers Ignore reduce use of polymers</p> <p>Allow monomers / smaller molecules / more reactive molecules / more useful molecules for 'feedstock'</p>	2

	Acceptable Answers	Additional Guidance	Mark
<b>17(e)(i)</b>	<p>An answer that makes reference to the following points:</p> <p>advantage of liquid CO<sub>2</sub></p> <ul style="list-style-type: none"> <li>• non-flammable / non-toxic / readily available / CO<sub>2</sub> can be reused (1)</li> </ul> <p>disadvantage of liquid CO<sub>2</sub></p> <ul style="list-style-type: none"> <li>• energy needed to generate (high) pressure / (high) pressure is expensive / risk of explosion under pressure / (1)</li> </ul>	<p>Allow reverse arguments for hexane</p> <p>Allow can be separated (from limonene) easily Allow hexane is non-renewable / finite Ignore 'removes CO<sub>2</sub> from atmosphere'</p> <p>Allow energy needed to maintain pressure Allow strength of vessel needed to withstand (high) pressure Ignore references to temperature Ignore just 'expensive' Do not award greenhouse gas / global warming</p>	<b>2</b>

Question Number	Acceptable Answers	Additional Guidance	Mark
17(e)(ii)	<ul style="list-style-type: none"> <li>calculation of mass of limonene required in 30 cm<sup>3</sup> of cleaning product (1)</li> <li>calculation of mass of orange peel needed to produce 1 g of limonene (1)</li> <li>calculation of mass of orange peel needed to produce enough limonene to make 30 cm<sup>3</sup> of cleaning product, in kg (1)</li> </ul>	<p><u>Example of calculation</u>  <math>0.841 \times 30 = 25.23 \text{ (g)}</math>            Ignore units in M1</p> <p>1 g limonene needs <math>(100 \div 1.63) \text{ g}</math> of peel  <math>= 61.3497 \text{ (g)}</math></p> <p><math>(100 \div 1.63) \times 25.23 = 1547.9 \text{ (g)}</math>  <math>= 1.55 \text{ (kg)}</math>            Allow final answer in grams if units quoted            Allow TE throughout            M2 could be subsumed in M3            Ignore SF except 1 SF            Correct answer with no working scores 3            NOTE : if ratio in M2 is inverted  <math>\text{mass} = 4.11 \times 10^{-4} \text{ (kg)}</math> and scores M1 and M3</p>	3

**Total for Question 17 = 13 marks**

**Total for Section B = 60 marks**

**Total for Paper = 80 marks**