



# Mark Scheme (Results)

January 2021

Pearson BTEC Nationals  
In Applied Science (31627H1C)  
Unit 5: Principles and Applications of Science II -  
Chemistry

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## Unit 5: Principles and Applications of Science II

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### General marking guidance

- All learners must receive the same treatment. Examiners must mark the first learner in exactly the same way as they mark the last.
- Marking grids should be applied positively. Learners must be rewarded for what they have shown they can do, rather than be penalised for omissions.
- Examiners should mark according to the marking grid, not according to their perception of where the grade boundaries may lie.
- All marks on the marking grid should be used appropriately.
- All the marks on the marking grid are designed to be awarded. Examiners should always award full marks if deserved. Examiners should also be prepared to award zero marks, if the learner's response is not rewardable according to the marking grid.
- Where judgement is required, a marking grid will provide the principles by which marks will be awarded.
- When examiners are in doubt regarding the application of the marking grid to a learner's response, a senior examiner should be consulted.

### Specific marking guidance

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The marking grids have been designed to assess learner work holistically. Rows in the grids identify the assessment focus/outcome being targeted. When using a marking grid, the 'best fit' approach should be used.

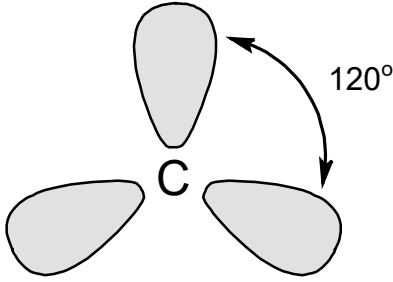
- Examiners should first make a holistic judgement on which band most closely matches the learner's response and place it within that band. Learners will be placed in the band that best describes their answer.
- The mark awarded within the band will be decided based on the quality of the answer, in response to the assessment focus/outcome and will be modified according to how securely all bullet points are displayed at that band.
- Marks will be awarded towards the top or bottom of that band, depending on how they have evidenced each of the descriptor bullet points.

### BTEC Next Generation Mark Scheme

Question Number	Answer	Additional Guidance	Mark
1 (a)	<b>B</b> carbon		1
1 (b)	<b>C</b> reduces the titanium (IV) chloride		1
1 (c)(i)	<p>sodium chloride is {melted/dissolved (in water)} (1)</p> <p>{current/charge} (passed through the electrolyte / carried by ions) (1)</p> <p>chloride ions travel to {positive electrode/anode} (1)</p> <p>chloride ions lose electrons/oxidised (1)</p> <p>accept any other valid response</p>	<p>allow liquid state/ molten/ brine/ (concentrated) solution / ions free to move</p> <p>allow use of electricity</p> <p>allow chlorine formed/produced at the positive electrode/anode</p> <p>allow equation showing loss of electrons /oxidation</p> <p>marks can be awarded for an annotated diagram</p>	4
1 (c)(ii)	<p>(diagram / Figure 2a shows) there is a greater activation energy (for titanium extraction) (1)</p> <p>More energy is needed (for the extraction of titanium) (1)</p> <p>ORA</p>	<p>allow enthalpy / energy level of <math>TiCl_4</math> is lower than NaCl</p> <p>allow higher peak shown in Figure 2a</p> <p>allow enthalpy change is more endothermic/ positive / greater (1)</p>	2
<b>Total</b>			<b>8 marks</b>

Question Number	Answer	Additional Guidance	Mark
2 (a)(i)	18.4 (°C)		1
2 (a)(ii)	291.6 (K)	allow 291-292 allow ECF	1
2 (b)(i)	<p>summation of mass (1) (25 + 25 =) 50</p> <p>substitution (1) (50) x 4.18 x 3.4</p> <p>evaluation (1) 710.6</p>	<p>award full marks for 710.6 without working</p> <p>allow 711, 714</p> <p>allow ECF</p>	3
2 (b)(ii)	<p>award <b>one</b> mark for any of the following up to a maximum of <b>two</b> marks.</p> <p>units are not per mole (1)</p> <p>temperature is not {standard/298K/25°C} (1)</p> <p>pressure is not {standard / 100 kPa / 1 atm} (1)</p>	<p>max 1 mark for "not under standard conditions" if no other valid answer seen</p>	2
<b>Total</b>			<b>7 marks</b>

Question Number	Answer	Additional Guidance	Mark
3 (a)	$C_{16}H_{34}$		1
3 (b)	<p>name of isomer V = butane (1)</p> <p>structural formula of isomer W =</p> <pre>       H             H-C-H           H       H             H-C - C - C-H               H   H   H           (1)           </pre>	allow shortened structural formula	2
3 (c)(i)	electron / e / $e^-$	reject electrons	1
3 (c)(ii)	<b>D</b> homolytic		1
3 (c)(iii)	<p><b>X</b> = HBr (1)</p> <p><b>Y</b> = <math>C_4H_9\cdot</math> (1)</p> <p><b>Z</b> = <math>Br_2</math> (1)</p>	<p>if <b>X</b> and <b>Y</b> incorrect then allow 1 mark if</p> <p><b>X</b> = <math>C_4H_9\cdot</math> <b>or</b> <b>Y</b> = HBr</p> <p>if <b>Y</b> and <b>Z</b> incorrect then allow 1 mark if</p> <p><b>Y</b> = <math>Br_2</math> <b>or</b> <b>Z</b> = <math>C_4H_9\cdot</math></p>	3
3 (c)(iv)	<p>(free radicals) combine together/combine (together) to form a bond (1)</p> <p>Accept any other valid response or equation.</p>		1
3 (d)	<p><math>C_8H_{18}</math> has a higher boiling point than <math>C_4H_{10}</math> (1)</p> <p><math>C_8H_{18}</math> has a longer chain/more {carbon(s) (atoms)/electrons} than <math>C_4H_{10}</math> (1)</p> <p><math>C_8H_{18}</math> has stronger intermolecular forces/ van der Waals forces (1)</p> <p>ORA throughout</p>	<p>allow needs more energy to turn into a gas / change state</p> <p>allow <math>C_8H_{18}</math> has a larger surface area / more contact between its molecules</p> <p>allow harder to separate molecules</p> <p>ORA throughout</p>	3
<b>Total</b>			<b>12 marks</b>

Question Number	Answer	Additional Guidance	Mark				
4 (a)	 <p style="text-align: right;">(2)</p> <p>three orbitals of similar shape and size (1)</p> <p>bond angle of 120° indicated (1)</p>	accept diagram drawn in a different plane	2				
4 (b)(i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Number of electrons in 2p</th> <th>Number of electrons in hybrid</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">2</td> <td style="text-align: center;">2</td> </tr> </tbody> </table>	Number of electrons in 2p	Number of electrons in hybrid	2	2		1
Number of electrons in 2p	Number of electrons in hybrid						
2	2						
4 (b)(ii)	<p>sp<sup>2</sup> (hybridised carbon) has (an electron in) a (2)p orbital <b>or</b> sp<sup>3</sup> (hybridised carbon) has no (electron in a) (2)p orbital (1)</p> <p>(sp<sup>2</sup> / sp<sup>3</sup>) hybrid orbitals (overlap to) form sigma/single bond (1)</p> <p>p orbitals (overlap to) form pi bond (1)</p> <p>pi <b>and</b> sigma give a double bond (1)</p>	<p>allow sp<sup>3</sup> (hybridised carbon) <u>only</u> has hybrid orbitals / same orbitals (in outer shell)</p> <p>allow sp<sup>3</sup> (hybridised carbon) (only) forms sigma bonds</p> <p>allow sp<sup>2</sup> (hybridised carbon) forms sigma and pi bonds</p>	4				
<b>Total</b>			<b>7 marks</b>				

Question number	Indicative content
5	<p>Learners:</p> <ul style="list-style-type: none"> <li>• may include other valid suggestions, not listed below, which should be credited</li> <li>• may cover a number of examples from the list below</li> <li>• would not be expected to cover all points to get full marks.</li> </ul> <p><b>Commercial importance of reaction:</b></p> <ul style="list-style-type: none"> <li>• C<sub>10</sub>H<sub>22</sub> is broken down</li> <li>• products are smaller chain alkane (i.e. octane) and alkene (i.e. ethene)</li> <li>• higher demand/more uses for the products by society than for large hydrocarbons/C<sub>10</sub>H<sub>22</sub></li> <li>• crude oil as a finite resource / limited supply of small hydrocarbons from crude oil</li> </ul> <p><b>Commercial importance of C<sub>8</sub>H<sub>18</sub>:</b></p> <ul style="list-style-type: none"> <li>• use as fuel (for vehicles)</li> <li>• combustion reaction</li> <li>• C<sub>8</sub>H<sub>18</sub> + 12½ O<sub>2</sub> → 8CO<sub>2</sub> + 9H<sub>2</sub>O</li> <li>• releases (heat) energy/exothermic</li> <li>• cracked again to form smaller hydrocarbons with more uses</li> </ul> <p><b>Commercial importance of C<sub>2</sub>H<sub>4</sub>:</b></p> <ul style="list-style-type: none"> <li>• use in manufacture of ethanol / polymer / poly(ethene) / plastics</li> <li>• polymerisation reaction / many small molecules add together to form a long chain molecule</li> </ul> $n \begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C} = \text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array} \longrightarrow \left[ \begin{array}{cc} \text{H} & \text{H} \\   &   \\ -\text{C} & - & \text{C}- \\   &   \\ \text{H} & \text{H} \end{array} \right]_n$ <ul style="list-style-type: none"> <li>• polymers have many uses, e.g. packaging, buckets, bowls, dustbins, water pipes</li> <li>• hydration of ethene to ethanol using steam</li> <li>• C<sub>2</sub>H<sub>4</sub> + H<sub>2</sub>O ⇌ C<sub>2</sub>H<sub>5</sub>OH</li> <li>• ethanol uses e.g. as a solvent, sterilising agent, fuel, feedstock</li> </ul>



<p><b>Mark scheme (award up to 6 marks)</b> refer to the guidance on the cover of this document for how to apply levels-based mark schemes*.</p>		
Level	Mark	Descriptor
Level 0	0	No rewardable material.
Level 1	1–2	<ul style="list-style-type: none"> <li>• Demonstrates adequate knowledge of scientific facts/concepts with generalised comments made</li> <li>• Generic statements may be presented rather than linkages being made so that lines of reasoning are unsupported or partially supported</li> <li>• The discussion shows some structure and coherence</li> </ul>
Level 2	3–4	<ul style="list-style-type: none"> <li>• Demonstrates good knowledge and understanding by selecting and applying some relevant scientific knowledge facts/concepts to provide the discussion being presented</li> <li>• Lines of argument mostly supported through the application of relevant evidence</li> <li>• The discussion shows a structure which is mostly clear, coherent and logical</li> </ul>
Level 3	5–6	<ul style="list-style-type: none"> <li>• Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of scientific facts/concepts to provide the discussion being presented</li> <li>• Line(s) of argument consistently supported throughout by sustained application of relevant evidence</li> <li>• The discussion shows a well-developed structure which is clear, coherent and logical</li> </ul>



Llywodraeth Cynulliad Cymru  
Welsh Assembly Government

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