



Mark Scheme

January 2018

Pearson BTEC Level 3- Applied Science

Unit 5 – Principles and Applications in  
Science II

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January 2018

Publications Code xxxxxxxx\*

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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.
- Crossed-out work should be marked, UNLESS the learner has replaced it with an alternative response.
- You will not see 'or words to that effect' (OWTTE). Alternative correct wording should be credited in every answer, unless the mark scheme has specified specific wording that must be present.
- Round brackets () indicate words that are not essential, e.g. '(hence) distance is increased'.
- Error carried forward (ECF), means that a wrong answer given in an earlier part of a question is used correctly in a later part of a question.
- / indicates that the responses are alternatives and either answer should receive full credit.
- Specific marking guidance for levels-based mark schemes\*

Levels-based mark schemes (LBMS) have been designed to assess learners' work holistically. They consist of two parts: indicative content and levels-based descriptors. Indicative content reflects specific content-related points that a learner might make. Levels-based descriptors articulate the skills that a learner is likely to demonstrate, in relation to the assessment outcomes being targeted by the question. Different rows in the levels, represent the progression of these skills.

When using a levels-based mark scheme, 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/objective 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.

## Section A: Organs and systems

Question Number	Answer	Additional Guidance	Mark
1 (a)(i)	D trachea		1
1 (a)(ii)	bronchiole(s)	allow bronchiol/bronchiale/bronchiule/bronchole/bronchiele  reject bronchi/bronchio/bronchial/bronchus	1
1 (b)(i)	relax/relaxes/relaxed	ignore collapse/expand	1
1 (b)(ii)	decrease(s)/reduce(s)/go(es) down		1
1 (b)(iii)	increase		1
1 (c)(i)	B day 6		1
1 (c)(ii)	450 – 150 (1)  300/150 x 100 (1) or (any number)/150 x 100	allow 150 – 450  200 alone gets full marks	2
total			8

Question Number	Answer	Additional Guidance	Mark
2 (a)	<p>any two from:</p> <p>(amino acids enter the cell) through a {channel/carrier} (protein) (1)</p> <p>by facilitated diffusion (1)</p> <p>down a concentration gradient (1)</p> <p>passive/no {ATP/energy} needed (1)</p>	<p>Allow canal (protein)</p> <p>allow shape of {molecule/substrate} specific to shape of channel.</p> <p>Ignore references to amino acid changing shape</p>	2
2 (b)(i)	<p>(phosphate heads) are {charged/polar/ionic/negative}(1)</p> <p>(so are) hydrophilic (1)</p>	<p>Ignore 5ositive</p> <p>allow water-loving/attracted to water</p> <p>ignore don't mix with water</p>	2
2 (b)(ii)	<p>(tails are) {non-polar/no charged/non-ionic } (1)</p> <p>(so are) hydrophobic (1)</p>	<p>allow water-hating/doesn't like water/repels water</p>	2
total			6

Question Number	Answer	Additional Guidance	Mark												
3 (a)(i)	X = bicuspid/mitral/AV/ atrioventricular (1)  Y = aortic/semi lunar (1)	Allow semi luna and semi luner	2												
3 (a)(ii)	prevent backflow (1)  from ventricle(s) to atrium/back into atrium (1)  from aorta/artery to ventricle(s)/back into ventricle(s) (1)	ignore any reference to named valves allow atria  ignore whether left or right  ignore pulmonary	3												
3 (b)	<table border="1"> <thead> <tr> <th>Phase of cardiac cycle</th> <th>atria</th> <th>ventricl es</th> <th>mar k</th> </tr> </thead> <tbody> <tr> <td>ventri cular systol e</td> <td>relax/rel axes /relaxed</td> <td>Contrac t/contr acts/co ntracte d</td> <td>1</td> </tr> <tr> <td>cardia c diastol e</td> <td>relax/rel axes /relaxed</td> <td>relax/r elaxes /relaxe d</td> <td>1</td> </tr> </tbody> </table>	Phase of cardiac cycle	atria	ventricl es	mar k	ventri cular systol e	relax/rel axes /relaxed	Contrac t/contr acts/co ntracte d	1	cardia c diastol e	relax/rel axes /relaxed	relax/r elaxes /relaxe d	1	All four correct is two marks 2-3 correct is one mark	2
Phase of cardiac cycle	atria	ventricl es	mar k												
ventri cular systol e	relax/rel axes /relaxed	Contrac t/contr acts/co ntracte d	1												
cardia c diastol e	relax/rel axes /relaxed	relax/r elaxes /relaxe d	1												
3 (c)	MP1: 1 heartbeat in any value between 0.9s and 1s (1)  MP2: $60 \div (\text{MP1})$ (1)  MP3: any number between 60 and 67 bpm (1)	allow any multiple  ECF from MP1  a value between 60 - 67 alone gains all 3 marks	3												
3 (d)	(right ventricle) has {less muscle/ thinner (wall)} (1)  (so produces) less pressure (when it contracts)/weaker contraction (1)  because {delicate lungs/shorter distance/less resistance to overcome/only has to go to lungs} (1)	allow ORA for each mark points  ignore references to volume	3												
total			13												

Question Number	Answer	Additional Guidance	Mark
4 (a)	<p>any three from:</p> <p>MP1: maintain homeostasis/description of/ reference to need of correct concentration of ions in blood(1)</p> <p>MP2: no concentration gradient if normal sodium ion concentration/ concentration gradient if not normal sodium ion concentration(between dialysis fluid and blood) (1)</p> <p>MP3: <u>diffusion</u> of sodium ions into / out of blood in correct context (1)</p> <p>MP4: only excess/above normal level {sodium ions/salt} in the blood removed (by dialysis) (1)</p> <p>MP5: difference in water concentration/ high level of sodium ions in dialysis fluid would {lower <math>\Psi</math> of dialysis fluid/cause water to pass from blood to dialysis fluid} (1)</p> <p>MP6: <u>by osmosis</u> (1)</p> <p>MP7: reference to effect of {too many or too few ions/change amount of water/ <math>\Psi</math>} (in blood)</p> <p>MP8: effect on red blood cells/body cells (1)</p>	<p>allow ORA for each mark points</p> <p>allow Na<sup>+</sup></p> <p>Ignore type of diffusion</p>	3

4 (b)	<p>any four from:</p> <p>MP1: ADH increases permeability/porosity of {distal tubule/collecting duct/nephron} to water (1)</p> <p>MP2: (more) aquaporins/water channels (1)</p> <p>MP3: more water reabsorbed back (into blood)/less urine produced/urine more concentrated/less water lost in urine (1)</p> <p>MP4: by osmosis/diffusion of water (from high to low <math>\Psi</math>) (1)</p> <p>MP5: negative feedback/homeostasis/ normal (blood) water potential restored (1)</p>	<p>ignore references to loop of Henle</p> <p>ADH increases number of water channels in walls of Distal Convoluted Tubule/collecting duct = 2 marks (MP1 and 2)</p>	4
total			7

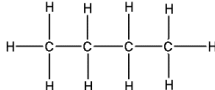
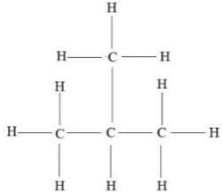
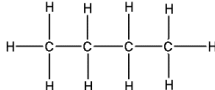
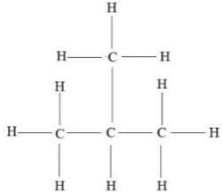
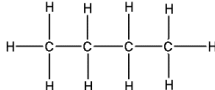
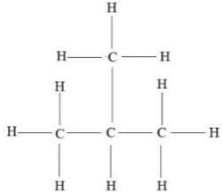
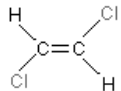
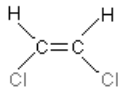


Question Number	Indicative content	Mark
5	<p>cardiovascular disease (CVD)</p> <ul style="list-style-type: none"> <li>• LDL/cholesterol can be deposited (as fatty plaques) {in wall of/under lining of} arteries and increase risk of {blood clots/thrombus}</li> </ul> <p>benefits of statins</p> <ul style="list-style-type: none"> <li>• help lower LDL levels in blood</li> <li>• reduce formation of fatty plaques/reduce risk of blood clots</li> <li>• reduces risk of stroke/heart attack</li> <li>• cheap</li> <li>• easy to take/only taken once a day/convenient</li> <li>• prevent artery disease getting worse</li> </ul> <p>risks of statins</p> <ul style="list-style-type: none"> <li>• cannot cure CVD</li> <li>• have to keep taking them</li> <li>• side effects include: <ul style="list-style-type: none"> <li>○ nosebleeds, sore throat</li> <li>○ muscle weakness/aches</li> <li>○ memory problems</li> <li>○ headaches/sickness/constipation/ diarrhoea</li> <li>○ inflammation of liver/pancreas</li> </ul> </li> <li>• increased risk of diabetes</li> <li>• evidence that people who have taken them and then stop have increased risk of CVD</li> <li>• doctors may prescribe them because they are cheap rather than educating people to change their lifestyle</li> </ul>	6

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Demonstrates some isolated knowledge of scientific facts/concepts with generalised comments made Generic statements may be presented rather than linkages being made so that lines of reasoning are unsupported or partially supported The discussion shows limited structure and coherence Mainly pros or cons not both
Level 2	3-4	Demonstrates good knowledge and understanding by selecting and applying some relevant scientific knowledge facts/concepts to provide the discussion being presented. Some pros and cons The discussion shows a structure which is mostly clear, coherent and logical
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of scientific facts/concepts to provide the discussion being presented. Pros and cons/balanced The discussion shows a well-developed structure which is clear, coherent and logical

## Section B: Properties and uses of substances

Question Number	Answer	Additional Guidance	Mark
6 (a)	<b>D</b> pH 10		1
6 (b)	can {react as/act as/be} a base or an acid (under acid or base conditions)  or  can react with an acid or a base	allow alkali instead of base  ignore reference to aluminium oxide or other substances (eg metal, metal oxide)	1
6 (c)	sodium hydroxide can dissolve in water/soluble (in water)  or  copper hydroxide cannot dissolve in water/insoluble (in water)	allow sodium hydroxide releases hydroxide ions when in water  allow an alkali is a base that can dissolve in water	1
6 (d)	An explanation that makes reference to any four of the following points:  It has {incomplete / partially filled} {3d energy levels/d-subshell/d-orbital} (1)  It has variable oxidation states/it can accept or lose electrons (1)  (so) can be reduced and oxidised back again (to its original form) (1)  lowers activation energy (1) by providing alternative reaction pathway/route (1)	allow can form complex ions/(temporary/dative covalent) bonds with reacting molecules (1)  weakening the bonds in the reacting molecules (1)	4

Question Number	Answer	Additional Guidance	Mark						
7 (a)	2-methylpentane		1						
7 (b)	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">Name of isomer</td> <td style="width: 50%; padding: 5px;">Displayed formula</td> </tr> <tr> <td style="padding: 5px;">butane</td> <td style="padding: 5px;">  </td> </tr> <tr> <td style="padding: 5px;">(2-) methylpropane</td> <td style="padding: 5px;">  </td> </tr> </table> <p>1 mark for each correct name</p> <p>1 mark for each correct structural formula</p>	Name of isomer	Displayed formula	butane		(2-) methylpropane		<p>max three marks if formula is incorrectly matched to the name</p> <p>can be in either order</p> <p>ignore 2 or any other number in front of methylpropane</p> <p>displayed formula must show all bonds</p>	4
Name of isomer	Displayed formula								
butane									
(2-) methylpropane									
7 (c)	(hexane) has more carbons/longer chain/more electrons/bigger molecule/stronger Van der Waals/intermolecular forces (1) ORA		1						
7 (d)(i)	A $C_nH_{2n}$		1						
7 (d)(ii)	$C_{10}H_{22} \rightarrow C_7H_{16} + C_3H_6$ (2) or $C_7H_{16}$ (1) $C_3H_6$ (1)	allow in either order	2						
7 (d)(iii)	<p>The two chlorine atoms can be on the same side or opposite sides of the <u>double bond</u> / two different atoms on each carbon atom in the double bond (1)</p> <p>or</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>trans</p> </div> <div style="text-align: center;">  <p>cis</p> </div> </div> <p>(1)</p> <p>and</p> <p>No free rotation around the double bond/<math>\pi</math> bond prevents the carbon atoms from {rotating/twisting} around (1)</p>	<p>Max of 1 mark for drawings with no annotation/explanation</p> <p>Ignore incorrect naming of cis and trans isomers</p> <p>Ignore inaccurate use of "chloride", "molecule", "structural isomers"</p>	2						

7(d)(iv)	<p>an explanation that makes reference to any four of the following points:</p> <ul style="list-style-type: none"> <li>a <math>\pi</math> bond is weaker than a <math>\sigma</math> bond</li> <li>overlap between atomic orbitals in <math>\pi</math> bond is only partial/ sideways</li> <li>electrons in <math>\pi</math> bond further away from attraction of the nuclei</li> <li>less energy needed to break the <math>\pi</math> bond / <math>\pi</math> bond breaks more easily</li> <li>higher electron density in alkenes</li> <li>attracts electrophiles/positively charged species (to react with)</li> </ul>	ORA	4
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Question Number	Answer	Additional Guidance	Mark
8 (a)(i)	$2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{l})$ element formulae correct (1) balancing of the elements correct (1) state symbols of the elements correct (1)	equation must show elements as the reactants equation must show formation of 1 mole of $\text{C}_2\text{H}_5\text{OH}$ allow balancing if element formulae are incorrect but numbers of atoms same on both sides of equation	3
8 (a)(ii)	any one of the following: <ul style="list-style-type: none"> <li>• carbon would not react with oxygen and hydrogen under standard conditions</li> <li>• several steps required not one reaction</li> <li>• there are potentially other products/ alternative reaction</li> <li>• activation energy is too high</li> </ul>	allow when carbon, oxygen and hydrogen react ethanol is not always produced/not the only product	1
8 (b)(i)	$(303.5 - 293 =) 10.5$ (1) substitution (1) $\text{heat energy} = 250 \times 4.18 \times 10.5$ evaluation (1) $10972.5$ (J)	award 3 marks for correct answer with no working shown. accept 10973 or 10972 or 10970 (reject 10970 if no workings shown)	3

8 (b)(ii)	substitution(1) $\frac{10970}{0.016}$  evaluation (1) 685625 (J mol <sup>-1</sup> )  conversion 685.625 (kJ mol <sup>-1</sup> )  or  substitution(1) $\frac{10972.5}{0.016}$  evaluation (1) 685781 (J mol <sup>-1</sup> )  conversion 685.781 (kJ mol <sup>-1</sup> )	ignore sign  award 3 marks for correct answer with no working shown.  allow any answer which rounds to 686   ignore significant figures	3
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Question Number	Answer	Additional Guidance	Mark
9(a)(i)	<b>A</b> addition		1
9 (a)(ii)	$  \begin{array}{c}  \text{H} \quad \text{H} \\    \quad   \\  -\text{C} - \text{C}- \\    \quad   \\  \text{H} \quad \text{H}  \end{array}  $	ignore brackets and n  each carbon must have 4 single bonds	1

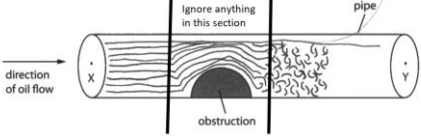
Question Number	Indicative content	Mark
9 (b)	<p><b>General</b></p> <ol style="list-style-type: none"> <li>it is a (free radical) substitution reaction</li> <li>it is a chain reaction</li> </ol> <p><b>Initiation</b></p> <ol style="list-style-type: none"> <li>first stage</li> <li>UV light or 300°C, provides energy for reaction</li> <li>homolytic bond fission</li> <li>single / unpaired electron on chlorine atoms / free radical formed</li> </ol> $\text{Cl}_2 \rightarrow 2\text{Cl}^\bullet$	6

	<p><b>Propagation</b></p> <p>7. next stage / continuation of the reaction</p> <p>8. chlorine radical removes a hydrogen from methane forms a methyl radical  <math display="block">\text{Cl}^\bullet + \text{CH}_4 \rightarrow \text{HCl} + \text{CH}_3^\bullet</math></p> <p>9. methyl radical removes a chlorine atom from chlorine molecule forms chloromethane and chlorine radical  <math display="block">\text{CH}_3^\bullet + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}^\bullet</math></p> <p>10. new chlorine free radical removes a hydrogen from another methane</p> <p><b>Termination</b></p> <p>11. end of the reaction / no more radicals formed / radicals combine</p> <p>12. methyl radical reacts with chlorine radical to form chloromethane  <math display="block">\text{CH}_3^\bullet + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{Cl}</math></p> <p>13. chlorine radicals react to form chlorine molecule  <math display="block">\text{Cl}^\bullet + \text{Cl}^\bullet \rightarrow \text{Cl}_2</math></p> <p>14. methyl radicals react to form ethane  <math display="block">\text{CH}_3^\bullet + \text{CH}_3^\bullet \rightarrow \text{CH}_3\text{CH}_3</math></p>	
Level	Mark	Descriptor
	0	No rewardable material.
<b>Level 1</b>	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 explanation shows some structure and coherence</li> </ul>
<b>Level 2</b>	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 explanation shows a structure which is mostly clear, coherent and logical</li> </ul>
<b>Level 3</b>	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 explanation shows a well-developed structure which is clear, coherent and logical</li> </ul>

### Section C: Thermal physics, materials and fluids

Question Number	Answer	Additional guidance	Mark
10 (a)	C (energy lost by the elastic band)		1
10 (b)	the band has been deformed/damaged/shape changed	ignore, answers relating to elastic limit/limit of proportionality	1
10 (c)	An explanation that makes reference to the following points:  it does not show that the force is proportional to the extension (1)  as the graph is not a straight line (through the origin) / curves continually (1)	uses numbers from the graph to show this.	2
total			4



Question Number	Answer	Additional guidance	Mark
11 (a)	(B) diameter of pipe		1
11 (b)	<p>streamline flow before obstruction/parallel lines (1)</p> <p>turbulent flow after the obstruction (1)</p> 	<p>must have at least 2 lines to show the streamline flow</p> <p>arrows on the flow lines are not required</p> <p>lines should cross or have individual curves</p> <p>ignore any markings between the two vertical lines shown on the diagram</p>	2
11 (c)	<p>An explanation that makes reference to the following points:</p> <p>oil has lower viscosity/ viscosity decreases less viscous (1)</p> <p>(Because)</p> <p><b>Any one from:</b></p> <p>particles have more energy (1)</p> <p>less force between particles (1)</p> <p>bonds broken (1)</p> <p>lower density (1)</p> <p><b>And</b></p> <p>oil flows faster/ velocity increases (1)</p>	<p>reject 'viscosity rises with temperature'</p> <p>allow 'thinner'</p> <p>accept molecules for particles</p>	3
total			6

Question Number	Answer	Additional guidance	Mark
12 (a)	D		1
12 (b)(i)	substitution (1) $5.56 \times 10^9 = \text{mass} \times 2.26 \times 10^6$  rearrangement (1) $\frac{5.65 \times 10^9}{2.26 \times 10^6}$  evaluation (1) $2.5 \times 10^3$ (kg) <b>or</b> 2500 (kg)	$2.5$ or $2.46 \times 10^3$ (kg) alone gains 3 marks  POWER OF TEN error 2 marks max	3
12 (b)(ii)	substitution (1) $1 - \frac{(298)}{T} = 0.56$  rearrangement (1) $T = \frac{(298)}{0.44}$  evaluation (1) 677 (K)	$298/0.56$ (1)  no sig fig penalty, allow 680  allow any value which rounds to 677  allow for <b>one</b> mark answer with no working for 533, 532 and 531	3

12 (c)	<p>An explanation that makes reference to the following points:</p> <p><u>Heating water to boiling point</u></p> <p>molecules stay within the liquid/forces between molecules/ inter molecular bonds/ molecules close together (1)</p> <p>when heated molecules gain kinetic energy/ collide more frequently/move faster/ vibrate more (1)</p> <p><u>Vaporising water</u></p> <p>molecules to escape from the liquid/break free from liquid (1)</p> <p>break (hydrogen) bonds between molecules/ molecules separate /free to move (1)</p>		4
total			8

Question Number	Answer	Additional guidance	Mark
13 (a)(i)	<p>(the glass has the greatest strength) as it has the greatest gradient/ steepest line /greatest (ultimate tensile) stress on the graph (1)</p> <p>OR</p> <p>(glass has) a lower strain (than copper for a given stress) (1)</p> <p>OR</p> <p>(glass has) a higher stress (than copper for a given strain) (1)</p>	<p>ignore descriptions of structure</p> <p>ORA</p> <p>ORA</p>	1
13 (a)(ii)	<p>(Copper is more ductile) as it has the greater {strain /change in length} for lower stress/ does not break (close to the elastic limit)</p> <p>OR</p> <p>Needs less stress to produce a greater{strain /change in length}</p>	allow stretches more without breaking	1
13 (b)	<p>conversion of <math>0.5\text{mm}^2</math> to <math>5 \times 10^{-7} \text{m}^2</math> (1)</p> <p>substitution (1)</p> $1 \times 10^9 = \frac{\text{weight}}{5 \times 10^{-7}}$ <p>rearrangement (1)</p> $1 \times 10^9 \times 5 \times 10^{-7} = (\text{weight})$ <p>evaluation (1)</p> <p>500 (N)</p> <p>OR</p> <p><math>5 \times 10^2</math> (N) (1)</p>	<p>conversion can take place at any step</p> <p>allow 3 marks max for the use of a wrongly converted area or a non converted area e.g. giving <math>5 \times 10^8</math> (N) as an answer if working is shown.</p> <p>positive POWER OF TEN error 3 marks</p>	4

13 (c)	<p>An explanation that makes reference to the following points:</p> <p>(creep is) deformation (1)</p> <p>(due to) mechanical stress (1)</p> <p>(caused by) continual heating and cooling /weather changes (1)</p> <p>(produces) change  {length/shape/strain over time} /  {fracture/fatigue/break/weaken/brittle}  (1)</p>	<p>ignore damage</p> <p>accept applied force or pressure</p> <p>accept crack</p>	4
total			10

Question Number	Answer	Additional guidance	Mark
14 (a)	<p>(a process taking place at) constant temperature /no change in temperature/fixed/same temperature</p>	<p>Ignore heat energy is constant or that the temperature can be controlled</p>	1
14 (b)	<p>Any two from the following:  (thermal) {energy/heat} is lost (to the environment) (1)</p> <p>not all input energy is available to do work (1)</p> <p>work is done against other forces/friction (1)</p> <p>energy converted to other named forms e.g. sound (1)</p> <p>process is not reversible</p>	<p>allow irreversible</p>	2

Question number	Indicative content
14 (c)	<p data-bbox="491 241 596 271"><u>General</u></p> <ul data-bbox="539 304 1350 528" style="list-style-type: none"> <li data-bbox="539 304 1350 398">• a heat engine uses an energy input provided in the form of heat to do work and then exhausts the heat which cannot be used to do work/produce mechanical energy</li> <li data-bbox="539 432 1350 528">• a petrol engine/heat engine uses a temperature difference to convert heat energy into mechanical energy/useful work done</li> </ul> <p data-bbox="491 562 711 591"><u>1 - Compression</u></p> <ul data-bbox="539 624 1350 1010" style="list-style-type: none"> <li data-bbox="539 624 1050 654">• the fuel/air mixture is compressed</li> <li data-bbox="539 687 1350 781">• when the air fuel mixture is compressed work is done on the mixture in an adiabatic compression by the piston.</li> <li data-bbox="539 815 1350 909">• the mixture reduces in volume and the pressure rises which makes the temperature rise as work is being done on the mixture.</li> <li data-bbox="539 943 1350 1010">• this is shown on the graph, on the compression line, by the volume becoming smaller as the pressure rises.</li> </ul> <p data-bbox="491 1043 644 1072"><u>2 - Ignition</u></p> <ul data-bbox="539 1106 1350 1330" style="list-style-type: none"> <li data-bbox="539 1106 1350 1173">• the mixture ignites which produces a big rise in pressure at a fixed volume</li> <li data-bbox="539 1207 1350 1274">• this is shown on the graph, on the ignition line, by a rise in pressure for no change in volume.</li> <li data-bbox="539 1308 1054 1337">• the temperature increases greatly.</li> </ul> <p data-bbox="491 1370 676 1400"><u>3 - Expansion</u></p> <ul data-bbox="539 1433 1350 1818" style="list-style-type: none"> <li data-bbox="539 1433 1350 1500">• the gas expands adiabatically so that the gas does work on the piston and pushes it down.</li> <li data-bbox="539 1534 1350 1601">• this is shown by the volume of the gas increasing and the pressure reducing</li> <li data-bbox="539 1635 1134 1664">• this reduces the temperature of the gas.</li> <li data-bbox="539 1697 1289 1727">• the volume of the gas increases as its pressure falls</li> <li data-bbox="539 1760 1350 1827">• this is shown on the graph by a rapid drop in pressure at a fixed volume.</li> </ul> <p data-bbox="491 1861 647 1890"><u>4 - Exhaust</u></p> <ul data-bbox="539 1924 1278 1953" style="list-style-type: none"> <li data-bbox="539 1924 1278 1953">• the gas leaves the cylinder at a lower temperature.</li> </ul>

**Mark scheme (award up to 6 marks)** refer to the guidance on the cover of this document for how to apply levels-based mark schemes\*.

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"> <li>No rewardable material.</li> </ul>
<b>Level 1</b>	1–2	<ul style="list-style-type: none"> <li>Adequate interpretation, analysis and/or evaluation of the scientific information with generalised comments being 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 explanation shows some structure and coherence</li> </ul>
<b>Level 2</b>	3–4	<ul style="list-style-type: none"> <li>Good analysis, interpretation and/or evaluation of the scientific information</li> <li>Lines of argument mostly supported through the application of relevant evidence</li> <li>The explanation shows a structure which is mostly clear, coherent and logical</li> </ul>
<b>Level 3</b>	5–6	<ul style="list-style-type: none"> <li>Comprehensive analysis, interpretation and/or evaluation of all pieces of scientific information</li> <li>Line(s) of argument consistently supported throughout by sustained application of relevant evidence</li> <li>The explanation shows a well-developed structure which is clear, coherent and logical</li> </ul>

**Ofqual**  




Llywodraeth Cynulliad Cymru  
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