



# Mark Scheme (Results)

June 2019

Pearson BTEC Level 3 National Diploma–  
Applied Science

Unit 5: Applications of Science II  
Physics

SECTION C: THERMAL PHYSICS,  
MATERIALS AND FLUIDS



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# Unit 5: Applications of Science II – sample marking grid

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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.

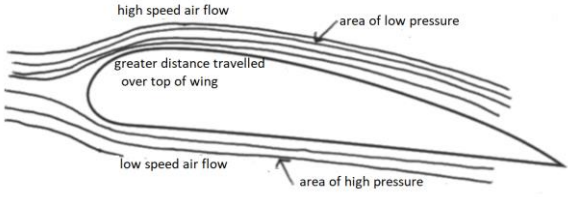
- Examiners should first make a holistic judgement on which band most closely matches the learner's response and place it within that band. Learners will be placed in the band that best describes their answer.
- The mark awarded within the band will be decided based on the quality of the answer, in response 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

### Applied Science Unit 5 1906

Question Number	Answer	Additional Guidance	Mark
1 (a)	C (gravitational potential)		1
1 (b)	D (watt)		1
1 (c)	An explanation that combines identification (1 mark) and reasoning (1 mark)  some energy is {wasted/lost/dissipated/given off/released} (1)  AND  (because it is) transferred to {thermal/heat/surroundings/environment/ motor} (1)  OR  (because it is doing work against) friction (1)	allow electricity for energy      accept sound	2
<b>Total mark</b>			<b>4</b>

Question Number	Answer	Additional Guidance	Mark
2 (a)	<p>streamlined/smooth surface/small surface area/pointed (1)</p> <p>so less/reduced {energy is used/friction/air resistance} (1)</p>	<p>allow aerodynamic</p> <p>allow cuts/slices through the air</p> <p>ignore less/reduced drag</p>	2
2 (b)	<p>lines not straight and not all the same shape (1)</p> <p>random directions/crossing/twisting/curving/bending (1)</p> <p>e.g.</p> <div data-bbox="411 1003 949 1809" data-label="Image"> <p>non-turbulent air                      turbulent air</p> <p>non-turbulent air                      turbulent air</p> <p>Figure 2</p> <p>Figure 2</p> </div>	<p>lines do not need to be joined to first set</p> <p>ignore arrows on lines</p>	2

2 (c)	<p>Award 1 mark for identification and 1 mark for linked expansion up to a maximum of 4 marks.</p>  <p>airflow is faster over (the top of) the wing (1)</p> <p>because the air travels a greater distance/ the wing is curved (making it a longer path) (1)</p> <p>so produces lower pressure (1)</p> <p>(pressure difference caused by) air traveling at different speeds above and below the wing (1)</p>	<p>marks can be gained from a labelled diagram</p> <p>allow reverse argument for each of the first three points</p>	4
<b>Total mark</b>			<b>8</b>

Question Number	Answer	Additional Guidance	Mark
3 (a)(i)	A (the kinetic energy of the steam particles increases)		1
3 (a)(ii)	<p>substitution (1)</p> <p>(W =) <math>4.5 \times 10^5 \times 0.3</math></p> <p>evaluation (1)</p> <p>135 000 (J)</p>	<p>allow full marks are awarded for correct answer of 135 000 (J) without working</p> <p>1.35 x 10<sup>5</sup> or 1.4 x 10<sup>5</sup></p> <p>allow answers rounding to 140 000 for full marks</p> <p>POT error gains 1 mark</p>	2
3 (b)	A (internal)		1
3 (c)	<p>A description that is in a logical order.</p> <p><b>(Before contact with window)</b></p> <p>steam {molecules/particles} are {far apart/moving freely/moving fast} (1)</p> <p><b>(Contact with the window)</b></p> <p>(when the steam comes into contact with the window it) water molecules/particles {lose (kinetic) energy/move more slowly} (1)</p> <p>move closer together (1)</p> <p><b>(After contact with window)</b></p> <p>(steam changes) from vapour to liquid (1)</p>	<p>allow gas for steam/vapour throughout</p> <p>allow no bonds between the molecules/particles</p> <p>allow molecules reduce in speed/slow down</p> <p>allow form bonds</p> <p>allow there is a phase change</p>	4
<b>Total mark</b>			<b>8</b>

Question Number	Answer	Additional Guidance	Mark
4 (a)	<p>Any one from: deformation/force/weight/ stress/shearing/torsion/ stretching/tension</p> <p>Accept any other appropriate response.</p>	<p>ignore 'heavy loads'</p> <p>allow bending allow compression allow pressure</p> <p>ignore strain ignore fatigue ignore gravity</p>	1
4 (b)	<p>Any one from:</p> <p>the steel will become plastic OR the steel will change shape permanently OR {atoms/crystals/particles} slip over each other/intermolecular forces broken</p>	<p>ignore 'deforms' on its own</p> <p>allow permanently deforms allow cannot return to its original shape</p> <p>allow intermolecular bonds broken</p>	1



<p>4 (c)(i)</p>	<p>conversion (1) 2.5(kN) to 2500 (N)</p> <p>substitution (1) <math>3.6 \times 10^5 = \frac{2500}{\text{area}}</math></p> <p>rearrangement (1) (area=) <math>\frac{2500}{3.6 \times 10^5}</math></p> <p>OR</p> <p>area = <math>\frac{\text{force}}{\text{stress}}</math></p> <p>evaluation (1) 0.0069 (m<sup>2</sup>)</p> <p>If stress is calculated, instead of area then maximum 2 marks</p> <p>substitution (1) stress = <math>\frac{2500}{0.007}</math></p> <p>evaluation (1) <math>3.57 \times 10^5</math>(Pa)</p>	<p>full marks are awarded for correct answer of 0.0069 (m<sup>2</sup>) without working</p> <p>conversion can take place at any stage</p> <p>substitution and rearrangement can be in either order</p> <p>allow <math>3.6 \times 10^5 = \frac{2.5}{\text{area}}</math></p> <p>(area=) <math>\frac{2.5}{3.6 \times 10^5}</math></p> <p>6.9 x 10<sup>-3</sup></p> <p>POT error gains 3 marks</p> <p>0.007 without working gives no marks</p> <p>without conversion to 2500 N gains one mark for <math>3.57 \times 10^2</math>(Pa)</p> <p>allow compensation mark if no other mark is awarded for selecting</p> <p><math>\text{stress} = \frac{F}{A}</math></p>	<p>4</p>
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<p>4 (c)(ii)</p>	<p>substitution (1)</p> $2.0 \times 10^8 = \frac{3.6 \times 10^5}{\text{strain}}$ <p>rearrangement (1)</p> $(\text{strain} =) \frac{3.6 \times 10^5}{2.0 \times 10^8}$ <p>evaluation (1)</p> $1.8 \times 10^{-3}$	<p>allow full marks for correct answer of <math>1.8 \times 10^{-3}</math> with no working</p> <p>substitution and rearrangement in either order</p> <p>strain = <math>\frac{\text{stress}}{E}</math></p> <p>allow 0.0018 ignore any units allow any correct POT error for 2 marks</p>	<p>3</p>
<b>Total mark</b>			<b>9</b>

Question Number	Answer	Additional Guidance	Mark
5 (a)	(6 + 273) 279.15 (K)	allow 279 or rounded to 279.2 or 279.1(K)  reject negative values	1
5 (b)	substitution (1) $0.35 = 1 - \frac{4680000}{Q_{in}}$ calculating the difference 1-0.35 (1)  rearrangement (1) $Q_{in} = \frac{4680000}{0.65}$ evaluation (1) 7 200 000 (J)	allow full marks for correct answer of 7 200 000 (J) with no working  substitution and rearrangement in either order       allow 7.2 x10 <sup>6</sup> (J)  POT error for 3 marks  allow 1.34 x 10 <sup>7</sup> for 2 marks  POT error for this incorrect answer 1.34 x 10 <sup>7</sup> gains 1 marks  allow 3.47 x 10 <sup>6</sup> for 2 marks  POT error for this incorrect answer 3.47 x 10 <sup>6</sup> gains 1 marks	4

Question number	Indicative content		
5 (c)	<p>Answers will be credited according to the learner's demonstration of knowledge and understanding of the material, using the indicative content and levels descriptors below. The indicative content that follows is not prescriptive. Answers may cover some or all of the indicative content, but learners should be rewarded for other relevant answers.</p>		
		<b>statements about function/working</b>	<b>statements about efficiency</b>
	<b>general statements</b>	<ul style="list-style-type: none"> <li>• input electrical supply/external work source provides the energy</li> <li>• heat is taken from inside to the outside</li> </ul>	<ul style="list-style-type: none"> <li>• insulation stops heat entering to increase efficiency</li> </ul>
	<b>compressor</b>	<ul style="list-style-type: none"> <li>• heats up when 'on'</li> <li>• compresses the vapour to form a liquid</li> </ul>	<ul style="list-style-type: none"> <li>• loses energy /energy is wasted when it runs</li> </ul>
	<b>condenser coils</b>	<ul style="list-style-type: none"> <li>• coloured black to radiate heat</li> <li>• thin metal of coils helps conduction</li> </ul>	<ul style="list-style-type: none"> <li>• heat is radiated which reduces efficiency /wastes energy</li> <li>• heat is conducted which reduces efficiency/ wastes energy</li> <li>• not all heat can be extracted from the vapour in the coils</li> <li>• efficiency depends on the temperature difference between vapour in coils and air/outside temperature</li> </ul>
	<b>expansion device</b>	<ul style="list-style-type: none"> <li>• liquid expands adiabatically to form a vapour/gas</li> <li>• gas leaving is cooler than the liquid entering</li> <li>• limits flow of liquid to the next stage (evaporator)</li> </ul>	<ul style="list-style-type: none"> <li>• this is very efficient/nearly 100% efficient/most efficient part of the cycle</li> </ul>
	<b>evaporator coils</b>	<ul style="list-style-type: none"> <li>• there is a change of state which needs heat energy input</li> <li>• heat energy is taken from the inside of the refrigerator (in order to produce a vapour)</li> </ul>	<ul style="list-style-type: none"> <li>• efficiency depends on how fast heat can be extracted from the coils</li> </ul>

	<b>judgement</b>		<ul style="list-style-type: none"> <li>• each part of the refrigerator is not 100% efficient</li> <li>• energy is lost at each stage of the cooling cycle</li> <li>• energy transfer can be limited, reducing efficiency</li> <li>• the high efficiency of the expansion device is off set by the low efficiency of other parts of the refrigerator.</li> </ul>
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**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\*.

<b>Level</b>	<b>Mark</b>	<b>Descriptor</b>
Level 0	0	No rewardable content.
Level 1	1–2	<ul style="list-style-type: none"> <li>· Adequate interpretation, analysis and/or evaluation of the scientific information</li> <li>· Generic statements may be presented rather than linkages being made so that lines of reasoning are unsupported or partially supported</li> <li>· A judgement is made which is partially supported by evidence</li> </ul>
Level 2	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>· A judgment is made which is supported by evidence</li> </ul>
Level 3	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>· A judgment is made which is fully supported by evidence</li> </ul>

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