



# Mark Scheme (Results)

Summer 2024

Pearson Edexcel GCSE  
In Physics (1PH0)  
Paper 1H

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## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question	Answer	Mark
1(a)	<p><b>D</b> it requires high temperature and pressure</p> <p><b>A</b> no emission of daughter nuclei <b>B</b> not a chain reaction</p> <p><b>C</b> does not produce radioactive waste</p>	<p><b>1</b></p> <p><b>AO1.1</b></p>

Question	Answer	Additional guidance	Mark
1(b)	<p>subtraction (1)</p> $6.69 \times 10^{-27} - 6.64 \times 10^{-27}$ <p>OR</p> $0.05 \times 10^{-27}$ <p>OR</p> $5.0 \times 10^{-29}$ <p>use of % (1)</p> $\frac{5.0 \times 10^{-29}}{6.69 \times 10^{-27}} \times 100$ <p>evaluation (1)</p> <p>0.75 %</p>	<p>accept negative mass difference throughout</p> <p>accept use of</p> $0.05 \times 10^{-27}$ $6.64 \times 10^{-27}$ <p>0.75/0.747/0.753 to any other power of 10 scores 2 marks</p> $\frac{6.64 \times 10^{-27}}{6.69 \times 10^{-27}} (\times 100\%)$ <p>or</p> <p>99% or 0.99 scores 1 mark</p> <p>award full marks for the correct answer without working</p>	<p><b>3</b></p> <p><b>AO2.1</b></p>

Question	Answer	Additional guidance	Mark
<b>1 (c) (i)</b>	50-70 (nm) inclusive		<b>1</b> <b>AO1.2</b>

Question	Answer	Additional guidance	Mark
<b>1 (c)(ii)</b>	<p>explanation linking</p> <p>(red shift means) <u>galaxies</u> must be moving away from Earth /us (1)</p> <p>more distant galaxies have bigger red shift (1)</p> <p>more distant galaxies moving faster (1)</p>	<p><u>galaxies</u> getting further apart</p> <p>ORA</p>	<b>3</b> <b>AO1.1</b>

**Total Question 1 = 8 marks**

Question number	Answer	Additional guidance	Mark
<b>2 (a)</b>	Substitution or rearrangement (1) $980 = 35 \times 10 \times h$	$(\Delta h =) \frac{\Delta GPE}{m \times g}$  or $(\Delta h =) \frac{980}{35 \times 10}$  allow use of 9.8 N/kg or 9.81 N/kg  allow substitution into visible incorrectly rearranged algebraic expression	<b>2</b> <b>A02.1</b>
	evaluation (1)  (h = ) 2.8 (m)	allow 2.85/2.86/2.9 for use of g = 9.8 N/kg or 9.81 N/kg  ignore use of negative for decrease in GPE  award full marks for the correct answer without working	

Question number	Answer	Additional guidance	Mark
<b>2 (b)</b>	substitution (1)		<b>3 AO2.1</b>
	$(v^2) = \frac{950 \times 2}{35}$	$\frac{1900}{35}$	
	evaluation of $v^2$ (1) 54(.29)		
	evaluation of $v$ (1) ( $v =$ ) 7.4 (m/s)	accept values that round to 7.3 (m/s) or 7.4 (m/s)	
		accept answer of 7 (one sig. fig.)  award 2 marks for an answer that rounds to 54 (m/s)  if no other mark scored, allow 1 mark for an answer that rounds to 0.23 (m/s) (use of mass in g)  award full marks for correct answer without working	

Question number	Answer	Additional guidance	Mark
<b>2(c i)</b>	thermal (energy/store) (1)	energy dissipated  energy wasted  energy lost  energy transferred to surroundings	<b>1 AO2.1</b>

		energy transferred due to friction	
		energy transferred due to air resistance	
		allow heat (energy)	
		ignore sound / not useful energy	

Question number	Answer	Additional guidance	Mark
<b>2 (cii)</b>	30 (J) (1)	accept -30 (J)	<b>1</b>
			<b>AO2.1</b>

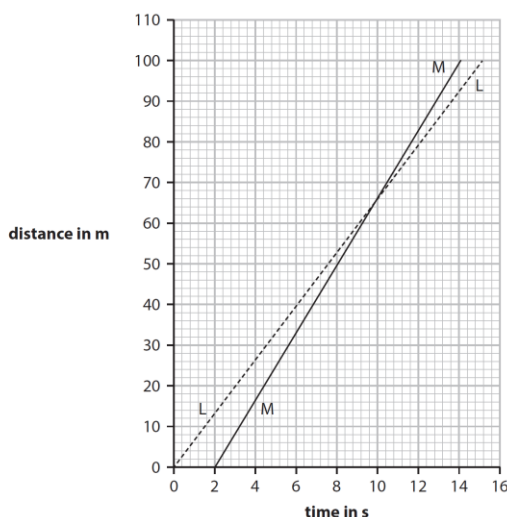
Question number	Answer	Additional guidance	Mark
<b>2 (ciii)</b>	substitution (1) $\frac{950}{980} (\times 100)$		<b>2</b>
	evaluation (1) 0.97 OR 97%	allow answers that round to 0.97 or 97% for 2 marks  allow 1 mark for answers that round to 97 or 0.97%  allow 1 mark for answers of 0.96 or 96% (truncated)  award full marks for correct answer without working	<b>AO2.1</b>

**Total Question 2 = 9 marks**



Question number	Answer	Additional guidance	Mark
<b>3 (ai)</b>	66 (m)	allow values between 64 and 68 inclusive	<b>1</b> <b>A03.2</b>
		allow values between 32 and 36 inclusive as the distance L has to run after M overtakes in this context	

Question number	Answer	Additional guidance	Mark
<b>3 (aii)</b>	select (1) $v = \frac{x}{t}$	allow any identifiable distance from graph divided by any identifiable time from graph e.g. $\frac{100}{15.2}$	<b>2</b> <b>A02.1</b>
	evaluation (1) 6.6 (m/s)	allow values that round to between 6.5 (m/s) and 6.7 (m/s) for example 6.666 (m/s) or 6.579 (m/s)	



		award full marks for correct answer without working	
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Question number	Answer	Additional guidance	Mark
<b>3 (bi)</b>	substitution (1)  (t =) $\frac{10 - 6.2}{2.5}$	$\frac{3.8}{2.5}$  allow $\frac{6.2 - 10}{2.5}$ or $\frac{3.8}{2.5}$	<b>2</b> <b>A02.1</b>
	evaluation (1) (t =) 1.5 (s)	1.52 (s)  allow -1.5(2) (s)  award full marks for correct answer without working	

Question number	Answer	Additional guidance	Mark
<b>3 (bii)</b>	substitution OR rearrangement (1)  (-)10 <sup>2</sup> = 2 × (-) 4.4 × x	(x =) $\frac{v^2 - u^2}{2 \times a}$  (x =) $\frac{(-)10^2}{2 \times (-) 4.4}$	<b>2</b> <b>A02.1</b>
	evaluation (1)  (x = ) 11 (m)	allow values that round to 11	

		(m) e.g. 11.36 (m)  ignore negative sign in answer line  accept 1.1(36) for one mark  award full marks for correct answer without working	
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Question	Answer	Additional guidance	Mark
<b>3 (c)</b>	<p>explanation linking</p> <p>mass/(change of/initial/final) velocity/(change of) momentum (1)</p> <p>with a consistent equation linking chosen factor to force (1)</p>	<p>accept speed/acceleration</p> <p>do not accept weight</p> <p>second marking point dependent on first marking point</p> <p>relevant equations are:  <math>F = ma</math>  <math>F = \frac{mv - mu}{t}</math>  <math>F = \frac{\Delta p}{t}</math>  <math>F = \frac{m\Delta v}{t}</math></p>	<b>2</b> <b>AO2.1</b>

**Total question 3=9 marks**

Question	Answer	Mark
4(a)	<b>A</b> gamma rays <b>B</b> X-rays, <b>C</b> ultraviolet, <b>D</b> microwaves, all applied externally	<b>1</b> <b>AO1.1</b>

Question	Answer	Additional guidance	Mark
4(b)(i)	explanation linking any 3 from:- positrons and electrons annihilate (1) (two) gamma (rays) produced/emitted (1) in opposite directions /at 180° (1) detected by radiation detector/ gamma cameras/scintillation counters (1) at (almost) the same time (1) time difference gives distance difference (1)	ignore positrons for this marking point allow triangulation	<b>3</b> <b>AO2.2</b>

Question	Answer	Additional guidance	Mark
4(b)(ii)	explanation linking any two from must be used a short time after production (1) half-life is short (1)	must be used while activity is high	<b>2</b> <b>AO1.2</b>

	activity decreases rapidly/decays rapidly (1)	accept decays before use / does not last long	
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Question	Answer	Additional guidance	Mark
<b>4 (c)</b>	any two from :-  irradiation does not make an object radioactive (1)  irradiation can be stopped by shielding (1)  irradiation source is outside the object (1)  irradiation stops when the source is removed (1)	ORA  ORA  source of contamination is in or on the object  effect of contamination is continuous  allow you can move away from irradiation	<b>2</b> <b>AO1.1</b>

Question	Answer	Additional guidance	Mark
<b>4(d)(i)</b>	correct use of the graph (1)	horizontal line in range 48-52 Bq to line for either isotope  allow two horizontal lines showing halving	<b>2</b> <b>AO2.1</b>

	110 to 130 (hours) inclusive (1)	of the activity  award full marks for the correct answer without working	
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Question	Answer	Additional guidance	Mark
<b>4 (d)(ii)</b>	<p><b>one</b> suggestion from:</p> <p>(Q) has longer half-life (1)</p> <p>(Q) does not decay as quickly/ takes longer to decay (1)</p> <p>(Q) (maintains) a higher (level of) activity (1)</p> <p>(Q) gives a higher <u>dose</u> (1)</p> <p>(Q) emits more ionising (type of) radiation (1)</p>	<p>allow reverse arguments</p> <p>activity decreases more slowly</p> <p>(always) more (radio)active / more decays per second</p>	<p><b>1</b></p> <p><b>AO2.2</b></p>

**Total question 4 = 11 mark**

Question	Answer	Additional guidance	Mark
5a (i)	<p>An explanation linking</p> <p>UVC/it has the smallest wavelength / highest frequency/ highest energy/most ionising (1)</p> <p>(it doesn't cause harm to people because) 100% absorbed by the Earth's atmosphere/no UVC reaches the Earth's surface/people (1)</p>	<p>allow shortest wavelength</p> <p>allow smaller for smallest / higher for highest / more for most</p>	<p><b>2</b></p> <p><b>AO3.2</b></p>

Question	Answer	Additional guidance	Mark
5(a)(ii)	<p>wavelength 280(nm) (1)</p> <p>substitution and rearrangement (1)</p> <p><math>f = \frac{3.0 \times 10^8}{280 \times 10^{-9}}</math></p> <p>evaluation (1)</p> <p><math>1.07 \times 10^{15}</math> (Hz)</p>	<p>allow 2.8 to any power of ten</p> <p>accept numbers that round up to <math>1.1 \times 10^{15}</math> (Hz)</p> <p>award 2 marks for values that round up to 1.1 to any other power of ten</p> <p>if no other mark scored allow substitution and rearrangement using an incorrect</p>	<p><b>3</b></p> <p><b>AO2.1</b></p>

		wavelength for 1 mark	
		award full marks for correct answer without working	

Question	Answer	Additional guidance	Mark
<b>5(b)</b>	<p>an explanation linking any <b>four</b> of the following:-</p> <p>UV/energy absorbed by electrons (1)</p> <p>electrons change orbit/energy level/shell (1)</p> <p>electrons in an 'excited' state (1)</p> <p>electrons emit energy/ move to lower energy level/fall down/de-excite (1)</p> <p>(energy) emitted as (visible) light / at a different frequency/wavelength (1)</p> <p>(process is called) fluorescence / (light emitted is) fluorescent (1)</p>	a labelled diagram can score up to 4 marks	<b>4</b> <b>AO1.1</b>

**Total Question 5= 9 marks**



Question	Answer	Mark
6a(i)	<b>A</b> all surfaces the laws of reflection always apply.	<b>1</b> <b>A01.2</b>

Question	Answer	Additional guidance	Mark
6 a(ii)	<p>an explanation linking <b>three</b> from</p> <p>mark the position of the mirror / mark the position of the rays of light/ place all apparatus on a sheet of paper (1)</p> <p>put in the normal to the mirror which is perpendicular to mirror (at the point of reflection) (1)</p> <p>identify/label angle of incidence and angle of reflection from the normal (1)</p> <p>use a protractor (to measure the angles of incidence / reflection / to find the normal) (1)</p>	<p>marks can be given for additions to diagram</p> <p>may be shown on diagram</p> <p>may be shown as <i>i</i> and <i>r</i> on diagram</p> <p>do not allow a mark for the use of angle of refraction</p>	<b>3</b> <b>A03.3</b>

Question	Answer	Additional guidance	Mark
<b>6b (i)</b>	<p>any one from</p> <p>the light enters the block at <math>90^\circ</math> (to the surface of the block) (1)</p> <p>the light enters the block at right angles (to the surface of the block) (1)</p> <p>the light enters the block perpendicular (to the surface of the block) (1)</p> <p>the light enters (the block) along/at the normal (1)</p> <p>the angle of incidence (when light enters block) is <math>0^\circ</math> (1)</p>		<b>1</b> <b>A03.3</b>

Question	Answer	Additional guidance	Mark
<b>6(b)(ii)</b>	<p>a description to include three from the following</p> <p>to increase the angle in the glass / angle of incidence (1)</p> <p>observe the refracted beam until the angle of refraction is <math>90^\circ</math> / the beam is along the edge / the beam just reflects into the glass block / the beams starts to total internally reflect (1)</p> <p>the angle in the glass / angle of incidence is the critical angle (1)</p> <p>repeat and take the average value(1)</p>	<p>accept move ray clockwise</p> <p>if no other mark scored award 1 mark</p>	<b>3</b> <b>A03.3</b>

		for move the ray of light	
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Question	Answer	Additional guidance	Mark
<b>6(c)</b>	<p>one from</p> <p>the image/ it cannot be produced /projected (on a screen) (1)</p> <p>the rays do not actually pass through the image (1)</p> <p>image formed when imaginary rays meet (1)</p> <p>the image is on the same side of the lens as the object (1)</p> <p>the image is upright (1)</p>	<p>ignore image is not real</p> <p>allow the image is in front of the lens</p> <p>not inverted / up side down</p>	<p><b>1</b></p> <p><b>AO1.1</b></p>

**Total Question 6 = 9 marks**

Question	Answer	Additional guidance	Mark
7(a)(i)	from 20 s to 45 s		<b>1</b> <b>AO1.1</b>

Question	Answer	Additional guidance	Mark
7(a)(ii)	<p>use of area from graph (1)</p> <p>process (1) EITHER calculation of area of trapezium OR calculation of area triangle and rectangle and triangle</p> <p>e.g.  <math display="block">\text{area} = \frac{[25 + 70]}{2} \times 15</math> OR  e.g.  area triangle = <math>\frac{15 \times 20}{2} = 150</math> (m)  area rectangle = <math>15 \times 25 = 375</math> (m)  area triangle = <math>\frac{15 \times 25}{2} = 187.5</math> (m)</p> <p>evaluation (1) 712.5 (m)</p>	<p>allow evidence of counting squares and area of one square</p> <p>accept 712 (m) or 713 (m)</p> <p>do not accept 710 (m)</p> <p>award full marks for the correct answer without</p>	<b>3</b> <b>AO2.1</b>

		working	
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Question	Answer	Additional guidance	Mark
<b>7(a)(iii)</b>	substitution and evaluation (1) (average speed =) $\frac{712.5}{70} = 10(.2) \text{ (m/s)}$	allow $\frac{710}{70} = 10(.1) \text{ (m/s)}$  allow ecf from their 7(a)(ii)  award full marks for the correct answer without working	<b>1</b> <b>AO2.1</b>

Question	Answer	Additional guidance	Mark
<b>7(b)</b>	identification of equation and substitution (1) $450 = m \times 0.35$  rearrangement and evaluation (1)  (m=) $\frac{450}{0.35}$  1300 (kg)	          accept values which round to 1300 (kg) e.g. 1286 (kg)  award full marks for the correct answer without working	<b>2</b> <b>AO2.1</b>

Question	Answer	Additional guidance	Mark
<b>7c (i)</b>	x represents <b>time</b> OR <b>t</b>  y represents <b>velocity</b> OR <b>v</b>	both correct in correct place for 1 mark  ignore units	<b>1</b> <b>AO1.1</b>

Question	Answer	Additional guidance	Mark
<b>7c(ii)</b>	attempt to find a gradient of the line that would give an answer between 0.18 and 0.24 (1)  evaluation(1)  0.21 (m/s <sup>2</sup> )	e.g. $\frac{12.5}{60}$ or $\frac{10}{42}$  values that are between 0.20 and 0.22 (m/s <sup>2</sup> ) e.g. 0.2083  do not allow fractions in the answer line for evaluation mark  award full marks for the correct answer without working	<b>2</b> <b>AO2.1</b>

Question	Answer	Additional guidance	Mark
<b>7c (iii)</b>	0	zero	<b>1</b> <b>AO2.1</b>

**Total question 7=11 marks**

Question	Answer	Mark
8(a)	D +2 A , B and C do not apply to an alpha particle	<b>1</b> <b>AO1.1</b>

Question	Answer	Additional guidance	Mark
8(b)	loss / gain of electrons (from atoms)	accept knock electrons out (of atoms)	<b>1</b> <b>AO1.1</b>

Question	Answer	Additional guidance	Mark
8(c)	<p>an explanation linking three from</p> <p>use of G-M tube (with counter) (1)</p> <p>no (obvious) radioactive sources present (1)</p> <p>measure (number of) counts in a given time (1)</p> <p>divide number of counts by time (1)</p> <p>repeat readings (1)</p> <p>calculate the average value (1)</p>	<p>allow Geiger counter / rate meter</p> <p>allow measure count rate / activity if rate meter used</p> <p>take readings in different positions in laboratory</p>	<b>3</b> <b>AO3.3</b>

Question	Answer	Additional guidance	Mark
<b>8(d)(i)</b>	<p>sketch with</p> <p>at least three objects labelled (1)</p> <p>allowed labels:  G-M tube  counter  aluminium  piece(s)/sheet(s)/foil  (metre) rule  <math>\beta</math>/beta/source</p> <p>aluminium / sheets between source and G-M tube with all three labelled (1)</p>	ignore beta particles / beta drawn as particles or waves	<b>2</b> <b>A03.3</b>

Question	Answer	Additional guidance	Mark
<b>8(d)(ii)</b>	<p>one from</p> <p>number of pieces/sheets (of aluminium/foil)(1)</p> <p>thickness of aluminium (between source and G-M tube) (1)</p>	allow amount for number	<b>1</b> <b>A03.3</b>



Question	Answer	Additional guidance	Mark
8(d)(iii)	<p><b>one</b> from</p> <p>distance between the source and the G-M tube (1)</p> <p>distance between source and aluminium pieces (1)</p> <p>distance between G-M tube and pieces of aluminium (1)</p> <p>activity of source (1)</p> <p>direction / angle of source (1)</p> <p>duration/time of measurement (1)</p>	<p>ignore background radiation / temperature</p> <p>accept beta / beta radiation for source for 1st, 2nd and 4th marking points</p> <p>do not allow 'distance of aluminium'</p> <p>accept (same) strength/intensity of source</p>	<p><b>1</b></p> <p><b>AO3.3</b></p>

Question	Answer	Additional guidance	Mark
8(d)(iv)	<p>-1 for beta <math>\beta</math> (1)</p> <p>correctly balanced equation with numbers in boxes adding to 38 (1)</p> ${}_{38}^{90}\text{Sr} \longrightarrow {}_{\boxed{-1}}^0\beta + {}_{\boxed{39}}^{90}\text{Y}$		<p><b>2</b></p> <p><b>AO1.1</b></p>

**Total question 8= 11 marks**

Question	Answer	Mark
9(a)(i)	<b>D</b>  <b>A</b> is not correct there is no vertical force <b>B</b> the centripetal force acts inward <b>C</b> is not correct there is no force acting at right angles to the radius	<b>1</b> <b>AO1.1</b>

Question	Answer	Additional guidance	Mark
9(a)(ii)	any <b>one</b> from:-  direction (of ball is) (continuously) changing (1)  there is a resultant force acting on the ball (1)  velocity/it is a vector (1)	ignore changing force /acceleration / centripetal force   velocity/it has direction	<b>1</b> <b>AO1.1</b>

Question	Answer	Additional Guidance	Mark
9 (b)	substitution or rearrangement (1)  $3500 = \frac{53 \times 4 (- 53 \times 0)}{\text{time}}$ or (time=) <u>change in</u> <u>momentum</u> force	in either order  $3500 = \frac{212}{\text{time}}$  (time =) $\frac{53 \times 4}{3500}$  (time =) $\frac{212}{3500}$  (t =) $\frac{mv - mu}{F}$	<b>3</b> <b>AO2</b> <b>.1</b>

	<p>evaluation (1)</p> <p><math>6.06 \times 10^{-2}</math> (s) or 0.0606 (s)</p> <p>rounded to 2sf (1)</p> <p><math>6.1 \times 10^{-2}</math> (s) or 0.061 (s)</p>	<p>accept</p> <p>0.06057 (s)</p> <p>0.06 (s)</p> <p>accept their calculation rounded to 2sf</p> <p>0.060 scores 2 marks (truncation)</p> <p>award three marks for the correct answer given to 2sf without working</p>	
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Question number	Indicative content	Mark
*9(c)	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>momentum</p> <ul style="list-style-type: none"> <li>• momentum is product of mass and velocity</li> <li>• <math>p = mv</math></li> <li>• momentum is a vector quantity</li> <li>• momentum of P = <math>mv</math></li> <li>• momentum of Q = <math>-mv</math></li> <li>• total momentum before collision is zero</li> <li>• <math>mv_p + (-mv_q) = 0</math></li> <li>• momentum after collision must be zero</li> <li>• total momentum before = total momentum after</li> </ul> <p>energy</p> <ul style="list-style-type: none"> <li>• before collision each trolley has kinetic energy</li> <li>• <math>KE = \frac{1}{2}mv^2</math></li> <li>• total KE before collision is sum of KE of both trolleys</li> <li>• KE after collision is zero</li> <li>• KE transferred to thermal (store)</li> <li>• KE transferred by heating and by sound</li> <li>• energy dissipated to surroundings</li> </ul> <p><b>Ignore references to equal and opposite forces and the laws of motion</b></p>	<p><b>6</b></p> <p><b>AO1.2</b></p> <p><b>AO2.2</b></p>

Command verb: Explain

AO targeting 3 marks AO1 strand 1 and 3 marks AO2 strand 1

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	<ul style="list-style-type: none"><li>• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)</li><li>• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)</li></ul>
Level 2	3-4	<ul style="list-style-type: none"><li>• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)</li><li>• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)</li></ul>
Level 3	5-6	<ul style="list-style-type: none"><li>• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)</li><li>• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)</li></ul>

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> isolated fact(s) about the momentum and/or energy of trolleys, before or after collision	<u>Possible candidate responses</u> momentum before collision equals momentum after collision  momentum is mass x velocity  momentum is a vector  energy cannot be created or destroyed  $KE = \frac{1}{2}mv^2$
Level 2	3–4	<u>Additional guidance</u> limited description of conservation of momentum and limited description of conservation of energy  OR detailed description of either conservation of energy or conservation of momentum	<u>Possible candidate responses</u> momentum/velocities of trolleys is equal and opposite before collision / zero before collision/zero after collision. trolleys have kinetic energy before collision  OR the trolleys have kinetic energy before the collision which is transferred to thermal energy after the collision.
Level 3	5–6	<u>Additional guidance</u> detailed description of conservation of momentum before and after collision and limited description of conservation of energy  OR  detailed description of energy conservation and limited description of conservation of momentum	<u>Possible candidate responses</u> momentum of trolleys before collision is equal and opposite giving zero, and momentum is zero after collision so momentum is conserved  energy is dissipated thermally after collision  OR  the trolleys have kinetic energy before the collision which is transferred to thermal energy after the collision.  momentum of trolleys is equal and opposite before collision / zero before

			collision/zero after collision.
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**Total for question 9 =11 marks**

Question	Answer	Mark
<b>10 (a)</b>	<p>B infrared ultraviolet</p> <p>A incorrect as infrasound is a longitudinal wave</p> <p>C ultrasound and infrasound are both longitudinal waves</p> <p>D ultrasound is a longitudinal wave</p>	<b>1</b> <b>AO1.1</b>

Question	Answer	Additional guidance	Mark
<b>10 (b)(i)</b>	<p>percentage transmitted (1)</p> <p><math>100 - 67 - 15</math></p> <p>18 (%)</p> <p>evaluation (1)</p> <p><math>0.25 \times \frac{18}{100}</math></p> <p>0.045 (J)</p>	<p>0.1675</p> <p>or</p> <p>0.0375</p> <p>or</p> <p><math>0.25 - 0.1675 - 0.0375</math></p> <p>or</p> <p><math>0.25 - 0.205</math></p> <p>allow 82% calculated as 0.205 (J) for 1 mark</p> <p>0.045 to any other power of ten scores 1 mark</p> <p>award full marks for the correct answer without working</p>	<b>2</b> <b>AO2.1</b>



Question	Answer	Additional guidance	Mark
<b>10(b)(ii)</b>	<p>one from</p> <p>increase the thickness (of it/ the absorber /the insulating board) (1)</p> <p>make the surface (of board) more reflective / make the board more absorbing (1)</p> <p>make board less/more dense (1)</p> <p>put an airgap in the insulating board (1)</p> <p>add another material with different density adjacent to board (1)</p>	<p>do not accept 'add more insulation' on its own</p> <p>ignore mass, surface area, volume, amount and size</p> <p>allow change the density (of the board)</p>	<p><b>1</b></p> <p><b>A03.1</b></p>

Question	Answer	Additional guidance	Mark
<b>10 (c)</b>	<p>An explanation linking more absorption giving less reflection of sound</p> <p>(coefficient of) absorption / <math>\alpha</math> is greater (for carpets / curtains than walls / wood floors)</p> <p>or</p> <p>more of the incident energy/sound is absorbed (1)</p>	<p>ignore references to insulation</p>	<p><b>2</b></p> <p><b>A03.1</b></p>

	(therefore)  less of the incident energy /sound is reflected (back into the room) or wooden floors and painted walls reflect sound (1)	accept echo/bounces around (the room) for reflection	
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Question number	Indicative content	Mark
<b>*10 (d)</b>	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p style="text-align: center;"><b>AO1</b></p> <ul style="list-style-type: none"> <li>• ultrasound pulses used</li> <li>• ultrasound has frequency above 20 kHz</li> <li>• boat has device for producing pulses</li> <li>• ultrasound pulses emitted</li> <li>• ultrasound pulses travel through sea water</li> <li>• pulses reflected by/bounce off/echo off ocean bed</li> <li>• pulses reflected/travel back to boat</li> <li>• time between emission and receipt of pulse measured by device on the boat</li> <li>• velocity of sound in sea water known</li> <li>• use of <math>v=d/t</math></li> </ul>	<p><b>6</b> <b>AO1.2</b></p> <p>A labelled diagram may give some information that is credit worthy</p>

	<ul style="list-style-type: none"><li>• speed of sound = distance/time</li><li>• <math>d = v \times t</math></li><li>• either distance halved or time halved prior to calculation of distance</li></ul> <p><b>accept 'sonar' for ultrasound</b></p>	
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Command verb: Explain

AO targeting: 6 marks AO1 strand 1

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"><li>• No rewardable material.</li></ul>
Level 1	1-2	<ul style="list-style-type: none"><li>• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1)</li><li>• Presents an explanation with some structure and coherence. (AO1)</li></ul>
Level 2	3-4	<ul style="list-style-type: none"><li>• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1)</li><li>• Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)</li></ul>
Level 3	5-6	<ul style="list-style-type: none"><li>• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1)</li><li>• Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)</li></ul>

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> isolated facts about measuring depth of ocean	<u>Possible candidate responses</u> sound emitted from boat sound goes through the sea sound bounces back / echoes time measured $\text{distance} = \text{velocity} \times \text{time}$ uses ultrasound (pulse)
Level 2	3–4	<u>Additional guidance</u> limited description of determination of depth of ocean	<u>Possible candidate responses</u> sound emitted from boat travels to ocean bed and is reflected  and  time taken from emission to receipt of wave is measured or $\text{distance} = \text{velocity} \times \text{time}$
Level 3	5–6	<u>Additional guidance</u> detailed description of determination of depth of ocean	<u>Possible candidate responses</u> ultrasound pulse emitted from boat ultrasound pulse travels to ocean bed and is reflected time taken for emission to receipt of pulse is measured velocity of sound in sea water known $\text{distance travelled} = \text{velocity} \times \text{time}$ halve distance / halve time measured to calculate depth of ocean  Any two from three of ultrasound, pulse, halving of distance or time

			required for Level 3.
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**Total for question 10 =12 marks**

**Total for paper = 100 marks**