Mark Scheme (Results)

October 2025

Pearson Edexcel International Advanced Subsidiary level In Physics
WPH15/01

Edexcel and BTEC Qualifications

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October 2025
Question Paper Log Number P78835A
Publication Code WPH15_01_2510_MS

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.

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>1</td><td>The only correct answer is D (Pushing a swing each time swing is at maximum height)

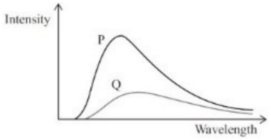
A is not the correct answer, because this is a free oscillation
B is not the correct answer, because this is a free oscillation
C is not the correct answer, because this is a free oscillation</td><td>1</td></tr>
<tr><td>2</td><td>The only correct answer is C
<table><tr><th>Alpha radiation</th><th>Gamma radiation</th></tr><tr><td>High ionisation and low penetration</td><td>Low ionisation and high penetration</td></tr></table>
A is not the correct answer, because α has high ionisation & γ has high penetration
B is not the correct answer, because α has high ionisation & γ has low ionisation
D is not the correct answer, because γ has low ionisation</td><td>1</td></tr>
<tr><td>3</td><td>The only correct answer is B (It is always in the opposite direction to the velocity)

A is not the correct answer, because this would sometimes increase the amplitude
C is not the correct answer, because this would sometimes increase the amplitude
D is not the correct answer, because this would increase the amplitude</td><td>1</td></tr>
<tr><td>4</td><td>The only correct answer is C $\left(\frac{1}{1.37 \times 10^{10} \times 3.15 \times 10^{7}}\right)$

A is not the correct answer, because conversion y to s is incorrect
B is not the correct answer, because conversion y to s is incorrect and units not s^{-1}
D is not the correct answer, because this does not have units s^{-1}</td><td>1</td></tr>
<tr><td>5</td><td>The only correct answer is A (damped)

B is not the correct answer, because the oscillation is not forced
C is not the correct answer, because the oscillation is not free
D is not the correct answer, because this is not resonance</td><td>1</td></tr>
</table>

<table>
<tr><td>6</td><td>The only correct answer is B (Distance of star X is half the distance of star Y from Earth)

A is not the correct answer, because $I \propto \frac{1}{d^2}$
C is not the correct answer, because $I \propto \frac{1}{d^2}$
D is not the correct answer, because $I \propto \frac{1}{d^2}$</td><td>1</td></tr>
<tr><td>7</td><td>The only correct answer is C


A is not the correct answer, because intensity is plotted against frequency
B is not the correct answer, because intensity is plotted against frequency
D is not the correct answer, because the hotter star has a higher peak</td><td>1</td></tr>
<tr><td>8</td><td>The only correct answer is A
<table>
<tr><th>Distance between Earth and Sun</th><th>Gravitational force</th><th>Gravitational potential energy</th></tr>
<tr><td>least</td><td>greatest</td><td>greatest</td></tr>
</table>
B is not the correct answer, because force is greatest when distance is least
C is not the correct answer, because magnitude of PE is least when distance is greatest
D is not the correct answer, because force is least when distance is greatest</td><td>1</td></tr>
<tr><td>9</td><td>The only correct answer is C ($\sqrt{2}$)

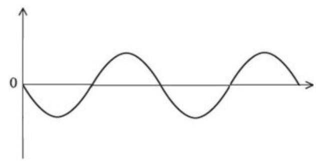
A is not the correct answer, because $T \propto \sqrt{m}$
B is not the correct answer, because $T \propto \sqrt{m}$
D is not the correct answer, because $T \propto \sqrt{m}$</td><td>1</td></tr>
<tr><td>10</td><td>The only correct answer is A ($\frac{1}{\sqrt{3}}$)
B is not the correct answer, because $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ and T is constant
C is not the correct answer, because $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ and T is constant
D is not the correct answer, because $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$ and T is constant</td><td>1</td></tr>
</table>

Question Number	Answer		Additional Guidance	Mark
11	Use of $g = \frac{GM}{r^2}$	**(1)**		
	$g = 5.8 \text{ N kg}^{-1}$	**(1)**	allow unit of m s^{-2} <u>Example of calculation</u> $g = \dfrac{6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2} \times 7.0 \times 10^{24} \text{ kg}}{(1.4 \times 6.4 \times 10^6 \text{ m})^2}$ $= 5.82 \text{ N kg}^{-1}$	**2**
	Total for question 11			**2**

Question Number	Answer		Additional Guidance	Mark
12	Use of $\frac{\Delta f}{f} \approx \frac{v}{c}$	**(1)**	must have 6.9124 ($\times 10^{14}$) in the denominator allow use of $z = \frac{\Delta f}{f}$ **and** $z = \frac{v}{c}$	
	$v = 1.1 \times 10^5 \text{ m s}^{-1}$	**(1)**	<u>Example of calculation</u> $\dfrac{v}{3.0 \times 10^8 \text{ m s}^{-1}} \approx \dfrac{(6.9149 - 6.9124) \times 10^{14} \text{ Hz}}{6.9124 \times 10^{14} \text{ Hz}}$ $v = \dfrac{3.0 \times 10^8 \text{ m s}^{-1} \times (6.9149 - 6.9124) \times 10^{14} \text{ Hz}}{6.9124 \times 10^{14} \text{ Hz}}$ $\therefore v = 1.09 \times 10^5 \text{ m s}^{-1}$	**2**
	Total for question 12			**2**

Question Number	Answer		Additional Guidance	Mark
13(a)	See an expression for gravitational potential energy, $\frac{GMm}{r}$ Equate gravitational potential energy expression to kinetic energy expression with algebra to get required expression	**(1)** **(1)**	Do **not** credit mgΔh <u>Example of derivation</u> $\frac{1}{2}mv^2 = \frac{GMm}{R}$ $v^2 = \frac{2GM}{R}$ $v = \sqrt{\frac{2GM}{R}}$	**2**
13(b)	Use of $v = \sqrt{\frac{2GM}{R}}$ with $v = c$ $R = 1.3 \times 10^{10}$ m	**(1)** **(1)**	<u>Example of calculation</u> $R = \frac{2 \times 6.67 \times 10^{-11}\ \mathrm{N\ m^2\ kg^{-2}} \times 4.30 \times 10^6 \times 1.99 \times 10^{30}\ \mathrm{kg}}{(3.0 \times 10^8\ \mathrm{m\ s^{-1}})^2}$ $R = 1.27 \times 10^{10}$ m	**2**
	Total for question 13			**4**

Question Number	Answer		Additional Guidance	Mark
14	Substitutes into $V = \frac{4}{3}\pi r^3$ to calculate volume **Or** Substitutes $V \propto r^3$ Conversion of temperature to K Use of $pV = NkT$ Temperature = 88°C **Or** Temperature = 361 K 88 (°C) < 95 (°C), so the temperature of the air in the balloon does not become equal to the temperature of the water **Or** Comparison of their calculated value with corresponding value for final situation and correct conclusion made	**(1)** **(1)** **(1)** **(1)** **(1)**	<u>Example of calculation</u> $V = \frac{4}{3}\pi\left(\frac{11.5 \times 10^{-2}\text{ m}}{2}\right)^3 = 7.963 \times 10^{-4}\text{ m}^3$ $\frac{p}{Nk} = \frac{T}{V} = \frac{(273 + 22)\text{ K}}{7.963 \times 10^{-4}\text{ m}^3} = 3.705 \times 10^5\text{ K m}^{-3}$ $V = \frac{4}{3}\pi\left(\frac{12.3 \times 10^{-2}\text{ m}}{2}\right)^3 = 9.743 \times 10^{-4}\text{ m}^3$ $T = 3.705 \times 10^5\text{ K m}^{-3} \times 9.743 \times 10^{-4}\text{ m}^3 = 360.9\text{ K}$ Temperature = (361 – 273) = 88.0°C $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ and $V = \frac{4}{3}\pi r^3$, so $\frac{r_1^3}{T_1} = \frac{r_2^3}{T_2}$ <u>Alternative method</u> $T_2 = T_1 \times \frac{r_2^3}{r_1^3}$ $T_2 = (273 + 22)\text{ K} \times \left(\frac{6.15\text{ cm}}{5.75\text{ cm}}\right)^3 = 360.9\text{ K}$	5
	Total for question 14			**5**

Question Number	Answer	Additional Guidance	Mark
15(a)(i)	x is the displacement from the equilibrium position **(1)** For equilibrium position accept: undisplaced point / position or fixed point / position or central point / position)		**1**
15(a)(ii)	The (resultant) force is in the opposite direction to the displacement **(1)**	Do **not** accept force is in the direction of the equilibrium position	**1**
15(a)(iii)	Use of $\omega = \frac{2\pi}{T}$ **(1)** Use of $v = \omega A \sin \omega t$ with $\sin \omega t = 1$ **(1)** Use of $E_k = \frac{1}{2}mv^2$ **(1)** $E_{k,max} = 1.1 \times 10^{-3}$ J **(1)** Alternative solution: Use of $T = 2\pi\sqrt{\frac{m}{k}}$ Use of $F = k\Delta x$ to calculate F Use of $W = \frac{1}{2}F\Delta x$ $E_{k,max} = 1.1 \times 10^{-3}$ J	<u>Example of calculation</u> $\omega = \frac{2\pi}{0.64\text{ s}} = 9.82\text{ rad s}^{-1}$ $v = 9.82\text{ rad s}^{-1} \times 3.5 \times 10^{-2}\text{ m} \times 1 = 0.344\text{ m s}^{-1}$ $E_{k,max} = \frac{1}{2} \times 1.8 \times 10^{-2}\text{ kg} \times (0.344\text{ m s}^{-1})^2 = 1.07 \times 10^{-3}$ J	**4**
15(b)	Minus sine graph drawn **(1)** Sinusoidal shape with approximately the same period as acceleration graph [amplitude should be approximately constant; the magnitude of the amplitude is not important] **(1)**	<u>Example of graph</u> 	**2**
	Total for question 15		**8**

Question Number	Answer	Additional Guidance	Mark
16(a)	**EITHER** Use of $\rho = \frac{m}{V}$ **(1)** Use of $\Delta E = mc\Delta\theta$ **(1)** $\Delta E = 42$ kJ **(1)** Time from graph [270 s] **and** compared with 300 s **and** consistent conclusion **Or** Energy from graph for 300 s [46 kJ] **and** compared with 42 kJ **and** consistent conclusion. **(1)** **OR** Use of $\Delta E = mc\Delta\theta$ with energy from graph for 300 s [46 kJ] **(1)** Use of $\rho = \frac{m}{V}$ **(1)** Final temperature = 62°C **(1)** Calculated final temperature compared with 65°C **and** consistent conclusion **(1)**	<u>Example of calculation</u> $m = 960\ \text{kg m}^{-3} \times 3.0 \times 10^{-4}\ \text{m}^3 = 0.288\ \text{kg}$ $\Delta E = 0.288\ \text{kg} \times 4200\ \text{J kg}^{-1}\ \text{K}^{-1} \times (100 - 65)\ \text{K} = 4.23 \times 10^4\ \text{J}$ t = 270 s for 42 kJ 270 s < 300 s, so claim is **not** accurate	4
16(b)	The rate of decease of temperature would increase **Or** Less energy transferred (as temperature changes by 35°C) **(1)** Hence the time taken for the colour to change would decrease **(1)** [MP2 dependent upon MP1]	MP1 accept temperature would decrease more quickly Ignore references to graph for MP2	2
	Total for question 16		**6**

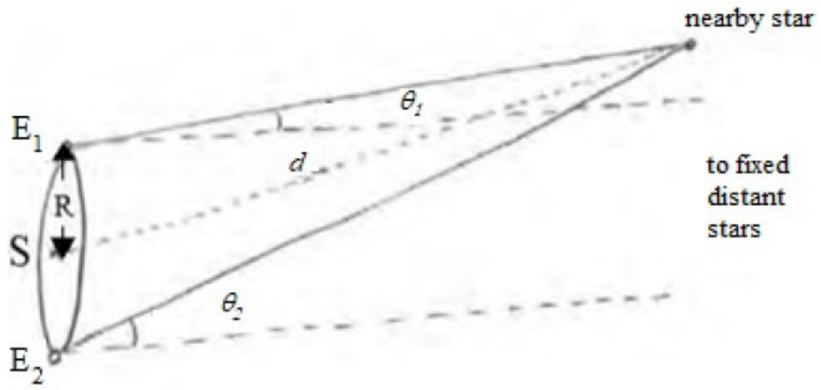
Question Number	Answer	Additional Guidance	Mark
17(a)	Top line correct **(1)** Bottom line correct **(1)**	$^{90}_{38}\mathrm{Sr} \rightarrow {}^{90}_{39}\mathrm{Y} + {}^{0}_{-1}\beta^{-} + {}^{0}_{0}\overline{\nu}_{e}$	**2**
17(b)(i)	Use of $\lambda t_{1/2} = \ln 2$ **(1)** Use of $A = \lambda N$ **(1)** $N = 1.2 \times 10^{26}$ **(1)**	Example of calculation $\lambda = \dfrac{\ln 2}{9.5 \times 10^{8}\ \mathrm{s}} = 7.30 \times 10^{-10}\ \mathrm{s}^{-1}$ $N = \dfrac{8.5 \times 10^{16}\ \mathrm{Bq}}{7.30 \times 10^{-10}\ \mathrm{s}^{-1}} = 1.16 \times 10^{26}$	**3**
17(b)(ii)	Use of $A = A_0 \mathrm{e}^{-\lambda t}$ **(1)** Conversion between seconds and years **(1)** t = 100 years, this is less than 1000 (years), so the suggestion is inaccurate **Or** After 1000 years, $A = 8.8 \times 10^{6}$ Bq which is less than 8.0×10^{15} (Bq) so the suggestion is inaccurate **(1)** (allow ecf for λ from (i))	Example of calculation $8.0 \times 10^{15}\ \mathrm{Bq} = 8.5 \times 10^{16}\ \mathrm{Bq} \times \mathrm{e}^{-7.30 \times 10^{-10}\ \mathrm{s}^{-1} \times t}$ $\ln\left(\dfrac{8.0 \times 10^{15}\ \mathrm{Bq}}{8.5 \times 10^{16}\ \mathrm{Bq}}\right) = -7.30 \times 10^{-10}\ \mathrm{s}^{-1} \times t$ $\therefore t = \dfrac{2.36}{7.30 \times 10^{-10}\ \mathrm{s}^{-1}} = 3.24 \times 10^{9}\ \mathrm{s}$ $\therefore t = \dfrac{3.24 \times 10^{9}\ \mathrm{s}}{3.15 \times 10^{7}\ \mathrm{s\ year}^{1}} = 103$ years	**3**
	Total for question 17		**8**

Question Number	Answer		Additional Guidance	Mark
18(a)(i)	Reverse temperature scale on horizontal axis including units Logarithmic scale values	(1) (1)	Accept °C and K but not °K Minimum of 3 values Maximum range of values is 60 000 K > T > 2 000 K	2
18(a)(ii)	Red giant stars are present top right of diagram **Or** The upper part of the main sequence is missing White dwarf stars are present bottom left of diagram	(1) (1)	Accept "red super giants" but not "super giants" on its own **MAX 1 mark** There are red giant **and** white dwarf stars on diagram)	2
18(b)(i)	Use of $\lambda_{\max}T = 2.898 \times 10^{-3}$ m K Calculates surface area (using $A = 4\pi r^2$) Use of $L = \sigma A T^4$ Ratio of star radii = 24 **Or** $25r_{Sun} = 1.74 \times 10^{10}$ m **Or** $\frac{r_{Arc}}{25} = 6.6 \times 10^{8}$ m Comparison of calculated value with appropriate value **and** consistent conclusion.	(1) (1) (1) (1) (1)	Example of calculation $T = \frac{2.898 \times 10^{-3}\ \text{m K}}{6.76 \times 10^{-7}\text{m}} = 4290\ \text{K}$ $A = \frac{L}{\sigma T^4} = \frac{6.54 \times 10^{28}\ \text{W}}{5.67 \times 10^{-8}\ \text{W m}^{-2}\text{K}^{-4} \times (4290\ \text{K})^4} = 3.41 \times 10^{21}\ \text{m}^2$ $r = \sqrt{\frac{3.41 \times 10^{21}\ \text{m}^2}{4\pi}} = 1.65 \times 10^{10}\ \text{m}$ $\frac{r}{r_{\text{sun}}} = \frac{1.65 \times 10^{10}\ \text{m}}{6.96 \times 10^{8}\ \text{m}} = 23.7$ $24 \approx 25$, so website claim is accurate **Or** $24 < 25$, so website claim is not accurate	5
18(b)(ii)	Arcturus would be to the right (of the Sun), as it has a lower (surface) temperature than the Sun Arcturus would be higher up (than the Sun) as it has a larger radius / luminosity (than the Sun)	(1) (1)	[Allow position corresponding to temperature of Arcturus calculated in (i)] Accept higher up and bigger (than the Sun) [Accept above and to the right (of the Sun) **Or** in the red giant region for MAX 1 mark]	2
	Total for question 18			**11**

Question Number	Answer	Additional Guidance	Mark
19(a)	(The balloon displaces air so) an upthrust acts on the balloon **Or** Upward force $= V\rho_A\ g$ **(1)** Weight of helium/balloon acts in opposite direction to upthrust **Or** Downward force $= V\rho_{He}g$ **(1)** Upthrust $>$ weight **(1)** Resultant force acts on the balloon (and balloon accelerates upwards) **(1)**	Allow "downwards" for "opposite direction to upthrust" May be seen as $U >$ W	4

<table>
<tr><td>*19(b)</td><td>Indicative content
IC1 When temperature rises (average) kinetic energy of atoms/molecules increases
IC2 (Mean) velocity/momentum of atoms/molecules increases
IC3 Atoms/molecules make more frequent collisions with balloon
IC4 Rate of change of momentum during collisions with balloon increases
IC5 Force (on balloon) increases
IC6 $p = \frac{F}{A}$ so pressure increases, (and balloon expands)</td><td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.
<table><tr><th>IC points</th><th>IC mark</th><th>Max linkage mark</th><th>Max final mark</th></tr><tr><td>6</td><td>4</td><td>2</td><td>6</td></tr><tr><td>5</td><td>3</td><td>2</td><td>5</td></tr><tr><td>4</td><td>3</td><td>1</td><td>4</td></tr><tr><td>3</td><td>2</td><td>1</td><td>3</td></tr><tr><td>2</td><td>2</td><td>0</td><td>2</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr></table>
<table><tr><td colspan="2">Number of marks awarded for structure of answer and sustained line of reasoning</td></tr><tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr><tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr><tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr></table></td><td>6</td></tr>
<tr><td></td><td>Total for question 19</td><td></td><td>10</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
20(a)	When binding energy increases energy is released **(1)** Binding energy (per nucleon) increases for ^{235}U (undergoing fission) **(1)** But binding energy (per nucleon) decreases for ^{4}He (undergoing fission) **(1)**	MAX 1 if not other mark scored Energy is released when the total mass decreases	3
20(b)(i)	Mass defect calculated **(1)** Conversion between u and kg **(1)** Use of $\Delta E = c^2 \Delta m$ **(1)** Conversion between J and MeV **(1)** Binding energy per nucleon calculated **(1)** $\text{B.E}/_{\text{nucleon}} = 8.5$ (MeV) [to at least 2 sf] **(1)**	Allow 1.67×10^{-27} kg in conversion for MP2 8.58 MeV or 8.6 MeV does **not** gain MP6 <u>Example of calculation</u> Total mass of nucleons = 28 × 1.00728 u + (56−28) × 1.00867 u = 56.4466 u $\Delta m = 55.93494 \text{ u} - 56.4466 \text{ u} = 0.51166 \text{ u}$ $\Delta m = 0.51166 \text{ u} \times 1.66 \times 10^{-27} \text{ kg u}^{-1} = 8.4936 \times 10^{-28} \text{ kg}$ $\Delta E = 8.4936 \times 10^{-28} \text{ kg} \times (3.0 \times 10^{8} \text{ m s}^{-1})^2 = 7.6442 \times 10^{-11} \text{ J}$ $\Delta E = \dfrac{7.6442 \times 10^{-11} \text{ J}}{1.60 \times 10^{-13} \text{ J MeV}^{-1}} = 477.8 \text{ MeV}$ $\text{B.E}/_{\text{nucleon}} = {}^{477.8 \text{ MeV}}/_{56} = 8.53 \text{ MeV}$	6
20(b)(ii)	Evidence of working **(1)** B.E. / nucleon for U in range (7.2 → 8.0) MeV **(1)**	<u>Example of calculation</u> B.E/nucleon for Fe = 8.6 units B.E./nucleon for U = 7.5 units B.E./nucleon for Fe = $\frac{7.5}{8.6} \times 8.5 \text{ MeV} = 7.4 \text{ MeV}$	2
	Total for question 20		**11**

Question Number	Answer		Additional Guidance	Mark
21(a)	Determine angular displacement of the star against background of distant / fixed stars over a 6 month period	**(1)**	[Accept “change in angle” or “parallax angle” for “angular displacement”] Accept diameter of the Earth’s orbit instead of reference to 6 month period	3
	Trigonometry is used to calculate the distance to the star	**(1)**	[Do not accept Pythagoras]	
	The diameter / radius of the Earth’s orbit about the Sun must be known / measured	**(1)**		
	Marks may be obtained from a suitably annotated diagram:  Diagram should indicate the Earth in two positions at opposite ends of a diameter, with lines drawn heading towards a point with a relevant angle marked		[Accept the symmetrical diagram seen in many textbooks]	

21(b)(i)	**ANY TWO FROM:** Small radius **Or** small surface area **(1)** Very dense **(1)** Very high (surface) temperature **(1)** Low luminosity **(1)** No fusion takes place **(1)**	Accept small volume Accept very hot	**2**
21(b)(ii)	Determine intensity of supernova (as observed from Earth) **(1)** [Allow "flux" for "intensity"] Luminosity of supernova is known **(1)** Use inverse square law to calculate distance (to galaxy / supernova) **(1)** [Allow reference to $I = \frac{L}{4\pi d^2}$ if I and L are defined]	Accept standard candle for supernova for all MP	**3**
21(c)(i)	**EITHER** $\frac{GMm}{r^2}$ equated to $m\omega^2 r$ **(1)** Use of $\omega = \frac{2\pi}{T}$ **(1)** Required height is total distance − radius of Earth **(1)** Height $= 3.6 \times 10^7$ m **(1)** **OR** $\frac{GMm}{r^2}$ equated to $\frac{mv^2}{r}$ **(1)** Use of $v = \frac{2\pi r}{T}$ **(1)** Required height is total distance − radius of Earth **(1)** Height $= 3.6 \times 10^7$ m **(1)**	<u>Example of calculation</u> $\omega = \frac{2\pi}{(24 \times 60 \times 60)\ \text{s}} = 7.27 \times 10^{-5}\ \text{rad s}^{-1}$ $r = \sqrt[3]{\frac{GM}{\omega^2}} = \sqrt[3]{\frac{6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2} \times 6.0 \times 10^{2}}{(7.27 \times 10^{-5}\ \text{rad s}^{-1})^2}}$ $= 4.23 \times 10^7$ m $h = 4.23 \times 10^7\ \text{m} - 6.4 \times 10^6\ \text{m} = 3.59 \times 10^7\ \text{m}$	**4**
21(c)(ii)	The lasers will act as sources of known luminosity/power **Or** the lasers are at a known distance **(1)**	Accept 'intensity' for 'luminosity'. Accept "standard candle" for "sources of known luminosity"	**1**
	Total for question 21		**13**