



# Mark Scheme (Results)

October 2021

Pearson Edexcel International Advanced  
Subsidiary Level in Physics  
(WPH15) Paper 01  
Thermodynamics, Radiation,  
Oscillations and Cosmology

Question Number	Answer	Mark
1	<b>C is the correct answer</b> A, B, D are incorrect as C is the definition of a standard candle.	(1)
2	<b>B is the correct answer</b> A is not the correct answer as it is true to say that the electric force between the nuclei is repulsive. C is not the correct answer as it is true to say that the gravitational force and the electric force both increase. D is not the correct answer as it is true to say that the gravitational force between the nuclei is attractive.	(1)
3	<b>D is the correct answer</b> A, B, C are incorrect as $T = 2\pi\sqrt{\frac{\ell}{g}}$ and $g_{\text{moon}} = \frac{g_{\text{Earth}}}{6}$	(1)
4	<b>D is the correct answer</b> A is not the correct answer as alpha radiation would not penetrate the body B is not the correct answer as alpha radiation is not very penetrating C is not the correct answer as gamma radiation is not very ionising	(1)
5	<b>C is the correct answer</b> A is incorrect as the frequency has been substituted for the period B is incorrect as period has been substituted for frequency and the half amplitude value used D incorrect as half amplitude has been substituted	(1)
6	<b>C is the correct answer</b> A, B and D are incorrect as $\lambda = \frac{\ln 2}{t_{1/2}}$ and this has been substituted incorrectly in the expression $\frac{\Delta N}{\Delta t} = (-)\lambda N$	(1)
7	<b>D is the correct answer</b> A is incorrect as this is the binding energy per nucleon of ${}^3\text{He}$ B is incorrect as this is the energy required to remove a single nucleon C is incorrect as this is the energy required to remove 2 nucleons	(1)
8	<b>D is the correct answer</b> A is incorrect as stars do not evolve along the main sequence B is incorrect as white dwarf stars do not evolve into main sequence stars C is incorrect as stars do not evolve along the main sequence	(1)
9	<b>D is the correct answer</b> A is incorrect as mass of stars increases along the main sequences B is incorrect as on an HR-diagram the temperature scale is an reverse scale C is incorrect as white dwarfs have smaller masses than main sequence stars	(1)
10	<b>D is the correct answer</b> A, B and C are incorrect because $T = \frac{2\pi}{\omega}$ and $\omega = \sqrt{\frac{a}{x}}$	(1)

Question Number	Answer	Mark
<b>11</b>	<p>Use of <math>I = \frac{L}{4\pi d^2}</math> (1)</p> <p><math>d = 8.1 \times 10^{16} \text{ m}</math> (1)</p> <p><u>Example of calculation</u></p> $d = \sqrt{\frac{L}{4\pi I}} = \sqrt{\frac{8.94 \times 10^{27} \text{ W}}{4\pi \times 1.09 \times 10^{-7} \text{ W m}^{-2}}} = 8.08 \times 10^{16} \text{ m}$	<b>2</b>
	<b>Total for question 11</b>	<b>2</b>

Question Number	Answer	Mark
<b>12</b>	<p>Use of <math>\Delta E = mc\Delta\theta</math> (1)</p> <p>Use of <math>P = \frac{\Delta E}{\Delta t}</math> (1)</p> <p>Use of <math>\Delta E = mL</math> (1)</p> <p><math>m = 0.189 \text{ kg}</math> (1)</p> <p><u>Example of calculation</u></p> $P = \frac{0.855 \text{ kg} \times 4190 \text{ J kg}^{-1} \text{ K}^{-1} \times (100 - 21.5) \text{ K}}{115 \text{ s}} = 2.45 \times 10^3 \text{ W}$ $2.45 \times 10^3 \text{ W} \times 175 \text{ s} = m \times 2.26 \times 10^6 \text{ J kg}^{-1}$ $\therefore m = \frac{2.45 \times 10^3 \text{ W} \times 175 \text{ s}}{2.26 \times 10^6 \text{ J kg}^{-1}} = 0.189 \text{ kg}$	<b>4</b>
	<b>Total for question 12</b>	<b>4</b>

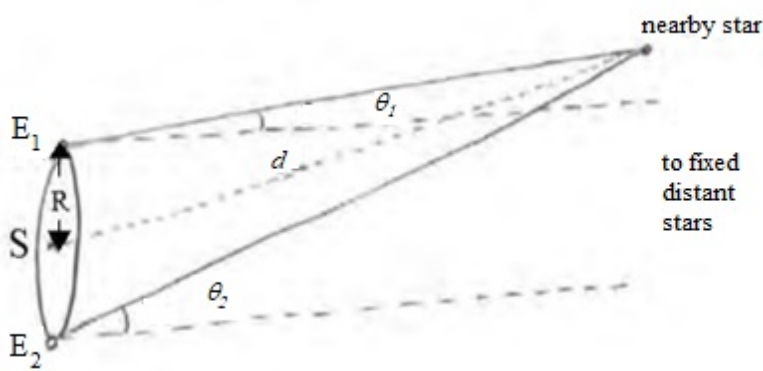
Question Number	Answer	Mark
<b>13(a)</b>	<p>Mass difference calculated (1)</p> <p>Conversion from u to kg (1)</p> <p>Use of <math>\Delta E = c^2 \Delta m</math> (1)</p> <p><math>\Delta E = 5.53</math> (MeV) (1)</p> <p>For full marks to be awarded some working should be shown – a bald answer scores zero. “Some working” must include at least two of the steps to the answer.</p> <p><u>Example of calculation</u></p> <p>Mass difference = <math>(228.02873 - 224.02021 - 4.00260) \text{ u} = 5.92 \times 10^{-3} \text{ u}</math></p> <p>Mass difference = <math>5.92 \times 10^{-3} \text{ u} \times 1.66 \times 10^{-27} \text{ kg u}^{-1} = 9.83 \times 10^{-30} \text{ kg}</math></p> <p><math>\Delta E = \left(3.00 \times 10^8 \text{ m s}^{-1}\right)^2 \times 9.83 \times 10^{-30} \text{ kg} = 8.85 \times 10^{-13} \text{ J}</math></p> <p><math>\Delta E = \frac{8.85 \times 10^{-13} \text{ J}}{1.60 \times 10^{-13} \text{ J MeV}^{-1}} = 5.53 \text{ MeV}</math></p>	<b>4</b>
<b>13(b)</b>	<p>(Mathematical) statement of momentum conservation (1)</p> <p>Use of <math>E_k = \frac{p^2}{2m}</math> (1)</p> <p><b>Or</b> use of <math>E_k = \frac{1}{2}mv^2</math> and <math>p = mv</math></p> <p>(Mathematical) statement of energy conservation (1)</p> <p><math>E_k = 5.4 \text{ MeV}</math> and statement is correct (1)</p> <p><u>Example of calculation</u></p> <p><math>p_\alpha = -p_{Ra}</math></p> <p><math>2m_\alpha E_\alpha = 2m_{Ra} E_{Ra}</math></p> <p><math>E_{Ra} = \frac{m_\alpha}{m_{Ra}} \times E_\alpha</math></p> <p><math>E_\alpha + E_{Ra} = 5.5 \text{ MeV}</math></p> <p><math>E_\alpha + \frac{m_\alpha}{m_{Ra}} \times E_\alpha = 5.5 \text{ MeV}</math></p> <p><math>E_\alpha = \frac{m_{Ra}}{m_{Ra} + m_\alpha} \times 5.5 \text{ MeV}</math></p> <p>So <math>E_k = \frac{224}{228} \times 5.53 \text{ MeV} = 5.43 \text{ MeV}</math></p>	<b>4</b>
	<b>Total for question 13</b>	<b>8</b>

Question Number	Answer	Mark
<b>14(a)</b>	<p>Use of <math>pV = NkT</math> (1)</p> <p>Temperature conversion (1)</p> <p><math>N = 6.02 \times 10^{23}</math> (1)</p> <p><u>Example of calculation</u></p> $N = \frac{pV}{kT} = \frac{1.01 \times 10^5 \text{ Pa} \times 0.0241 \text{ m}^3}{1.38 \times 10^{-23} \text{ J K}^{-1} \times (20.0 + 273) \text{ K}} = 6.02 \times 10^{23}$	<b>3</b>
<b>14(b)</b>	<p>Use of <math>\frac{1}{2}m\langle c^2 \rangle = \frac{3}{2}kT</math> (1)</p> <p>Use of 60.5 % (1)</p> <p>Ratio = 2.7 (Do not award MP3 if a value for either mass has been assumed) (1)</p> <p><u>Example of calculation</u></p> $\frac{1}{2}m_1\langle c_1^2 \rangle = \frac{1}{2}m_2\langle c_2^2 \rangle$ $\therefore \frac{m_1}{m_2} = \frac{\langle c_2^2 \rangle}{\langle c_1^2 \rangle}$ $\frac{\langle c_c^2 \rangle}{\langle c_m^2 \rangle} = 0.605^2 = 0.366$ $\frac{m_c}{m_m} = \frac{\langle c_m^2 \rangle}{\langle c_c^2 \rangle} = \frac{1}{0.366} = 2.73$	<b>3</b>
	<b>Total for question 14</b>	<b>6</b>

Question Number	Answer	Mark																																								
*15	<p>This question assesses a student’s ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>The following table shows how the marks should be awarded for structure and lines of reasoning.</p> <table><tr><td></td><td>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> <p>Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning</p> <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> <p>Indicative content</p> <p>IC1 There is a very high temperature (in the core)</p> <p>IC2 (So) nuclei/protons have a high <u>kinetic</u> energy</p> <p>IC3 (Sufficient) to overcome electrostatic repulsion</p> <p>IC4 And allow nuclei/protons to get close enough to fuse</p> <p>IC5 Gravitational forces produce a very high density (in the core)</p> <p>IC6 (So) the collision rate is high enough to sustain fusion</p>		Number of marks awarded for structure of answer and sustained line of reasoning	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2	Answer is partially structured with some linkages and lines of reasoning	1	Answer has no linkages between points and is unstructured	0	IC points	IC mark	Max linkage mark	Max final mark	6	4	2	6	5	3	2	5	4	3	1	4	3	2	1	3	2	2	0	2	1	1	0	1	0	0	0	0	<p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(1)</p> <p>6</p>
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2	2	0	2																																							
1	1	0	1																																							
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	Total for question 15	6																																								

Question Number	Answer	Mark								
16(a)	<table><tr><th><math>H_{\alpha}</math> / nm</th><th>Point</th></tr><tr><td>656.2837</td><td>B</td></tr><tr><td>656.2797</td><td>C</td></tr><tr><td>656.2757</td><td>A</td></tr></table> <p>(1)</p>	$H_{\alpha}$ / nm	Point	656.2837	B	656.2797	C	656.2757	A	1
$H_{\alpha}$ / nm	Point									
656.2837	B									
656.2797	C									
656.2757	A									
16(b)	<p><b>MAX 2 from:</b></p> <p>Light from the edge of the Sun moving toward the Earth is received with a shorter wavelength [Accept “point A” for “edge moving toward the Earth” and “blue shift” for “shorter wavelength”] (1)</p> <p>Light from the edge of the Sun moving away from the Earth is received with a longer wavelength [Accept “point B” for “edge moving away from the Earth” and “red shift” for “longer wavelength”] (1)</p> <p>There is a variation in the relative velocity between the Earth and different points on the Sun’s surface [Can be awarded if A and B incorrectly linked to change in wavelength] (1)</p> <p>[Reference to Doppler effect can score max 1]</p>	2								
16(c)	<p>Use of <math>\frac{\Delta\lambda}{\lambda} = \frac{v}{c}</math> with <math>\lambda = 656.2797</math> nm (1)</p> <p>Use of <math>v = \frac{2\pi r}{T}</math> to calculate <math>T</math> (1)</p> <p>Conversion of <math>T</math> into days. (1)</p> <p><math>T = 27.8</math> days which is approximately 28 days (1)</p> <p><b>OR</b></p> <p>Conversion of <math>T = 28</math> days into seconds (1)</p> <p>Use of <math>v = \frac{2\pi r}{T}</math> to calculate <math>v</math> [1820 m s<sup>-1</sup>] (1)</p> <p>Use of <math>\frac{\Delta\lambda}{\lambda} = \frac{v}{c}</math> with <math>\lambda = 656.2797</math> nm (1)</p> <p><math>v = 1830</math> m s<sup>-1</sup> which is approximately 1820 m s<sup>-1</sup> (1)</p> <p><b>OR</b></p> <p>Conversion of <math>T = 28</math> days into seconds (1)</p> <p>Use of <math>v = \frac{2\pi r}{T}</math> to calculate <math>v</math> [1820 m s<sup>-1</sup>] (1)</p> <p>Use of <math>\frac{\Delta\lambda}{\lambda} = \frac{v}{c}</math> with <math>\lambda = 656.2797</math> nm to calculate <math>\Delta\lambda</math> (1)</p> <p><math>\Delta\lambda = 3.98 \times 10^{-3}</math> m which is approximately <math>4.0 \times 10^{-3}</math> m (1)</p> <p>Full credit for other approaches e.g. comparison of calculated value of <math>v/c</math> from <math>T = 28</math> days and calculated value of <math>v/c</math> from <math>\frac{\Delta\lambda}{\lambda}</math> (1)</p> <p><u>Example of calculation</u></p> $v = c \times \frac{\Delta\lambda}{\lambda} = 3.00 \times 10^8 \text{ m s}^{-1} \times \frac{(656.2837 - 656.2797) \text{ nm}}{656.2797 \text{ nm}} = 1828 \text{ m s}^{-1}$ $T = \frac{2\pi r}{v} = \frac{2\pi \times 7.0 \times 10^8 \text{ m}}{1828 \text{ m s}^{-1}} = 2.41 \times 10^6 \text{ s}$ $T = \frac{2.41 \times 10^6 \text{ s}}{86400 \text{ s day}^{-1}} = 27.8 \text{ days}$	4								
Total for question 16		7								



Question Number	Answer	Mark
17(a)	<p>Find (angular) displacement of the star (as Earth moves around the Sun) over a 6 month period  <b>Or</b> find (angular) displacement of the star (as Earth moves around the Sun) over a diameter of the Earth's orbit (1)</p> <p>Measurements are made against the background of (more) distant stars (1)</p> <p>Radius/diameter of the Earth's orbit about the Sun must be known/measured (to calculate the distance to the star) (1)</p> <p>[For full credit, it must be clear that angles are being measured]</p> <p>[Marks can be obtained from an annotated diagram]</p>  <p>[Accept the symmetrical diagram seen in many textbooks]</p>	3
17(b)	<p><b>EITHER</b></p> <p>Distant galaxies are receding (1)</p> <p>The velocity of recession can be calculated from the redshift (1)</p> <p>A graph of recessional velocity against distance has a gradient equal to the Hubble constant <math>H_0</math> (1)</p> <p>The age of the universe is <math>1/H_0</math> (1)</p> <p><b>OR</b></p> <p>Distant galaxies are receding (1)</p> <p>The redshift can be calculated (1)</p> <p>A graph of redshift against distance has a gradient equal to <math>H_0/c</math> (1)</p> <p>The age of the universe is <math>1/H_0</math> (1)</p>	4
<b>Total for question 17</b>		<b>7</b>

Question Number	Answer	Mark
<b>18(a)(i)</b>	<p>Use of <math>\Delta F = k\Delta x</math> (1)</p> <p><math>k = 346 \text{ (N m}^{-1}\text{)}</math> (1)</p> <p><u>Example of calculation</u></p> <p><math>k = \frac{15.0 \text{ kg} \times 9.81 \text{ m s}^{-2}}{0.425 \text{ m}} = 346.2 \text{ N m}^{-1}</math></p>	<b>2</b>
<b>18(a)(ii)</b>	<p>(When the cradle is displaced):</p> <p>there is a (resultant) acceleration/force that is proportional to the displacement from the equilibrium position (1)</p> <p>and (always) acting towards the equilibrium position (1)</p> <p>(An equation with symbols defined correctly is a valid response for both marks For equilibrium position accept: undisplaced point/position or fixed point/position or central point/position)</p>	<b>2</b>
<b>18(a)(iii)</b>	<p>Use of <math>T = 2\pi\sqrt{\frac{m}{k}}</math> (1)</p> <p><math>T = 1.1 \text{ s}</math> (1)</p> <p><u>Example of calculation</u></p> <p><math>T = 2\pi\sqrt{\frac{(7.25+2.55) \text{ kg}}{350 \text{ N m}^{-1}}} = 1.05 \text{ s}</math></p>	<b>2</b>
<b>18(b)</b>	<p>The maximum load the spring can support when oscillating is less than the maximum load the spring supports when in equilibrium. (1)</p> <p>As when the mass is below the equilibrium position the force exerted on the spring is greater than the force at equilibrium. (1)</p>	<b>2</b>
<b>Total for question 18</b>		<b>8</b>

Question Number	Answer	Mark
<b>19(a)(i)</b>	<p>Top line correct (1)  Bottom line correct (1)</p> <p><u>Example of calculation</u></p> ${}_{27}^{60}\text{Co} \rightarrow {}_{28}^{60}\text{Ni} + {}_{-1}^0\beta^{-} + {}_0^0\bar{\nu}_e$	<b>2</b>
<b>19(a)(ii)</b>	The mass of the Ni nucleus is much larger than total mass of the other two particles (1)	<b>1</b>
<b>19(b)</b>	<p>Use of <math>\lambda = \frac{\ln 2}{t_{1/2}}</math> (1)  Use of <math>A = A_0 e^{-\lambda t}</math> (1)  t = 6.0 (years) (1)</p> <p><u>Example of calculation</u></p> $\lambda = \frac{\ln 2}{5.27 \times 3.16 \times 10^7 \text{ s}} = 4.16 \times 10^{-9} \text{ s}^{-1}$ $1.85 \times 10^{14} \text{ Bq} = 4.07 \times 10^{14} \text{ Bq} e^{-4.16 \times 10^{-9} \times t}$ $\therefore t = \frac{\ln \left( \frac{4.07 \times 10^{14} \text{ Bq}}{1.85 \times 10^{14} \text{ Bq}} \right)}{4.16 \times 10^{-9} \text{ s}^{-1}} = 1.886 \times 10^8 \text{ s}$ $\therefore t = \frac{1.894 \times 10^8 \text{ s}}{3.16 \times 10^7 \text{ s year}^{-1}} = 5.996 \text{ years}$	<b>3</b>
<b>19(c)</b>	<p>Required % transmission calculated (1)  Distance x read from graph for required transmission (1)  x = 1.1 cm, so shielding would be insufficient (1)</p> <p><b>OR</b></p> <p>Required % transmission calculated (1)  % transmission read from graph for 1.0 cm shielding (1)  % transmission <math>\approx</math> 33%, so shielding would be insufficient (1)</p> <p><u>Example of calculation</u></p> $\text{Required \% transmission} \leq \frac{1.2 \times 10^{14} \text{ Bq}}{4.0 \times 10^{14} \text{ Bq}} \times 100\% = 30\%$ <p>From graph, for required % transmission thickness of shielding = 1.1 cm,</p>	<b>3</b>
<b>Total for question 19</b>		<b>9</b>

Question Number	Answer	Mark
20(a)	A main sequence star is fusing hydrogen (into helium) in the core of the star (1)	1
20(b)(i)	Use of $L = A\sigma T^4$ and $A = 4\pi r^2$ (1) $r = 6.94 \times 10^8$ (m) (1) <u>Example of calculation</u> $r = \sqrt{\frac{L}{4\pi\sigma T^4}} = \sqrt{\frac{3.83 \times 10^{26} \text{ W}}{4\pi \times 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4} (5780 \text{ K})^4}} = 6.94 \times 10^8 \text{ m}$	2
20(b)(ii)	Use of $L = A\sigma T^4$ and $A = 4\pi r^2$ (1) Use of $\lambda_{\text{max}} T = 2.898 \times 10^{-3} \text{ m K}$ (1) $\lambda_{\text{max}} = 9.8 \times 10^{-7} \text{ (m)}$ (ecf value of $r$ from (i)) (1) <u>Example of calculation</u> $T = \sqrt[4]{\frac{L}{4\pi r^2 \sigma}} = \sqrt[4]{\frac{1600 \times 3.83 \times 10^{26} \text{ W}}{4\pi (150 \times 7.0 \times 10^8 \text{ m})^2 \times 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}}} = 2972 \text{ K}$ $\lambda_{\text{max}} = \frac{2.898 \times 10^{-3} \text{ m K}}{2972 \text{ K}} = 9.75 \times 10^{-7} \text{ m}$	3
20(b)(iii)	$\lambda_{\text{max}}$ is not in the wavelength range for red light (1) <b>Or</b> $\lambda_{\text{max}}$ is in the infrared wavelength range (1) There is a range of wavelengths emitted around the value of $\lambda_{\text{max}}$ (1) The most intense region of the visible spectrum will be red light (dependent upon MP2) (1) [Accept annotated sketches of the black body curve]	3
20(c)	(The mass of the Sun decreases and so) the gravitational force exerted on the planet decreases (1) The gravitational force provides a centripetal force (1) $F = m\omega^2 r$ , $\omega$ decreases and so $T$ must increase (1) <b>OR</b> (The mass of the Sun decreases and so) the gravitational force exerted on the planet decreases (1) The gravitational force provides a centripetal force (1) $F = \frac{mv^2}{r}$ , $v$ will decrease and so $T$ must increase (1) <b>OR</b> Equate $F = \frac{GMm}{r^2}$ with $F = m\omega^2 r$ (1) Derive expression for $T$ (1) Deduce that $T$ will increase (1)	3
	<b>Total for question 20</b>	<b>12</b>

Question Number	Answer	Mark
21(a)(i)	Use of $V_{\text{grav}} = -\frac{GM}{r}$ (1)	2
	$V_{\text{grav}} = (-) 5.53 \times 10^7 \text{ (J kg}^{-1}\text{)}$ (1)	
	<u>Example of calculation</u> $V_{\text{grav}} = -\frac{6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2} \times 5.98 \times 10^{24} \text{ kg}}{(6.36 \times 10^6 + 8.5 \times 10^5) \text{ m}} = -5.532 \times 10^7 \text{ J kg}^{-1}$	
21(a)(ii)	Use of $\Delta V \times m$ (1)	2
	$\Delta E_{\text{grav}} = 3.7 \times 10^{10} \text{ J}$ (1)	
	<u>Example of calculation</u> $\Delta E_{\text{grav}} = (-5.53 - (-6.27)) \times 10^7 \text{ J kg}^{-1} \times 4990 \text{ kg} = 3.69 \times 10^{10} \text{ J}$	
21(b)	<p>Equate <math>F = \frac{GMm}{r^2}</math> with <math>F = m\omega^2 r</math> (1)</p> <p>Substitute for <math>\omega</math> using <math>\omega = \frac{2\pi}{T}</math> (1)</p> <p>Use of <math>T^2 = \frac{4\pi^2 r^3}{GM}</math> (1)</p> <p><math>T = 6090 \text{ s}</math> <b>Or</b> <math>T = 1.69 \text{ hours}</math> (1)</p> <p>Number of orbits in 1 day = 14.2, so claim is not valid (1)</p> <p><b>OR</b></p> <p>Equate <math>F = \frac{GMm}{r^2}</math> with <math>F = \frac{mv^2}{r}</math> (1)</p> <p>Substitute for <math>v</math> using <math>v = \frac{2\pi r}{T}</math> (1)</p> <p>Use of <math>T^2 = \frac{4\pi^2 r^3}{GM}</math> (1)</p> <p><math>T = 6090 \text{ s}</math> <b>Or</b> <math>T = 1.69 \text{ hours}</math> (1)</p> <p>Number of orbits in 1 day = 14.2, so claim is not valid (1)</p> <p><u>Example of calculation</u></p> $\frac{GMm}{r^2} = m\omega^2 r$ $\therefore T = 2\pi \times \sqrt{\frac{r^3}{GM}} = 2\pi \times \sqrt{\frac{(6.36 \times 10^6 \text{ m} + 8.5 \times 10^5 \text{ m})^3}{6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2} \times 5.98 \times 10^{24} \text{ kg}}} = 6091 \text{ s}$ $\therefore T = \frac{6090 \text{ s}}{(60 \times 60) \text{ s hour}^{-1}} = 1.69 \text{ hours}$ <p>Number of orbits in 1 day = <math>\frac{24 \text{ hours}}{1.69 \text{ hours}} = 14.2</math></p>	5

<b>21(c)</b>	Advantage: satellite can cover more of the Earth's surface <b>Or</b> satellite passes close to the polar regions (1) <b>Or</b> better resolution, as satellite closer to the Earth	
	Disadvantage: satellite has to be tracked in the sky <b>Or</b> satellite data cannot be received continuously (1) <b>Or</b> cannot provide continuous viewing of a single location	<b>2</b>
<b>Total for question 21</b>		<b>11</b>