



02.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	(force of) gravity causes the satellite to accelerate (towards the Earth)	allow satellite is (constantly) accelerating	1	AO1 4.8.1.3
	the acceleration causes a change in direction	acceleration causes a change in speed negates this mark point	1	
	velocity changes because direction changes		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2	length of orbit taken from graph = 42 100 (km)	an answer of 15 scores 5 marks	1	AO2 4.8.1.3 4.5.6.1.2
	42 100 = 7.73 × time or time = $\frac{42\,100}{7.73}$	allow their distance = 7.73 × time	1	
	time (1 orbit) = 5446(s)	allow a value consistent with their distance	1	
	number of orbits = $\left(\frac{24 \times 3600}{5446}\right)$ = 15.86	allow $\left(\frac{24}{1.51}\right) = 15.86$	1	
	number of orbits = 15	allow a value consistent with their distance	1	
		allow a value consistent with their distance	1	
		an answer of 16 scores 4 marks		

	<p>or</p> <p>length of orbit taken from graph = 42 100 (km) (1)</p> $7.73 = \frac{\text{distance}}{24 \times 3600} \text{ (1)}$ <p>distance = 667 872 (km) (1)</p> <p>number of orbits = <math>\left(\frac{667\,872}{42\,100}\right)</math> = 15.86 (1)</p> <p>number of orbits = 15 (1)</p>		
		allow a value consistent with their two distances	
		allow a value consistent with their two distances	
		up to full marks can be awarded for a method calculating velocity in km/h and time in hours	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3	the predicted data is very close to the actual data		1	AO3 4.8.1.3
4	supported the prediction (made by Bode)  so provides evidence that the equation is true / correct / works / accurate	allow predicted and actual values are very close  allow proves for provides evidence	1  1	AO3 4.8.1.3
<b>Total</b>			<b>11</b>	

03.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	wavelength	this answer only	1	AO1 4.8.2 iso
2	(extremely) hot and dense	ignore very small	1	AO1/1 4.8.2 iso
3	(directly) proportional	allow a correct description of direct proportionality  ignore positive correlation	1	AO3/2b 4.8.2
4	$6 \times 10^{24}$		1	AO2/2 4.8.2 WS4.4
5	the furthest galaxies are moving the fastest  (this suggests) the universe is expanding (from a very small region)		1  1	AO1/1 4.8.2
6	expanding at (an ever) greater rate	allow expanding faster	1	AO3/1a 4.8.2
7	any one from:  <ul style="list-style-type: none"> <li>• detects false claims</li> <li>• detects inaccurate data</li> <li>• detects bias</li> <li>• verifies new data</li> <li>• provides a consensus (of opinion)</li> </ul>	allow provides credibility allow detects mistakes allow removes bias allow checks validity  ignore shows data is accurate ignore proves a theory	1	AO1/1 4.8.2 WS 1.6
8	wavelength (seems to have) decreased  frequency (seems to have) increased		1  1	AO2/1 4.8.2
<b>Total</b>			<b>10</b>	

04.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	(force of) gravity fusion	do not allow weight	1 1	AO1 4.8.1.1
2	distance = speed × time  or s = vt	allow a correct re-arrangement  do not allow d = st	1	AO1 4.5.6.1.2
3	$1.5 \times 10^{11} = 3.0 \times 10^8 \times t$  $t = \frac{1.5 \times 10^{11}}{3.0 \times 10^8}$  t = 500 (s)		1 1 1	AO2 4.5.6.1.2

4	<p><b>Level 3:</b> Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.</p>	5–6	AO1 4.8.1.2
	<p><b>Level 2:</b> Scientifically relevant facts, events or processes are identified and their relevance is clear. The account is not fully accurate.</p>	3–4	
	<p><b>Level 1:</b> Facts, events or processes are identified and simply stated but their relevance is not clear.</p>	1–2	
	<p><b>No relevant content</b></p>	0	
	<p><b>Indicative content:</b></p> <ul style="list-style-type: none"> <li>• fusion (processes in stars) produce new elements</li> <li>• cloud of gas / hydrogen <b>and</b> dust <b>OR</b> nebula</li> <li>• pulled together by gravity</li> <li>• causing increasing temperature (to start the fusion process)</li> <li>• (to become a) protostar</li> <li>• hydrogen nuclei fuse to form helium nuclei</li> <li>• and the star becomes main sequence</li> <li>• hydrogen begins to run out</li> <li>• helium nuclei fuse to make heavier elements</li> <li>• up to iron</li> <li>• the star expands (to become a)</li> <li>• red super giant</li> <li>• (the star collapses rapidly) and <u>explodes</u></li> <li>• called a supernova</li> <li>• creating elements heavier than iron</li> <li>• and distributing them throughout the universe</li> <li>• leaving behind a neutron star</li> <li>• or a black hole.</li> </ul>		
5	Temperature	1	AO1 4.6.3.2
<b>Total</b>		<b>13</b>	

05.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	gravitational force inwards and forces as a result of fusion reactions outwards	allow fusion energy for fusion reactions outwards	1	AO1 4.8.1.1
	are in equilibrium / balanced	allow radiation pressure for fusion reactions outwards  dependant on scoring 1st mark point  allow for 1 mark forces are in equilibrium	1	
2	(the star will) expand to become a red giant	the answers must be in the correct sequence to score all 3 marks	1	AO1 4.8.1.2
	(the star will) collapse to become a white dwarf	allowed outer layers ejected for collapsed	1	
	(the star will) cool to become a black dwarf	if no other marks score, allow red giant, white dwarf, black dwarf in the correct order for 1 mark	1	
3	A	reason only scores if A is chosen	1	AO3 4.8.2
	it is (moving away from Earth) the <u>slowest</u> or it is the <u>closest</u> (to the Earth)		1	
<b>Total</b>			<b>7</b>	

06.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	satellite	allow moon	1	AO1 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	12.5 cm = 0.125 m		1	AO2 4.6.1.2
	$3 \times 10^8 = f \times 0.125$	this mark may be awarded for an incorrectly / not converted value for wavelength	1	
	$f = \frac{3 \times 10^8}{0.125}$	this mark may be awarded for an incorrectly / not converted value for wavelength	1	
	$f = 2\,400\,000\,000$ (Hz)	this mark may be awarded for an incorrectly / not converted value for wavelength	1	
	$f = 2.4 \times 10^9$ (Hz)	this mark may be awarded for an incorrectly calculated value for frequency in standard form using the given data	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	gravitational force causes the Hubble Space Telescope to accelerate towards the Earth		1	AO1 4.5.1.1 4.5.6.1.3 4.8.1.3
	this changes the direction of motion (but not the speed)		1	
	so changes the velocity of the Hubble Space Telescope	if no other marks awarded, allow 1 mark for gravitational force maintains circular orbit	1	



Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	galaxy A has the greater <u>red shift</u>		1	AO3 4.8.2
	(so) A is travelling (away from us) faster (than B)		1	
	(because) A is further away (from us than B)		1	
		if no other marks awarded, allow 1 mark for galaxy A and galaxy B are moving away from us		
Total Question 6			12	