Question Number	Answer		Mark
17(a)(i)	Equate $F = \frac{GMm}{r^2}$ with $F = m\omega^2 r$ Use of $\omega = \frac{2\pi}{T}$ to calculate T Use of $n = \frac{8.64\times10^4 \text{s}}{T}$ to calculate number of orbits in 1 day In 1 day Salyut 1 would make 16.3 orbits, and so the claim is correct. **OR** Equate $F = \frac{GMm}{r^2}$ with $F = m\omega^2 r$ Use of $\omega = \frac{2\pi}{T}$ Use of $T = \frac{8.64\times10^4 \text{s}}{16}$ to calculate orbital time if 16 orbits in 1 day 5310 s < 5400 s and so the claim is correct. **OR** Equate $F = \frac{GMm}{r^2}$ with $F = m\omega^2 r$ Use of $\omega = \frac{2\pi}{T}$ to calculate T Use their value of T to calculate time t for 16 orbits If $t < 8.64 \times 10^4$ s, then claim is correct. Accept use of $F = \frac{GMm}{r^2}$ with $F = \frac{mv^2}{r}$ for MP1 and use of $v = \frac{2\pi r}{T}$ for MP2. <u>Example of calculation</u> $m\omega^2 r = \frac{GMm}{r^2}$ $\therefore \omega^2 = \frac{GM}{r^3} \ \therefore \omega = \sqrt{\frac{6.67\times10^{-11}\text{Nm}^2\text{kg}^{-2} \times 5.98\times10^{24}\text{kg}}{(6.37\times10^6\text{m} + 2.11\times10^5 \text{ m})^3}}$ $\therefore \omega = 1.183\times10^{-3}$ rad s^{-1} $\therefore T = \frac{2\pi}{\omega} = \frac{2\pi \text{ rad}}{1.183\times10^{-3} \text{ rad s}^{-1}} = 5311$ s Number of orbits $= \frac{8.64\times10^4 \text{ s}}{5310 \text{ s}} = 16.3$ If 16 sunrises per day, $T = \frac{8.64\times10^4\text{s}}{16} = 5400$ s	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	**(4)**

17(a)(ii)	Use of $V_{grav} = -\frac{GM}{r}$	(1)	
	Recognises that $\Delta E_{\text{grav}} = m \times \Delta V_{\text{grav}}$	(1)	
	$\Delta E_{\text{grav}} = (-)3.7 \times 10^{10}$ J	(1)	**(3)**
	Example of calculation $\Delta V_{\text{grav}} = -\frac{GM}{r_2} + \frac{GM}{r_1}$ $\Delta V_{\text{grav}} = GM\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ $\Delta V_{\text{grav}} = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2} \times 5.98 \times 10^{24}\ \text{kg}\left(\frac{1}{6.58 \times 10^6\ \text{m}} - \frac{1}{6.37 \times 10^6 \text{m}}\right)$ $\therefore \Delta V_{\text{grav}} = -2.00 \times 10^6\ \text{J kg}^{-1}$ $\therefore \Delta E_{\text{grav}} = -2.00 \times 10^6\ \text{J kg}^{-2}\ \times 18400\ \text{kg} = -3.67 \times 10^{10}\ \text{J}$		
17(b)	A (large) drag force acted on the satellite	(1)	
	Work is done on satellite (by drag force) and temperature of satellite increases	(1)	
	OR		
	Air in front of satellite is compressed	(1)	
	Energy is transferred to satellite (from hot air) and temperature of satellite increases	(1)	**(2)**
	MP2 dependent upon MP1		
	Total for Question 17		**9**