Question	Expected Answers	Marks	Additional guidance
1 (a) (i)	Horizontal component of **L** provides the centripetal force (WTTE) Vertical component of **L** balances the weight (WTTE)	B1 B1	
(a) (ii)	$F = mv^2/r$ correct rearranged into $v = \sqrt{(Fr/m)}$ $v = \sqrt{(1.8 \times 10^6 \times 2000/1.2 \times 10^5)} =$ **173** m s^{-1} (or 170)	C1 A1	Allow correct substitution of values into $F = mv^2/r$ for C1 mark
(b)	$mv^2/r = GMm/r^2$ $T = 2\pi r/v$ Correct manipulation of equations to give $T^2 = \frac{4\pi^2 r^3}{GM}$	B1 M1 A1	Do not allow a bare $v^2 = GM/r$ for the first mark – we need to see where this has come from.
(c) (i)	**Equatorial** orbit (WTTE) (QWC mark) Period is 24h/1day/same as Earth **OR** moves from West to East (WTTE)	B1 B1	QWC equatorial or equator must be spelled correctly
(c) (ii)	Correct rearrangement of $T^2 = (4\pi^2 r^3/GM)$ to give $r^3 = T^2GM/4\pi^2$ correct sub. $r^3 = \{6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times (8.64 \times 10^4)^2\}/4\pi^2 = 7.57 \times 10^{22}$ $r =$ **4.23×10^7 m** (or 4.2 or 4.3 x 10^7)	C1 C1 A1	(1 day = 8.64 x 10^4s is given on the data sheet). For those who use $g = GM/r^2$ with g = 9.81 award 1 mark for r= 6.4 x 10^6 m.
	Total	12	

Question	Expected Answers	Marks	Additional guidance
2 (a)(i)	resultant OR net OR overall force acts (on object) perpendicular to the velocity OR towards the centre of the circle	B1	Ignore any reference to "centripetal force"
(a)(ii)	velocity OR direction is always changing acceleration is in direction of force OR is towards the centre/perp. to velocity	B1 B1	Allow a (resultant) force is acting (hence there is an acceleration))
(b)	centripetal force OR $mv^2/r = GMm/r^2$ OR $v^2/r = GM/r^2$ $v^2 = GM/r \Rightarrow r = GM/v^2$ $r = 6.67 \times 10^{-11} \times 6 \times 10^{24} / 3700^2$ r = **2.92×10^7** m	C1 C1 C1 A1	
(c)(i)	Any mass ejected in the same direction as the satellite (WTTE)	B1	Idea of rocket motor pushing against direction of motion of satellite.
(c)(ii)	v^2r = constant OR $v^2 = GM/r$ OR $v = \sqrt{\{(6.67 \times 10^{-11} \times 6 \times 10^{24})/2 \times 10^7\}}$ new $v = \sqrt{(3700^2 \times 2.94/2)}$ = **4500** m s^{-1} (4473)	C1 A1	
	Total	**10**	