Question Number	Answer	Mark
18(a)	Use of $I = P / A$ (1) $A = 4\pi r^2$ with $r = 1.50 \times 10^{11}$ (m) (1) Solar intensity at the solar panel = 1350 W m^{-2} (1) <u>Example of calculation</u> For intensity of sunlight at the panel: $I = P / A = (3.83 \times 10^{26}\ W) / 4\pi\ (1.50 \times 10^{11}\ m)^2 = 1355\ W\ m^{-2}$	**3**
18(b)	Use of $v = f\lambda$ with $v = 3.00 \times 10^8$ m s^{-1} (1) Use of $E = hf$ (1) Energy of photon = 3.7×10^{-19} (J) (1) (Correct substitution into E = hc/λ can score both MP1 & MP2) <u>Example of calculation</u> $v = f\lambda$, $(3.00 \times 10^8\ m\ s^{-1}) = f \times (532 \times 10^{-9}\ m)$, $f = 5.64 \times 10^{14}$ Hz $E = hf = (6.63 \times 10^{-34}\ J\ s) \times (5.64 \times 10^{14}\ Hz) = 3.74 \times 10^{-19}$ J	**3**
18(c)(i)	Use of speed = distance / time with $v = 3.00 \times 10^8$ m s^{-1} (1) Height of orbit = 4.8×10^5 m (1) (Allow MP1 for candidates who fail to halve the time) <u>Example of calculation</u> Distance = speed × time = $(3.00 \times 10^8\ m\ s^{-1}) \times (3.20 \times 10^{-3}\ s / 2)$ Height of orbit = 480 km	**2**
18(c)(ii)	Photons from other/unknown sources also arrive at the satellite **Or** only photons emitted (by the laser) should be recorded **Or** other (wavelengths of) photons are not emitted (by the laser) (1) (Allow 'light' or 'waves' for 'photons')	**1**
18(d)	(For a flat surface) measurements give the same time/distance (1) (Higher elevation means that) photons/light will return in less time **Or** $s = vt/2$ gives smaller distance to the ice (1)	**2**
	Total for question 18	**11**