Question Number	Answer		Mark
17ai	Use of $P = VI$ $P = 0.11$ (W) (MP1 - Allow methods where R is calculated and then either $P = I^2R$ or $P = V^2/R$ is used to calculate P) Example of calculation $P = VI = 12.0\ \text{V} \times 9.2 \times 10^{-3}\ \text{A} = 0.11\ \text{W}$	(1) (1)	**2**
17aii	Use of $E = Pt$ to calculate energy of LED Use of $v = f\lambda$ **and** $E = hf$ to calculate photon energy Divides total energy in one minute by energy of a photon Number of photons in one minute = 2.1×10^{19} (candidates who do not convert minutes into seconds can score a maximum of 2 marks – MP2 and MP3) ("show that" value leads to 1.9×10^{19}) (allow full e.c.f. from (i)) Example of calculation $E = Pt = 0.11\text{W} \times 60\ \text{s} = 6.6\ \text{J}$ $\text{f} = \frac{v}{\lambda} = \frac{3.00 \times 10^{8}\text{ms}^{-1}}{627 \times 10^{-9}\text{m}} = 4.78 \times 10^{14}\ \text{Hz}$ $E = hf = 6.63 \times 10^{-34}\ \text{Js} \times 4.78 \times 10^{14}\ \text{Hz} = 3.17 \times 10^{-19}\ \text{J}$ Number of photons in one minute = $\frac{6.6\ \text{J}}{3.17 \times 10^{-19}\text{J}} = 2.1 \times 10^{19}$	(1) (1) (1) (1)	**4**
17b	(Lower wavelength leads to) greater (photon) energy Therefore fewer photons (in one minute) (MP1 – accept hc/λ increases or hf increases) (MP2 dependent on awarding of MP1)	(1) (1)	**2**
17c	Use of $A = 4\pi r^2$ Use of $I = P/A$ $I = 2200$ (W m^{-2}, which is greater than 1100 W m^{-2}) so student is correct (MP2 – allow if use $A = 0.69/1100$) Example of calculation $A = 4\pi\ (0.005)^2 = 3.14 \times 10^{-4}\ \text{m}^2$ $I = \frac{0.69\ \text{W}}{3.14 \times 10^{-4}\text{m}^2} = 2196\ \text{W m}^{-2}$	(1) (1) (1)	**3**
	Total for question 17		**11**