Question Number	Answer		Mark
12(a)	A standard candle is a (astronomical) object of known luminosity	(1)	**1**
12(b)(i)	Use of $P = \frac{\Delta E}{\Delta t}$	(1)	**4**
	Use of $I = \frac{P}{A}$	(1)	
	Use of $I = \frac{L}{4\pi d^2}$	(1)	
	$L = 2.2 \times 10^{35}$ (W)	(1)	
	Example of calculation $P = \frac{9.40 \times 10^{-23}\ \text{J}}{1.15 \times 10^{-3}\ \text{s}} = 8.17 \times 10^{-20}\ \text{W}$ $I = \frac{8.17 \times 10^{-20}\ \text{W}}{1.00 \times 10^{-4}\ \text{m}^2} = 8.17 \times 10^{-16}\ \text{W m}^{-2}$ $L = 4\pi d^2 I = 4\pi \times (4.60 \times 10^{24}\ \text{m})^2 \times 8.17 \times 10^{-16} = 2.17 \times 10^{35}\ \text{W}$		
12(b)(ii)	Source luminosity is much larger than the luminosity of the Sun **Or** source is equivalent to the combined output of many Suns **Or** $L_{FRB}/L_{Sun} \sim 5 \times 10^8$	(1)	**2**
	So such a large power output is unlikely to be artificially produced. **Or** the temperature would be much greater than that of the Sun (so not likely to be artificially produced) [dependent on MP1] Response consistent with their calculated value in (b)(i)	(1)	
	Total for question 12		**7**