Question Number	Answer		Mark
18a	Conversion of eV into J Use of $E = hf$ Use of $v = f\lambda$ with $v = 3.00 \times 10^8$ ms^{-1} $\lambda = 654$ (nm), so light (for this transition) is red Example of calculation $1.9 \text{ eV} \times (1.60 \times 10^{-19} \text{ JeV}^{-1}) = 3.04 \times 10^{-19}$ J $f = \frac{E}{h} = \frac{3.04 \times 10^{-19} \text{ J}}{6.63 \times 10^{-34} \text{Js}} = 4.59 \times 10^{14}$ Hz $\lambda = \frac{v}{f} = \frac{3.00 \times 10^8 \text{ ms}^{-1}}{4.59 \times 10^{14} \text{ Hz}} = 6.54 \times 10^{-7}$ m	(1) (1) (1) (1)	**4**
18b	Converts 8.60 light years into metres Use of $I = P/A$ Use of $A = 4\pi r^2$ Power of Sirius A $= 9.73 \times 10^{27}$ W Example of calculation $8.60 \times 365 \times 24 \times 60 \times 60 \times (3.00 \times 10^8 \text{ ms}^{-1}) = 8.14 \times 10^{16}$ m $P = I \times A = (1.17 \times 10^{-7} \text{ Wm}^{-2})\ (4\pi)\ (8.14 \times 10^{16} \text{ m})^2 = 9.73 \times 10^{27}$ W	(1) (1) (1) (1)	**4**
18c	Atoms have fixed/certain/discrete energy levels **Or** Emitted photons have discrete energy Only certain transitions are possible (in a hydrogen atom) **Or** Some transitions are not possible (in a hydrogen atom) (For MP2, allow "differences in energy (levels)" for "transitions")	(1) (1)	**2**
	Total for question 18		**10**