Relativity and Quantum

**Question 9.** Suppose a star radiates energy at the rate of 7×1029 W, and that its mass is 3.2×1030kg. Estimate the lifetime of the star in years.



**Question 10.** Suppose at 610 nm, the dark-adapted eye can sense a 100 ms long flash of light of total energy 5×10−17J. How many photons would this correspond to?



**Question 11.** A beam of electrons is incident on a gas of hydrogen atoms. (a) What minimum speed must they have to the atoms to make a (4) → (2) energy level transition? (b) What frequency of light would be emitted via this transition?

Hydrogen atoms will be initially in their ground state so the energy required would be that necessary to kick the electrons up to (4) from (1). So the electron speed must be…



**Question 12.** An elementary model of the nucleus consists of a proton being confined to a one dimensional box of size L. If it is observed that the nucleus emits photons of wavelength λ = 4×10-12 m when decaying from excited states, estimate the size of the nucleus L, supposing that the nucleus decayed from its first excited state to its ground state.

We have the energy levels of the proton would be:



The frequency of wavelength emitted would be:



Solving for L we have:

