PHAS1102 PHYSICS OF THE UNIVERSE
Problem class 1 - Stellar astrophysics - Week 8, 2011

The following may be adopted if required:

Planck constant	h	6.63×10^{-34} J s
Speed of light	c	3.0×10^{8} m s^{-1}
Stefan-Boltzmann constant	σ	5.7×10^{-8} W m^{-2} K^{-4}
Solar radius	$R_\odot$	7.0×10^{8} m
1 eV		1.6×10^{-19} J

1. The continuous spectra of two main sequence stars reach maximum intensities at 60 nm and 1.5 μm respectively. Determine the temperature and the approximate 1-d spectral classes of the two stars.

2. The ionisation potential of the hydrogen atom is 13.6 eV. From this fact, deduce the (approximate) wavelength (in nm) of light needed to excite an electron from the $n = 2$ to the $n = 3$ orbit of the hydrogen atom. What is the name of the series of hydrogen transitions whose lower level corresponds to $n = 2$, and the name of the transition between levels with $n = 2$ and $n = 3$?

3. The spectrum of a star shows an absorption line due to neutral sodium present in a foreground interstellar cloud. If the observed wavelength of this line is 588.965 nm, and its rest wavelength is 588.995 nm, what is the velocity of the interstellar cloud with respect to the observer? Is the cloud moving away or towards us?

   In which spectral band does the absorption line appear? What are the frequency and the energy of the line at rest? (You should specify clearly the units of these quantities.)

4. Consider star 'A' emitting as a black-body at 4,000 K and star 'C' emitting as a black-body at 10,000 K. Star 'A' has *double* the radius of star 'C'. How much more energy is emitted by star 'C' than star 'A'?

5. The Sun is a G2V star, while star 'HD 13189' is a K2II star. Explain in detail what is meant by these classification terms. (Include a list of the full sequence of Harvard types in your answer.)

6. A sunspot usually has two regions: the dark central core, or umbra, and a lighter border, or penumbra. The normal photosphere has a temperature of 5800 K, and the umbra of a sunspot is 1600 K cooler than the photosphere. Calculate how much less intense the radiation is (per unit area) from the umbra of sunspot compared to the surrounding photosphere, hence explain the visual appearance of a sunspot.

7. A red star and a blue star have the same size and are at the same distance from Earth. Which one looks brighter in the night sky? Why? (Ignore the interstellar gas and dust.)