PHAS1202 Atoms, Stars & the Universe – In-Course Assessment (14 December 2016)
Attempt all questions and show FULL workings. Distribution of marks is given in square brackets [ ].

The following may be assumed if required:

Planck constant	h	$= 6.63 \times 10^{-34}$ J s
1 eV		$= 1.6 \times 10^{-19}$ J
Proton mass		= 1.0078 amu
Helium mass		= 4.0026 amu
Mass of the Sun	$M_\odot$	$= 2.0 \times 10^{30}$ kg
Solar Luminosity	$L_\odot$	$= 3.8 \times 10^{26}$ W
Solar radius	$R_\odot$	$= 6.96 \times 10^{8}$ m
Effective temperature of the Sun		= 5800 K
Constant in Wien's law		$= 3 \times 10^{-3}$ m K
1 year	yr	$= 3.16 \times 10^{7}$ s
1 parsec	pc	$= 3.1 \times 10^{16}$ m
Speed of light	c	$= 3.0 \times 10^{8}$ m s^{-1}
Gravitational constant	G	$= 6.67 \times 10^{-11}$ m^3 kg-1 s^{-2}
Hubble constant	H_o	$= 75$ km s^{-1} Mpc^{-1}

1. *Without using the Stefan-Boltzmann constant*, calculate the radius (in units of $R_\odot$) of a white dwarf if it has a temperature of 70000 K and a luminosity of 5 $L_\odot$. Determine the wavelength of the maximum intensity of the continuous spectrum of this star. State what observational waveband this corresponds to. **[7]**

2. Sirius A has a luminosity 23.5 times that of the Sun and burns H into He. How many kg of H does Sirius A burn into He each second?
   If Sirius A has 2.3 times the mass of the Sun and 10% of its mass is in the core, calculate the lifetime (in years) of Sirius A and compare it to that of the Sun. **[7]**

3. 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 $n = 3$? **[6]**

4. List three important physical characteristics that distinguish Population I stars from Population II stars in galaxies. State which population group (a) the Sun and (b) Globular Clusters stars belong to. **[4]**

5. Suppose that the Sun is in a circular orbit of radius 8.0 kpc about the Galactic Centre, with an orbital velocity of 220 km s^{-1}. Determine the number of orbits completed by the Sun since the birth of the solar system. From your answer, briefly state what can inferred about the nature of the spiral arms. **[6]**

6. What are the differences in appearance between an SBa, Sc type and E6 type galaxy? **[5]**

7. Determine the distance to a galaxy whose spectral line of calcium is observed at 402.8 nm instead of the rest wavelength of 393.3 nm. **[5]**