

PHAS1202 Atoms, Stars & the Universe

In-Course Assessment (13 December 2017)

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	$= 6.63 \times 10^{-34} \text{ J s}$
1 eV		$= 1.6 \times 10^{-19} \text{ J}$
Proton mass		$= 1.0078 \text{ amu}$
Helium mass		$= 4.0026 \text{ amu}$
Mass of the Sun	M_{\odot}	$= 2.0 \times 10^{30} \text{ kg}$
Solar Luminosity	L_{\odot}	$= 3.8 \times 10^{26} \text{ W}$
Solar radius	R_{\odot}	$= 6.96 \times 10^8 \text{ m}$
Effective temperature of the Sun		$= 5800 \text{ K}$
Stefan-Boltzmann constant, σ		$= 5.7 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Constant in Wien's law		$= 3 \times 10^{-3} \text{ m K}$
1 year	yr	$= 3.16 \times 10^7 \text{ s}$
1 parsec	pc	$= 3.1 \times 10^{16} \text{ m}$
Speed of light	c	$= 3.0 \times 10^8 \text{ m s}^{-1}$
Gravitational constant	G	$= 6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$
Hubble constant	H_o	$= 75 \text{ km s}^{-1} \text{ Mpc}^{-1}$
Age of the solar system		$= 4.5 \times 10^9 \text{ yr}$

1. How much more energy is emitted by a star at 20,000 K than by one of the same radius at 5000 K? What is the predominant observational waveband of each star? Also express your last answer in terms of peak wavelengths. [5]

2. Calculate the main sequence lifetime (in years) of a $10\text{-}M_{\odot}$ star if it has a luminosity of $10^4 L_{\odot}$ and 10% of its mass will be converted from hydrogen to helium in the core. What will be the end state of this star? [5]

After this star has used up its fusion supply of hydrogen, its temperature decreases by a factor of 5 and the luminosity increases by a factor of 2. Determine the factor by which the radius increases? [3]

(CONTINUED - TURN OVER)

3. Use the table below to answer the following questions:

Star	Spectral Type
Aldebaran	K5 III
α Centauri A	G2 V
Antares	M1 I
Canopus	F0 II
Formalhaut	A3 V
Regulus	B7 V
Sirius	A1 V
Spica	B1 V

- (a) Which star has the highest effective temperature?
- (b) Which star has the lowest effective temperature ?
- (c) Which star is the most similar to the Sun ?
- (d) Which star is a red supergiant ?
- (e) Which star has the smallest radius ?

[5]

4. What are the differences in appearance between an SBa, Sc type and E6 type galaxy?

[5]

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 be inferred about the nature of the spiral arms.

[7]

6. 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]

7. When we observe a quasar with redshift $z = 0.15$, estimate how far into its past (in years) we are looking? State why this estimate is not exact.

[5]