ASTR 300 Stars and Stellar Systems Fall 2009

Homework Set No. 5 Due Nov 5, 2009

Please type up or print out your homework and staple the pages together. Leave a blank space to write in mathematical equations or diagrams. Make sure you **show your work** for any calculations – "magical" answers will receive no credit. Problems are **due at the beginning of the lecture**.

Review questions, Problems, etc. which have a chapter and number noted are from your text *Stars and Galaxies, 6th edition*.

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1. Why do some astronomers say that brown dwarfs are not really stars? Why are brown dwarfs hard to study?

2. What sort of star is Eta Carinae (η Car)? How is it relevant to a discussion of the extreme ends of the main sequence?

3. In the model shown in Figure 12-2 of the text, what fraction of the sun's mass is hotter than 9,300,000 K? What fraction of the sun's *volume* does this region occupy?
(Note: The volume of a sphere is $\frac{4}{3}\pi R^3$.)

4. What happens to the radius of a white dwarf as it cools off? A white dwarf with a surface temperature of 20,000 K has a luminosity of 1/100 $L_\odot$. What is the radius of this object (in solar radii)? When it has cooled to 5000 K, what will its luminosity be then?

5. If the stars at the turnoff point in a star cluster are of spectral type A0, about how old is the cluster?

6. A globular cluster contains a million stars in a sphere 20 pc in diameter. What is the average distance between the stars? How does this compare with the distance to the nearest stars to the Sun? (Hint: What share of the volume of the cluster surrounds the average star?)

7. Presumably, all the white dwarfs in our galaxy were produced by sun-like stars of medium mass. Why couldn't any of these white dwarfs have been produced by the deaths of the lowest mass stars?
(Chapter 13, Review Question 2)

8. Look at Fig. 13-3 in your text. What is the radius of a 0.5 $M_\odot$ white dwarf? What is the radius of a 1 $M_\odot$ white dwarf? Why is there no reference to the surface temperature of the white dwarf in this diagram? How does the luminosity of a 1 $M_\odot$ white dwarf compare to that of a 0.5 $M_\odot$ white dwarf if they both have a surface temperature of 10,000 K?

9. The coolest stars at the centers of planetary nebulae are about 25,000 K. Why don't astronomers see planetary nebulae with cooler central stars? (Hint: What kind of photons excite the gas in a planetary nebula?)
(Chapter 13, Review Question 5)

10. If a planetary nebula is 0.2 light-years in diameter and is expanding at a velocity of 20 km/s, typical for a planetary nebula, how old is it? (Hint: 1 ly = 9×10^{12} km.)