Astronomy 111 **Fall 2017**

Homework Assignment #5

(remember: no ragged edges; write on one side of page only; leave room for comments/corrections)

due in class Tu. 11/14

1. Arrange the following stars in order of evolutionary stage:

a) A star with no reactions going on in the core, which is made primarily of carbon and oxygen

b) A star of uniform composition, containing hydrogen but with no nuclear reactions going on in the core

c) A star that is fusing hydrogen to helium in its core

d) A star that is fusing helium to carbon in its core and hydrogen to helium in a shell around the core

e) A star that has no nuclear reactions going on in the core but is fusing hydrogen to helium in a shell around the core

2. A spherical planetary nebula is observed to be expanding uniformly at 20 km/sec. Its diameter is 1 light year. Find its age in **years**.

3. The Galaxy is about 10 billion years old. What must be true of the original main sequence masses of stars that are now white dwarfs? Put another way, could a currently observed white dwarf have been a 1 M_{sun} main sequence star? Why or why not?

4. (Question based on Problem 10.13)

a) Calculate the total thermal energy stored in a $1M_{\odot}$ white dwarf with an average internal temperature of 10^7 K. Assume an average mass per particle equal to the mass of a proton.

b) If the star radiates like a 10^4 K blackbody, estimate its luminous lifetime, assuming a typical radius for a white dwarf, and comment.

5. a) Use the equation of hydrostatic equilibrium to estimate the required central pressure in a $1M_{\odot}$ white dwarf of radius 10^4 km, following the reasoning in Example 9.4 in the text (p.169). You should get a pressure ~ 10^{22} Pa =N/m^2.

b) Calculate the thermal gas pressure at the center of the white dwarf, assuming a temperature of 10^7K. You will need to calculate the average mass density from the data in part a) and assume the average mass per particle is 0.5 x the mass of a proton (average mass of $m_p + m_e \sim 0.5m_p$). Comment on the ability of thermal pressure to support the white dwarf.

c) Calculate the degenerate gas pressure according to equation 10.11 in the text and compare to the values in parts a) and b), and comment. Assume Z/A=1.

Kutner:
Ch. 10: Problems 7, 9, 10