PHYS 321: PROBLEM SET 5

Due Mar 26, 2018 Mon @ 11:30 am

Solve the problems listed below, and ***write up your answers clearly and completely****. Do not turn in rough work – instead, make a clean copy after checking your calculations. Use English sentences and phrases to explain your solution and describe your answers step by step. Even if you did not get the correct answer, you may get partial credits for these steps!*

1. (2 credits) We wrote the mean molecular weight μ for a fully ionized gas as $\frac{1}{\mu} = 2X + \frac{3}{4}Y + \frac{1}{2}Z$. Derive this relationship for μ, indicating the assumptions and approximations used in each step.

2. (2 credits) Star Vega is an A0 V star. Use hydrostatic equilibrium and scaling arguments of Example 10.1.1 of the textbook to compare the central pressure of the Sun with Vega (Hint: look up necessary parameters you need from Appendix G of the textbook. Comparing with the Sun means expressing in units of the solar values.)

3. (4 credits) Estimate the hydrogen-burning lifetimes of stars near the lower and upper ends of the main sequence. The lower end of the main sequence occurs near 0.072 $M_\odot$, with $\log_{10} T_e = 3.23$ and $\log_{10}(L/L_\odot) = -4.3$. On the other hand, an 85 $M_\odot$ star near the upper end of the main sequence has an effective temperature and luminosity of $\log_{10} T_e = 4.705$ and $\log_{10}(L/L_\odot) = 6.006$, respectively. Assume that the 0.072 $M_\odot$ star is entirely convective so that, through convective mixing, all of its hydrogen, rather than just the inner 10% of the massive stars, becomes available for burning.

4. (2 credits) Using the information given in the problem above, calculate the radii of a 0.072 $M_\odot$ star and a 85 $M_\odot$ star. What is the ratio of their radii?