Astronomy 45

Introduction to Astrophysics

Fall 2002

Problem Set 9 - Due Monday December 2, 2002

1. Saturn is at an average distance of 9.54 AU from the Sun. It has a radius R=6×10^9 cm and a mass $M = 5.69 \times 10^{26}$ kg. The solar luminosity $L_\odot = 3.84 \times 10^{33}$ ergs s^{-1}. What is the solar flux received by Saturn? Saturn emits 2.8 times the energy it receives from the Sun. If the additional energy is produced by gravitational contraction of the planet, at what rate must Saturn shrink each year given that its gravitational potential energy is -GM^2/R.

2. A star has a density which varies with radius r as $\rho_0(R^2/r^2)$ where R is the stellar radius. Calculate the pressure $P(r)$ as a function of r.

3. Assume the solar luminosity is produced by the conversion of hydrogen to helium. Given that $L_\odot = 3.83 \times 10^{33}$ ergs s^{-1} , how much mass of hydrogen is converted to helium each second?

4. Consider two non-relativistic white dwarfs *with the same central density*, one of which is made of carbon with μ_e = 2.00 and the other of iron with μ_e =2.15. Which star has the smaller radius and which the smaller mass? Also calculate the ratio of the Chandrasekhar masses of the two stars.