

Problem Set 4
(due October 28)

1. The mass of a hydrogen atom is 1.007825 u, where 1 u is an atomic mass unit. The mass of a helium atom is 4.002603 u. How much energy is released when 1 kg of H is converted into He?
2. Consider a star of mass $M = 10M_{\odot}$. Assume that the mass-luminosity relationship has the form $L \propto M^3$.
 - (a) What is the main-sequence (i.e., hydrogen burning) time for this star?
 - (b) What is the *neutrino luminosity* of this star? Do you think that many of these neutrinos would be detected in an experiment that used chlorine as its detector?
3. The composition of the center of a certain star is 60% H and 35% He.
 - (a) Assuming complete ionization, what is the mean mass per particle, μ , in units of m_H ?
 - (b) Using the ideal gas equation of state, find the pressure at the center of the star if the central density is $5.0 \times 10^4 \text{ kg m}^{-3}$ and the temperature is $T_c = 1.5 \times 10^7 \text{ K}$.
4.
 - (a) Estimate the rate at which the Sun is losing mass due to nuclear reactions. Express your answer in solar masses per year. Compare your result to the mass loss due to the solar wind which is $\sim 3 \times 10^{-14} M_{\odot} \text{ yr}^{-1}$.
 - (b) Assuming that these rates are constant with time, what fraction of the Sun's mass is lost over its main sequence lifetime?