Homework #4

1. Ryden & Peterson - Problem 17.2

2. Ryden & Peterson - Problem 17.3

3. Knowing that the wavelength of the $J = 1 \to 0$ transition of $^{12}$C$^{16}$O is 2.6 mm,
   
   (a) Calculate the separation between the carbon and oxygen atoms in the CO molecule.

   (b) Calculate the wavelength of the $J = 1 \to 0$ transition of the isotopic molecule $^{12}$C$^{18}$O.

4. For the H II region described by Equation (16.20),
   
   (a) How much thermal energy is contained in the Strömgren sphere?

   (b) What is the optical depth of the Strömgren sphere to Thomson scattering?

   (c) Estimate the luminosity in thermal Bremsstrahlung radiation and compare it to the ionizing luminosity of the star. At what frequencies does this radiation appear? Approximate the thermal Bremsstrahlung spectral emissivity as

   $$ \varepsilon_{\nu} \approx 6.8 \times 10^{-38} n_e n_p T^{\frac{1}{2}} e^{-\frac{h\nu}{kT}} \left[ \frac{\text{erg cm}^3 \text{s Hz}}{\text{erg cm}^3 \text{s Hz}} \right] $$

5. If a cloud collapses initially at constant temperature (isothermal), how does its Jeans mass change as a function of its density? How could this explain fragmentation and formation of several stars from a single cloud?

6. If the cloud in Problem 5 eventually becomes adiabatic (conserving energy), its temperature will then be proportional to $\rho^{(\gamma - 1)}$. If this is a molecular cloud, how does its Jeans mass then change as a function of its density? How would this affect fragmentation of the cloud?

7. Derive an approximate value for the contraction time of the 60 $M_\odot$ pre-main-sequence star whose evolutionary track is illustrated in Figure 12.11 distributed in class on Tues., Feb. 8. Compare your value to the one listed in the accompanying Table 12.1.