ASTR705 ISM
HW #7
Due Wednesday, 4/5 in class

1) Consider an electron in an H I cloud with $n_H = 30$ cm^{-3}, $T = 100$ K, $n(\mathrm{H}^+) = 0.005$ cm^{-3}, $n(\mathrm{C}^+) = 0.005$ cm^{-3}, and $n_e = 0.01$ cm^{-3}.
a) What is the probability per unit time for a given proton to radiatively recombine with an electron?
b) What is the probability per unit time for a given C^+ ion to radiatively recombine with an electron?

2) Suppose that an electron recombines into the $n = 4$, $\ell = 3$ ($4f$) level of hydrogen.
a) What is the probability that an Hα photon will be emitted during the radiative cascade down to the ground state?
b) What is the probability for Hβ?
c) What is the radiative recombination rate into all levels higher in energy than $4f$ for Case A and Case B recombination?

3) The 12.8 μm Ne^+ line is caused by the $^2\mathrm{P}_{1/2}$ to $^2\mathrm{P}_{3/2}$ transition.
a) What is the collisional excitation (not ionization) and de-excitation rate of this transition? The units should be cm^3 s^{-1}. You may have to assume a temperature.
b) What is the ratio of Ne^+ in the upper state compared to the lower state?

4) Under what conditions are Case A and Case B recombination appropriate? I'm looking for numbers here, not just general arguments!