Astronomy 223
Planetary Physics
Winter 2011
Problem Set #2
February 9, 2011
Due: Wednesday, Feb. 16th

1) Find the paper Burrows & Sharp (1999), Astrophysical Journal, vol 512, p. 843-863. For instance, here: http://adsabs.harvard.edu/abs/1999ApJ...512..843B
Read as much of the paper as you like. It covers equilibrium chemistry in tremendous detail. We're interested in Table 1 and the Appendix. You'll also use the attached atmospheric pressure-temperature profiles for a Jupiter model, a 600 K "young Jupiter", and 1500 K brown dwarf. Using the abundances of C, N, O, and H from Table 1, and Equations A1-A9, **plot**, for each of the three profiles, the mixing ratio of CH_4, CO, H_2O, N_2, and NH_3 as a function of pressure in the atmospheres. The mixing ratio can be defined as the partial pressure of the molecule of interest divided by the total pressure. Since the appendix expressions actually give you the: (partial pressure of the molecule) / (the pressure of H_2), you can assume that the total pressure is 20% larger than the pressure of H_2. You can ignore the loss of O into silicate condensates below 1700 K. **Convince yourself** that the plotted results make sense. :)

2) NASA engineers circularized the orbit of the Mars Global Surveyor spacecraft by skimming the upper atmosphere of Mars near the spacecraft's periapse. This maneuver was repeated during a 16-month "orbit insertion" phase of the mission in 1997 and 1998. This has become a standard method for circularizing spacecraft orbits. Atmospheric drag reduces the orbital energy and lowers the apoapse without the expense and risk of using a large thruster engine. But a new element of risk, of a different kind, is introduced by the aerobraking approach. If a meteorological event, such as a global dust storm, raises the mean temperature of the atmosphere, the atmosphere puffs up and the spacecraft encounters a higher density than expected. It is a consequence of hydrostatics that a temperature change by a small percentage can change the density near periapse altitude by a relatively large factor. As a result, it became very important to monitor the atmospheric temperature carefully. **Check this out** for yourself. Find the atmospheric mean molecular weight and Martian surface gravity. Assume an isothermal and constant g atmosphere and a periapse altitude of 120 km. By what factor does the periapse density change when the mean atmospheric temperature changes from 150 K to 165 K?

3) On Mars some of CO_2 atmosphere can freeze out onto the polar caps during the ~300 day winter. The latent heat of CO_2 is about 5.7×10^5 J/kg. The surface temperature in the polar regions during winter is about 145 K. Assume that the surface can effectively radiate to space. Estimate the depth of CO_2 snow that accumulates in a winter. Assume a snow/ice density of 0.3 g/cm^3