ASTR 321-Fall 2007
Problem set #7

due tuesday Dec. 4

1) Diamonds require a minimum pressure to form and inside Earth they do not form at a depths shallower than 150Km. What is the smallest size (diameter in km) body where the pressure at its center could allow the formation of diamonds? Use 3500 kg/m3 for both bodies. The pressure inside Earth, close to its surface is the just the weigh of a column of rock $P=\rho gh$ where ρ is the density, g is the local gravitational constant and h is the depth of the column {this is the weight of a column of unit area and length =h}. The pressure in the center of a spherical body is proportional to the square of the bodies size and is given on page 194 of the text.

2) The pressure (P) in a constant temperature atmosphere varies with altitude (Z) as

$$P = P_o e^{-Z/H}$$

where P_o is the surface pressure, Z is the altitude and H is the scale height (the change in altitude required for the pressure to decrease by e^{-1}). As derived from hydrostatic equilibrium ($dP/dr= -g\rho$) and the perfect gas law ($P=\rho kT/\mu M_h$) -see page 322 in the text

$$H = \frac{kT}{g\mu M_h}$$

where μ is the molecular weight (relative to hydrogen), M_h= hydrogen mass, K is the Boltzmann constant, T is absolute temperature, and g is the local gravitational constant.

Assuming a pure N_2 (molecular wt =28) atmosphere and a temperature of 300K calculate the pressure at the top of Mt Rainier (height defined to be 5km) <u>relative</u> to the pressure at sea level (the answer should be a ratio less than 1).

3) What would the pressure ratio have been on the ancient earth when it had a pure CO_2 atmosphere ? (molecular weight =44)

4) Is the pressure at the top of Mt Rainier lower or higher on a hot day versus a cold day? Assume that the sea-level pressure is constant.