ASTRONOMY 020

Practice Set #10

Not to be turned in

1. Show that the equilibrium temperature of a planet that was derived in class,

$$T_p = (1 - A)^{1/4} (R_\odot / 2 r_p)^{1/2} \, T_\odot , \tag{1}$$

   can be simplified to the form

$$T_p \approx 279 (1 - A)^{1/4} (r_p)^{-1/2} \, \mathrm{K}, \tag{2}$$

   where r_p is now expressed in units of AU. All quantities in the equations are as defined in the text or notes.

2. To a good approximation, the Earth's atmosphere is composed of 78% nitrogen molecules (N_2), 21% oxygen molecules (O_2), and 1% Argon atoms (Ar). (You can see Table 4-1 in the textbook for a more detailed breakdown, but need not consider such details here.)
   (a) Calculate the mean molecular weight μ of gas in the Earth's atmosphere, i.e., if particles have an average mass $m = \mu m_{\mathrm{H}}$, then what is the value of μ?
   (b) Given the average surface temperature $T = 290$ K near the Earth's surface, estimate the distance above the surface at which the gas density drops to $1/e$ of its surface value; this is the scale height.

3. On a clear night, if you are patient and away from city lights, you can see about 10 meteors per hour. The meteoroid that creates a meteor has a typical mass of about 1 g (and burns up about 100 km above the Earth's surface). Estimate the amount of mass of meteoroids that enters the Earth's atmosphere per year. Compare to the estimated 10^9 kg of smaller dust particles that fall on the Earth each year. What is the ratio of the two amounts? Taking the combined infall due to dust and meteoroids, what is the ratio of the total mass added in the Earth's 4.5 billion year life (assuming a constant infall rate) to the Earth's current mass.

4. Zeilik & Gregory, Chapter 7, problem 17, part (a) only.