'G&G 140a

The Atmosphere, Ocean and Environmental Change

Problem Set #2 (Due Friday **Sept. 17)**

1. Mars has a radius of 3.39 x 10^6 m and a surface gravity of 3.73 ms^{-2}. Calculate the escape velocity for Mars and the typical speed of a CO_2 molecule (assume T = 250 K). How can Mars retain its CO_2 atmosphere? (Hint: the molecular weight of carbon dioxide is 44. Use the formulae given in class.)

2. Give an approximate altitude or depth above or below sea level (in kilometers) for:
   a) the tropopause
   b) the ozone layer
   c) the stratosphere
   d) the cruising altitude of a light plane (Cessna 172, Piper 180, etc.)
   e) the cruising altitude of a DC-10
   f) the cruising altitude of the Concorde
   g) a typical cumulus cloud
   h) a cirrus cloud
   i) Mt. Everest
   j) Mt. McKinley (Alaska)
   k) Mt. Washington (New Hampshire)
   l) the thickness of the turbulent boundary layer on a sunny day
   m) the top of a cumulonimbus anvil
   n) the density scale height
   o) depth to the abyssal plain
   p) depth to a deep ocean trench
   q) thickness of the earth's crust
   r) radius of the earth

3. If the sea level air density is 1.2kg/m3, and the scale height is 8000meters, estimate the air density at an altitude of 5000meters. What assumptions have you made? What is the density at 50,000m?

4. Using the Stefan-Boltzmann Law, $F = \sigma T^4$, determine the flux of radiant energy emitted from one square meter of a) the Sun's surface (T=6000K), and b) the Earth's surface (T=288K). [The Stefan-Boltzmann Constant is $\sigma = 5.735 \cdot 10^{-8} Wm^{-2} K^{-4}$]. Do these two objects emit at the same wavelength?

5. Using the formula for the average temperature of a planet, $T = [\frac{S(1-a)}{4\sigma}]^{1/4}$ predict the earth's temperature assuming that S=1380W/m2 and a=0.33. How much would this predicted temperature change if the albedo were increased to 0.4? Explain.

6. What is the special structure and property of a greenhouse gas molecule? Give a few examples of greenhouse gases.

7. Given an atmospheric surface pressure of 1013hPa, a surface gravity of g=9.81m/s2 and an earth radius of 6370km, compute the mass of the earth's atmosphere.

8. On a typical day, the pressures at hill base and hill top are measured to be p=1020mb and 950mb

9. Recall the tank experiment done in class. Imagine that the exit valve coefficient is K=10 (cgs units). Predict the steady state depth of water (z) for inflow rates of 20, 40 and 80 milliliters/second. Explain any problems you encounter. (Hint: Use $Q_{out} = K\sqrt{z_{eff}}$ and $z_{eff} = z + 6$)