Assignment III, PHYS 308 (Atmospheric Physics)
Fall 2016
Due 9/9/16 at start of class

> Please provide full, legible, easy to follow solutions to the following problems. I can't give you credit if I can't read it (or I can't follow your reasoning). Extensive exposition on your thought process or strategy is always appreciated. Don't just give me a string of equations! A solution involves a thought process/words as well as mathematical manipulation!

1. As I'm writing this, the sea-level equivalent pressure in Charleston is 30.16 inches of Mercury. If I went to Denver (elevation 5225 ft.), what would the measured (station) pressure have to be (in mbar) if the sea-level equivalent pressure is the same as Charleston? You may assume Charleston is at sea level.

2. Assume that the Venusian atmosphere is pure CO_2 (more or less true). Also assume the temperature of the surface gas on Venus matches the planet's mean surface temperature of about 740K. The radius of Venus is about 6.05×10^6 m and its mass is about 4.87×10^{24} kg. Find the scale-height (the height above the surface where the pressure is e^{-1} of its surface pressure) in the Venusian atmosphere. [Note – you will not need to know anything about how much actual gas is there to find this! Cool.]

3. What is the solar constant for Pluto when it is at its furthest distance from the sun (at that time, Pluto is approximately 7.4×10^{12} m away from the sun).

4. A hypothetical star has an emissivity ϵ that depends on the star's radius via the function $\epsilon(r) = \frac{r}{R}$ with $0 \le r \le R$. (We will assume that for this star, ϵ is independent of wavelength). Assume that this star is somehow constrained to always emit the exact same total power, no matter what its current radius may be. From this information, you should be able to derive an expression for $T(r)$ for this star. Your task: Find $\frac{T(R/2)}{T(R/4)}$.

5. A few years ago, Dr. Carson's research group discovered a new planet which we will call "Derek" (the nickname the students in his lab gave the planet). Assume Derek's star is a perfect blackbody, and use these basic facts about the system: $T_{\text{star}} \approx 11360$ K, $R_{\text{star}} \approx 1 \times 10^9$ m, $R_{star-Derek} \sim 8.25 \times 10^{12}$ m, $A_{\text{SW-Derek}} \approx 0.52$, $A_{\text{LW-Derek}} = 0$.

   a) What is the peak wavelength of the blackbody spectrum of the star?

   b) What is the solar constant for Derek?

   c) If we assume the planet has no atmosphere and all the energy input comes from the closest star, what would the radiative equilibrium temperature of the planet be?

   d) What would the peak wavelength of the planet be if it had the temperature calculated in part (c) above? [Note: the actual expected peak of the planet's blackbody spectrum is about 1.7μm, which should *not* be what you get when you calculate it. Unlike Earth, where the difference between our calculated temperature and the actual average surface temperature is largely due to atmospheric effects, this time the biggest reason your calculated temperature isn't accurate for "Derek" is due to internal heating within the planet itself.]