Lab #1 — Astronomy 184L — Life in the Universe
The Scenic Skyride

Due on Wednesday, September 10, 2008 by 3 pm *sharp*

There are three main scientific goals of this lab: (1) Understand the geologic context of northern Arizona; (2) Gain "first-hand" experience with the environment and experiments of the Mars Phoenix spacecraft; and (3) Learn about life in extreme environments (and ecological niches).

Note: Our field trip will take us to 11,500 feet elevation – probably the highest above sea level that most of you have ever been. There are several special cautions. **This is very important.** At such high elevations, it is very easy to get dehydrated – drink lots of water. It is also very easy to get sunburned – wear sunscreen and hats. Finally, everyone reacts to hypoxia — low oxygen intake, which happens above 10,000 feet — differently. For most people, there is mild dizziness and/or nausea that passes after a little while. Both physical and mental performance can be *significantly* impaired. You must move slowly (don't try to run around). You must think twice or three times before doing anything unusual or out of the ordinary. If you feel significantly ill, sit down, drink some water, and let me know. Our destination is *almost a mile higher than Flagstaff.*

The assignment is described below. **This assignment is due on Wednesday, September 10, 2008, by 3 pm — sharp!** The labs can be turned in either in the box outside my office or in my mailbox in the main Physics and Astronomy office. I am leaving work on September 10 at 3 pm sharp, and if your lab does not come with me then you will get a zero.

You should work in pairs on this assignment. As this is your first lab assignment, you can work with anyone in the class. Each group member will receive the same grade for this lab. If you are not able to find a partner, let me know, and I will help make matches.

I would guess that what you turn in might be something like 3 pages, with something like 1 page for each of the three parts. Don't do a lot more than this. Some things I am asking you to write about we'll cover when we're on the mountain; other things you'll have to or want to look up. Don't forget to cite your sources if other than the oral presentations on the mountain.

The assignment

Part 1: Discuss and describe the geologic history of northern Arizona. When did these volcanos (Mt. Agassiz, Mt. Humphreys) erupt? What kind of volcanos are they? How come the San Francisco peaks are so much taller than the rest of the volcanos in the volcanic field?

What notable, identifiable natural landmarks can you see from the top? How far can you see?

Part 2: What is the atmospheric pressure on top of the peaks? You can calculate the pressure on top this way:

$$P = P_0 \times \left(1 - \frac{L \times H}{T_0}\right)^{\frac{gM}{RL}} \tag{1}$$

where P is the pressure at altitude H; P_0 is the pressure at sea level; L is the temperature lapse rate, which tells you roughly how much colder it is for every kilometer up you go – you can assume $L = 0.0065$ K/m here; T_0 is the standard sea level temperature – you can assume $T_0 = 288$ K; g is the gravitational acceleration; M is the molecular weight of dry air – assume $M = 0.029$ kg/mol; and R is a gas constant – take $R = 8.3$ J/mol/K.

You need to be extremely careful about *units* in using this equation. What are the units of pressure? Do the rest of the units work our correctly here? A hint is that 1 Joule (J), which is a measurement of work, is equal to 1 kg m^2/s^2. Another hint is to think about what your units for H are.

Now that you've calculated the pressure on top of the peaks, compare this quantitatively to the surface pressure on Mars. Also, compare the temperatures at the top of the peaks and on the surface of Mars.

The Earth's atmosphere is around 385 parts per million CO_2 – that is, around 0.0385% CO_2. Mars' atmosphere is around 95% CO_2. Imagine taking a box of atmosphere from the top of the peaks and the same size box of atmosphere from near the surface of Mars where the Mars Phoenix spacecraft is. Which one of these contains more CO_2?

To do this part of the assignment, you will have to look up some basic information, like the gravitational acceleration, the surface pressure and temperature on Mars, etc. Every thing you look up needs to be cited. That is, you need to provide a reference for each thing you look up. This is so that both you and I can go back and check what you did if something seems wrong.

Finally, be careful how many decimal places you keep. Here is a handy rule of thumb: you should generally not have more non-zero numbers in your answer (regardless of where the decimal point is) than you have in your measurements (or numbers you looked up). I doubt that any of you will have measurements in this lab with more than 2 or 3 numbers in them so your final numbers should also not have more than that many non-zero numbers, even if your calculator can produce them. That is, if you think that the gravitational acceleration is 9.8 m/s^2 (two non-zero numbers), then your final answer for pressure should not have more than 2 or 3 non-zero numbers in it.

Part 3: What kinds of things are living on the peaks? Describe the ecological niches that they inhabit. Where else on Earth might similar niches be found? How are these niches similar/different to conditions on Mars?