

Lab #2: Scenic skyride — Astronomy 184L — Life in the Universe

Due by 18 September 2009

There are three main scientific goals of this lab: (1) understand the geologic context of northern Arizona; (2) compare and contrast the environment at the top of the peaks and that on Mars; and (3) learn about life in extreme environments and ecological niches.

Note: Our field trip will take us to 11,500 feet elevation – possibly 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, so please drink lots of water. It is also very easy to get sunburned, so please wear sunscreen and hats. Finally, everyone reacts to hypoxia — low oxygen intake, which happens above 10,000 feet — differently. For many people there can be 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 should 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 by 3 pm on Friday, September 18. The labs can be turned in either to me directly; under my office door; or in the main Physics and Astronomy office next door to my office. 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 2–3 pages, with something like 1 page for each of the three parts. Each pair of students should turn in just one lab, and both will receive the same grade for this lab. 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.

1 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:

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

where P is the pressure at altitude H (careful – what units?); 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 meter 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 (look it up – careful: what units?); 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. 1 K is one degree Kelvin; Kelvins is a temperature scale in which 273 K is the temperature at which water freezes and 0 K is absolute zero.

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 out correctly here? A hint is that 1 Joule (J), which is a measurement of work, is equal to $1 \text{ kg m}^2/\text{s}^2$. 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. 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.

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?