General Astronomy (29:61)
Fall 2012
Homework Set #9
Assigned: November 20, 2012
Due: November 30, 2012

1. You are hiking in the Rockies, and reach the summit of a tall mountain. You have a barometer (pressure-measuring device) with you. The reading for the atmospheric pressure is 6.0×10^4 N/m^2. Approximately what is the height of the mountain you are on?

2. Let's imagine you are in the atmosphere of Jupiter, the upper atmosphere that we saw with the telescope at the observatory the other night. Is the pressure you measure influenced by the existence or non-existence of a solid surface to Jupiter? In other words, does the pressure depend on whether Jupiter has a solid surface or not? Naturally, you have to give a physical argument for your answer.

3. *Here's a fun one.* Imagine a proton is fired with velocity $\vec{v}$ parallel to the surface of the Earth. It is at high enough altitude that air molecules don't impede its motion, but low enough that the altitude is much smaller than the radius of the Earth.
   (a) On what part of Earth is it possible for the Lorentz force from the Earth's magnetic field to exactly balance the gravitational force on the proton so it continues to move in the same direction and speed?
   (b) What is the speed (magnitude of the vector velocity) such that this balance occurs? Think about your answer after you have obtained it.

4. The boundary between the Earth's magnetosphere and the solar wind is called the *Magnetosheath* in astronomy and space science. On the average, it is about $15R_\oplus$ from the center of the Earth in the direction towards the Sun.
   (a) Estimate the magnitude of the Earth's magnetic field at the magnetosheath.
   (b) A typical kinetic energy of a proton in the solar wind is about 850 electron Volts (eV) when it encounters the Earth, due to the flow speed of the solar wind. Calculate the Larmor radius of a solar wind proton in the magnetic field given in (a).
   (c) Do these calculations support the contention made in lecture that the Earth's magnetic field acts like a force field to deflect the solar wind? Explain your answer.

5. You are on the planet Mercury at the time of perihelion. At the location of your base, the Sun is on the meridian. Half a sidereal year (sidereal year on Mercury), Mercury is at aphelion. You are still at your base. Where is the Sun in the sky? Describe your reasons for your answer.

6. Problem 9.2 from the textbook

7. Problem 10.7 from the textbook