Homework set #3 (assigned 24 February, due 5 March)

Instructions. As always, these questions have many parts to them. Please make sure you read all of each of these questions, and answer all the questions I ask you. Please remember that while I do not officially "count off" for grammar, spelling, and overall writing style, I do care about such things deeply. You should *definitely* proofread your homeworks not only to see if your answers make sense and have the correct units labeled, but also to see if your wording and spelling are correct.

Some of the math questions here are pretty straightforward and some require more creative thinking. I want to see how well you can do at each of those things. It will definitely help me to see what you have done if you write, in words, what it is that you are doing and trying to do (in addition to writing mathematical formulae).

1) Most telecommunications satellites are in geostationary orbits, that is, they are always above the same place on the Earth. That is why satellite dishes don't have to track back and forth across the sky to find their satellites. How far above the Earth's surface do geostationary satellites orbit? Another kind of satellite orbit is called LEO (low Earth orbit). Some weather satellites and the space station occupy these orbits. Their orbital periods are around 90 minutes. How far above the Earth's surface are these satellites? For problems like this (actually, for every problem), a great way to start is to write down what you know, and what you are trying to find out. You might also want to draw a picture. Oftentimes, these simple steps can take you a long way toward figuring out how to do a problem. You must show your work for this problem; it is not acceptable to just look up the answer.

2) The relationship between temperature and distance from the Sun in the Solar nebula probably followed a relation something like this:

$$T(r) = T_1 \sqrt{\frac{1\text{ AU}}{r}}$$

where T_1 is the temperature at 1 AU (assume $T_1 = 273$ K), r is distance from the Sun in AUs, and $T(r)$ is the temperature at some distance r. Write down what the temperatures in the Solar nebula would have been at the current orbital distances of the planets. Also write down, for each planet, the density of the planet.

Chemical species in the Solar nebula could only condense where temperatures were cooler than the species' condensation temperatures. Where in the Solar nebula could the following species (with their condensation temperatures in parentheses) have condensed? These species are listed in decreasing order of density. The species of interest are nickel (1300 K), iron (1300 K), calcium (1400 K), silicon (1200 K), aluminium (1400 K), magnesium (1200 K), sodium (600 K), water (150 K), ammonia (75 K), and methane (30 K). How do the condensation locations of these species correlate to planetary densities? Why is this? Do the densities and condensation temperatures exactly correlate, why or why not?

3) The magnitude of the tides raised on the Earth by the Moon and by the Sun is proportional to m^2/r^6, where m is the mass of the other body and r is the distance to the other body. Which is greater, tides raised on the Earth by the Moon or by the Sun? How much bigger? Explain, using this information, the difference between neap and spring tides.

4) The planet Uranus has an unusual orientation: its rotation pole is in the ecliptic plane[1]. What are seasons like on Uranus? Feel free to draw some pictures in your answer. I am looking for a fairly complete discussion here (more like a paragraph than a sentence, though you shouldn't feel like this guideline is absolute).

[1] The ecliptic plane is the plane in which the planets of the Solar System orbit.

Additional fact if you feel like doing a calculation: Uranus' orbital distance from the Sun is around 19 AU, that is, you might discuss how long seasons last on Uranus.

5) Massive stars are quite luminous and have very short lives. Knowing what you have learned about how stars work and how fusion works, explain why you think this is.

6) From the New York Times, Space.com, CNN, the BBC, or any other reputable news source, choose any recent astrobiologically relevant news article. Please do not choose an article that we have already talked about in the course so far. Write a one page summary, review, and discussion about this article. What are the main points of this article? Do you believe the conclusions? How does it relate to material that we have covered (and will cover) in the course?