Astron 300 Problem Set 1

Due: Wednesday, Sep 15 at the beginning of class

Homework Policy: You can consult class notes and books. Always try to solve the problems yourself; if you cannot make progress after some effort, you can discuss with your classmates or ask the instructor. However, you cannot copy other's work: what you turn in must be your own. Make sure you are clear about the process you use to solve the problems: partial credit will be awarded.
Reading: Carroll & Ostlie, Chapter 1

Problem 1 The Height of the Sun

We saw in class how the seasons are caused by the tilt of the Earth's axis relative to the plane of its orbit. This results in the Sun appearing to change altitude from one season to another, with it high in the summer and low in the winter.

a. Assume that the latitude of Milwaukee is 43° N. What is the altitude (i.e., how many degrees above the horizon) of the Sun at noon on the summer solstice? The winter solstice? The equinoxes? [Hint: the Sun is far away, so a line from the center of the Earth to the Sun is parallel to a line from Milwaukee to the Sun. Also, look at Figure 1.12(a).]

b. Assume that the latitude of the US research post McMurdo Station on Antarctica is 78° S. What is the altitude of the Sun at noon on Dec. 21? Jun. 21?

c. What about midnight on Dec. 21 and Jun. 21? What do these results imply for the lengths of day and night at different times of the year?

d. The Milwaukee Water Tower is 175 feet high. Using the plot on page 11 of C&O (this plot shows the Declination of the Sun: that is like latitude but extended into the sky), estimate for which months the shadow of the Water Tower at noon is more than twice as long as the tower is tall.

Problem 2 Synodic Periods

In class we showed that, when considering the synodic period S (the time between when Earth and another planet are closest together) of Mars (whose orbit is outside that of Earth), the result was $1/S = 1/P_{\rm Earth} - 1/P_{\rm Mars}$.

a. Derive this result for Venus, whose orbit is *inside* that of Earth. [Note: the result is given on page 6, but you must *show the derivation*].

b. The observed synodic periods of Venus and Mars and 583.9 days and 779.9 days, respectively. Calculate their sidereal periods.

c. Which planet (for these purposes, consider Mars, Jupiter, Saturn, Uranus, and Neptune) has the shortest synodic period? Why? [You can find planetary data in Appendix C or online.]

Problem 3 Circumpolar Stars

Circumpolar stars are those stars that never set below the horizon of the local observer. For an observer at latitude L, what is the range of Declinations for such stars? [Hint: you may want to consult Figure 1.12(a) on p. 11. Also, in the northern hemisphere, the North Star (Polaris) is circumpolar.]

Problem 4 Star Trails

Using the attached image, or going to
http://www.lsc-group.phys.uwm.edu/~kaplan/astron300_fall2010/Palomar_startrails.jpg,
look at an image I took of the night sky from Palomar Observatory. The image was pointed North, and Polaris is visible in the middle (you should be able to identify which star it is). I left the camera shutter open for a while to create a "star trail" image. From the image (paper or electronic), estimate the length of the exposure. [Hint: remember that the Earth rotates, which causes the stars to appear to rotate around the north pole, which remains stationary. You may want a protractor, and if you don't have a real one you can find some links on the class website.]