

## Homework #1

Due Sept. 13

Remember that you must *justify your answer* and/or *show your work* to receive full credit. The grader must be able to understand how you arrived at your answer.

1. Sketch the shadow of a gnomon at dawn, dusk, and noon on the vernal equinox for someone living on the equator. Do the same for the winter and summer solstice. Justify your results in terms of the “two sphere model.”

2. The “Tropic of Cancer” is an imaginary east-west line that is  $23.5^\circ$  north of the equator. Sketch the shadow of a gnomon at dawn, dusk, and noon on the vernal equinox for someone living right on the Tropic of Cancer? Do the same for the winter and summer solstice. Now do the same thing for someone living north of the Tropic of Cancer, and for someone living between the Tropic of Cancer and the equator. Justify your results in terms of the “two sphere model” of the earth, sun, and stars. *Hint:* The ecliptic is inclined at an angle of  $23.5^\circ$  relative to the equator.

3. In about 135 BCE, the Greek astronomer Hipparchus obtained an improved estimate of the length of the year, defined as the number of days between successive vernal equinoxes. Using the observations of an astronomer 145 years earlier, he found that assuming exactly 365.25 days per year, the moment of the vernal equinox in his lifetime that was predicted by the observation of the earlier astronomer was about 12 hours too late. What is the improved estimate of the length of the year obtained from these numbers. How far off is it from the modern value?

4. An industrious physics 101 student at the University of Maryland wants to measure the radius of the earth using a method similar to that of Eratosthenes. She calls her friend in Lincoln, Nebraska, which she knows is about 1000 miles east of the University of Maryland. She asks her friend to make a gnomon and note the time at which the sun is most nearly overhead. According to her friend, the sun is most nearly overhead about one hour earlier than at Maryland. Using these numbers, give an estimate for the radius of the earth.