1. **51 Pegasi and its planet** orbit a point that is at the center of mass. (If 51 Pegasi and its planet were sitting on a see-saw, they would balance if the pivot is at the center of mass.) Here we will think about the scale of the motions of a star and its planet by thinking about the earth and the sun. The mass of the earth is 1/1,000,000 that of the sun. The earth is 150 million km from the sun. A year is 30,000,000 s. Ignore the other planets.
    a. (3 pts.) How far is the center of mass of the earth-sun system from the center of the sun?
    b. (3 pts.) Draw a scaled picture of the sun and the location of the center of mass of the earth-sun system. The radius of the sun is 700,000 km. (To see the center of mass, you will need to magnify your drawing.)
    c. (3 pts.) Calculate the speed of the sun as it orbits the center of mass of the earth-sun system. (1 pt.) Can you walk at this speed?
2. **Erathosthenes in a parallel universe**. Suppose Erathosthenes lived on an earth that is 1/4 as big as the real one. Keep the distance between Alexandria and Syene the same.
    a. (3 pts.) Draw a diagram that shows the well, the stick, the shadow with the actual angle, Syene, and Alexandria.
    b. (5 pts.) Draw the same diagram showing the case with a smaller earth. You must show what is different in this diagram.
3. The **autumnal equinox** will occur at 5:18 pm EDT on September 22.
    a. (5 pts.) Does the autumnal equinox occur at a different time for people in Hawaii, which is 6 hours behind us? Explain your reasoning. Many statements about the equinox are approximately true but not precisely true. Make certain that you know the precise definition of the equinox.
    b. (5 pts.) Draw a picture of the earth as viewed from the sun on the autumnal equinox. On your drawing, show the north and south poles where they pierce the surface of the earth. How would this drawing change if the date were the summer solstice?