Astronomy (Schroeder) Name: _____
fall, 2009

Exercise 3

Due Tuesday, September 15, 5:00 pm

1. When it is closest to earth, the planet Venus subtends an angle of approximately one minute of arc, or 1/60 of a degree. (Such small angles can be measured only with a telescope. Galileo was the first to make important telescopic observations of Venus.) Suppose that, for lack of a better hypothesis, we guess that Venus is the same size as earth. (By coincidence, this guess turns out to be approximately true.) In this case, what would be the distance to Venus, when it is at its closest? Please answer this question by doing a "big circle" calculation, showing your diagram and your arithmetic in the space below. The trick is to imagine a big circle, centered on earth, passing through Venus. First calculate how many Venus's would fit around the circumference of the circle. Express your final answer both in earth diameters and in miles. (The diameter of the earth is 8,000 miles.)

2. During an average orbit, the planet Mercury is never seen farther than 23° away from the sun in our sky. Draw a sketch of earth's orbit around the sun in the Copernican model, then, using a protractor, draw lines from earth toward Mercury's maximum angle to either side of the sun. Use these lines and a compass to draw the orbit of Mercury, to scale, on the same sketch. Then measure radius of each orbit with a ruler. If the true radius of earth's orbit is one "astronomical unit", what is the radius of Mercury's orbit in astronomical units?

3. The planet Mercury crosses in front of the sun roughly once every 109 days, or once every 0.3 years. Use this observation to determine the time needed for Mercury to complete one orbit around the sun. (Hint: First determine how many orbits Mercury completes in 0.3 years. Then set up a ratio, as in the lecture slides, to find the number of years needed for one orbit.)

4. Use your answers to the previous two problems to check that Kepler's third law (time squared = radius cubed) holds for Mercury (at least approximately).

5. Kepler's laws also apply to comets, which tend to have highly eccentric elliptical orbits. Imagine a comet that is moving at a speed of 2.5 kilometers per second at its farthest point from the sun. Its closest point to the sun is ten times closer than the farthest point; how fast is it moving at its closest point? (Explain your reasoning briefly, with a sketch of the orbit.)