PHYSICS 113
Assignment #1
SOLUTIONS

Chapter 1

17. Suppose you are on a strange planet and observe, at night, that the stars do not rise and set but circle parallel to the horizon. Now you walk in a constant direction for 8000 miles, and at your new location on the planet you find that all stars rise straight up in the east and set straight down in the west, perpendicular to the horizon.
a) How could you determine the circumference of the planet without any further observations?
c) What is the circumference, in miles, of that planet?

Since the stars do not rise or set, you must be at the North (or South) pole of the planet. When you walk to the point where the stars rise and set perpendicular to the horizon, you are at the equator of the planet.
a) By walking from the North pole to the equator, you've covered 1/4 of the circumference of the sphere (viewed as a circle). Thus **by multiplying by 4, you can determine the entire circumference**.
c) Since the distance is 8000 miles, the entire circumference of the planet must be 4 x 8000 miles = **32000 miles**.

Chapter 2

14. What is the semimajor axis of a circle of diameter 24cm? What is its eccentricity?

A circle of diameter of 24cm has a major axis (from one edge diametrically across to the other edge) of 24cm. The semimajor axis is one-half of the major axis (= 24cm / 2 = 12cm). As you can see, it is simply the radius of the circle and equal to **12cm**. A circle has an eccentricity of **zero**.

19. What would be the period of a planet whose orbit has a semi-major axis of 4 AU? Of an asteroid with a semimajor axis of 10 AU?

According to Kepler's Third Law, $P^2 = D^3$ where P is expressed in units of years and D in units of AU. Thus $P = D^{3/2}$. For a planet that has D = 4 AU, $P = (4)^{3/2} = (4 \times 4 \times 4)^{1/2} = (64)^{1/2} =$ **8 years**. For an asteroid that has D = 10 AU, $P = (10)^{3/2} = (10 \times 10 \times 10)^{1/2} = (1000)^{1/2} =$ **31.6 years**.

Chapter 3

9. Where are you on the Earth according to the following descriptions? (Refer back to Chapter 1 as well as this chapter.)
a) The stars rise and set perpendicular to the horizon.

b) The stars circle the sky parallel to the horizon.
c) The celestial equator passes through the zenith.
d) In the course of a year, all stars are visible.
e) The Sun rises on September 23 and does not set until March 21 (ideally).

a) **Earth's Equator**
b) **Earth's North *or* South Pole**
At the North (geographic) Pole, an observer will only ever be able to see the upper (Northern) half of the Celestial Sphere. The observer would never be able to see a constellation such as the Southern Cross since it is in the southern half of the Celestial Sphere. At the Earth's South Pole, an observer will only ever be able to see the southern half of the Celestial Sphere (they would never be able to see the Big Dipper).
c) **Earth's Equator** (the Celestial Equator would be directly overhead)
d) **Earth's Equator**
All stars can be observed at some time during the year from the Earth's Equator. Of course, only one-half of the Celestial Sphere can be seen at any given time at any particular point on the Earth. However, over a period of six months, the Earth is on opposite sides of the Sun and thus an observer on the equator will see both (opposite) sides of the celestial sphere. Therefore an observer at the Equator will see all the constellations (e.g., Little Dipper and Southern Cross).
e) **Earth's South Pole** (note that it is summer in the southern hemisphere)
This is why the regions inside the Antarctic Circle (and Arctic Circle) are referred to as "The Land of the Midnight Sun" since on at least one day during the year (number of days depends on Earth's latitude) there will be at least 24 hours of continuous daylight. During their respective winters, there will also be at least 24 hours of continuous darkness.