Astronomy 1 | fall 2009
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# Solutions to Assignment 2

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## 1 Ch. 2 #6

The celestial sphere doesn't exist per se. It's just a helpful way of thinking about the motions of the stars when viewed from the earth. Anyone attempting to fly to and land on the celestial equator would be embarking on a never-ending pointless journey to nowhere.

## Ch. 2 #8

The zenith is the point directly above someone standing on the earth (opposite the direction of the center of the earth), 90 degrees up from any point on the horizon. To see the celestial equator at the zenith you must be standing on the earth's equator. To see the celestial pole at zenith you must be standing at the corresponding pole on the earth.

## 2 Ch. 2 #10

The Big Dipper is on the northern hemisphere of the celestial sphere, close to the north celestial pole. A person near Earth's south pole can only see things in the southern celestial hemisphere because the Earth blocks the view of everything else. Such objects are always below the horizon for the observer, meaning they never rise or set in the night sky.

## Ch. 2 #12

The stars appear to move opposite to the motion of the observer due to the Earth's rotation. An observer looking up at the north celestial pole is rotating clockwise with the Earth, so the sky and the stars appear to rotate counterclockwise. A star at a given angle above the horizon will stay at that same angle as it rotates around the north celestial pole. An observer on the equator, on the other hand, is moving from East to West due to the Earth's rotation, so the stars will appear rise in the East and set in the West. If you're standing directly on the equator the stars will rise exactly vertically from the horizon. In general, the motion of the stars one observes during the course of the night depends on the observer's latitude. See Figure 2-11 in the book.

## 3 Ch. 2 #63 "Starry Night"

(a) If we set the location as Santa Barbara, CA, we are of course in the northern hemisphere. The background stars are rotating counterclockwise. See the explanation in the previous solution for the reason why. Yes there are circumpolar stars. It is easiest to see this if you look straight at Polaris, the North Star. Santa Barbara's latitude is about 24 deg N, so Polaris appears about 34 deg above the horizon. All of the stars within a radius of about 34 deg from Polaris will thus be circumpolar. (b) If we now look at the southern horizon, the stars that have risen in the East reach some maximum elevation before setting in the West. Looking south we don't see any circumpolar stars.

## 4 Ch. 3 #4

(a) A new moon happens when the Moon is between the Earth and the Sun. When we look at a new Moon there is no sunlight reflected off the Moon's surface because the side that is illuminated by the Sun is facing towards the Sun and away from us. Since the new moon is in the same direction in the sky as the Sun, it rises at about the same time as the Sun, roughly 6:00a.m. (b) The first quarter Moon has made it one quarter of a rotation (clockwise looking down from the North) around the Earth. This corresponds to moving a quarter of the way around the celestial sphere towards the East, so it rises a quarter of a day, or about six hours later, at noon. (c) By the same argument one can see that the full Moon, which is now on the opposite side of the Earth from the Sun, rises at 6:00p.m.— about the time of sunset. (d) The third quarter Moon will thus rise at midnight.

## Ch. 3 #7

At any given time, only half of the Moon is illuminated by the Sun (unless there is an eclipse). That means that when we see the dark side of the new Moon facing us, we know that the illuminated side is facing towards the Sun. The answer is no: the far side of the Mon is not the same as the dark side of the Moon. Since an observer on the Earth never sees the far side of the Moon, our definition of the "far side" of the Moon remains constant. The "dark side" of the Moon is continually changing, just as the parts of the Earth experiencing day and night are changing.

## Ch. 3 #8

(a) The same side of the moon always faces the Earth, so as the moon goes around its orbit different parts of the Moon are illuminated by the Sun. The Sun's light hits a given part of the Moon at some times, but not others, so the Sun has to rise and set for an observer on the Moon. On the Moon the sun rises about every 29 days and sets about 14 days later. (b) The Earth, on the other hand, never rises or sets. If you stay at the same position on the moon, you either always see the Earth or you never see it. This happens because of the synchronous rotation of the moon. Since we always see only one side of the Moon, that side of the Moon always “sees” us and the far side of the Moon never “sees” us, since we can’t see it.

## 5 Ch. 3 #14

The umbra is the main shadow of the Earth where the light from the Sun is totally blocked. In the penumbra parts of the suns can still be seen, so during a penumbral eclipse some light from the Sun is still reaching the Moon. It may be an easy event to miss because the Moon is still partially illuminated. See Figure 3-8 in the book.

## Ch. 3 #15

The path of the Moon through the umbra of the Earth determines the duration of totality for an eclipse. The longest path is through the center of the umbra, but at different times during the year the path may be closer to the edge of the (circular) umbra, so the time it spends in the shadow is shorter.

## 6 Ch. 4 #18

If we add the perihelion distance to the aphelion distance, then we have the length of the major axis, which is 0.5 AU. The semi-major axis is half this length, so a=0.25 AU. Now we plug into the basic form of Kepler’s Law, solving for P, which is the period in years:

$$P^2 = a^3 \Rightarrow P = a^{3/2} = (0.25AU)^{3/2} = 0.125yrs = 1.5mo$$

## Ch. 4 #20

Galileo was one of the first people to point the (then newly invented) telescope up at the sky. He noticed that when looking at the planet Venus at different times of the year, different portions of it were illuminated, similar to the phases of the Moon. This could not happen in Ptolemy’s geocentric model. See figures 4-14 and 4-15 in the book. Another important observation of Galileo is the discovery that Jupiter has orbiting moons. This weakened the Ptolemaic argument further because if it was proof that there are objects in the solar system, which don’t orbit the earth. These observations could not have been made prior to the invention of the telescope because it is impossible to see either the phases of Venus or the “Galilean” moons of Jupiter with the naked eye.