Due: January 3, 2014   Name: _____KEY_____

1. Why do the constellations that are visible in the sky at night change with the seasons?
     a. Because the Earth rotates about an axis.
     b. Because the Earth revolves around the Sun.
     c. Because the Earth is a sphere.
     d. Because the celestial sphere revolves around the Earth.

2. Suppose your telescope can give you a clear view of objects and features that subtend angles of at least 2.00 arcsec. What is the diameter of the smallest crater you can see on the Moon?
(The average distance to the Moon is 384,400 km)

$$r = 384{,}400 \text{ km (from Appendix Table 5 p. 534)}$$
$$\theta = 2.00 \text{ arcsec}$$
$$D = \frac{\pi r \theta}{180} = \frac{\pi\left(384{,}400 \text{ km}\right)}{180}\left(2.00 \text{ arcsec} \times \frac{1 \text{ deg}}{3600 \text{ arcsec}}\right) = \boxed{3.73 \text{ km}}$$

3. One star has an altitude of 15 degrees, 35 minutes and an azimuth of 28 degrees, 16 minutes east of north. A second star has an altitude of 15 degrees, 35 minutes and an azimuth of 27 degrees, 58 minutes east of north. By how many arc seconds are these two stars separated?

The altitudes are the same, so the angular separation is due only to azimuth.

$$\Delta\theta = \theta_2 - \theta_1 = \left(28\frac{16}{60}\right)^\circ - \left(27\frac{58}{60}\right)^\circ = \left(\frac{18}{60}\right)^\circ$$
$$= \frac{18}{60}\text{ deg} \times \frac{3600 \text{ arcsec}}{\text{deg}} = \boxed{1080 \text{ arcsec}}$$

4. As a star rises and moves across the sky, which of the following change?
     a. Its right ascension
     b. Its declination
     c. Its azimuth
     d. Its altitude

5. What is the celestial equator? How is it related to the Earth's equator? How are the north and south celestial poles related to the Earth's axis of rotation? At what location on Earth would the celestial equator pass through your zenith?

The celestial equator is the great circle on the celestial sphere that is midway between the celestial poles. The plane of the celestial equator is the same as the plane of the Earth's equator. The north and south celestial poles are at the intersection of the celestial sphere with the extension of the Earth's axis of rotation. If you were at the Earth's equator, the celestial equator would pass through your zenith.

6. What is the ecliptic? Why is it tilted with respect to the celestial equator? Does the Sun appear to move along the ecliptic, the celestial equator, or neither? By about how many degrees does the Sun appear to move on the celestial sphere each day?

The ecliptic is the intersection of the plane of the Earth's orbit and the celestial sphere. The ecliptic is tilted relative to the celestial equator because the Earth's equator is tilted relative to the plane of the Earth's orbit. The Sun appears to move eastward along the ecliptic approximately one degree per day.

7.   On November 1 at 11:00 p.m. you look toward the eastern horizon and see the bright star Mintaka rising. At approximately what time will Mintaka rise one week later, on November 8?

A star rises 4 minutes earlier each evening, so in one week Mintaka rises 7 × 4 = 28 minutes earlier, at 10:32 p.m.

8.   Use the Seasons Interactive module on the textbook companion site (select chapter 1 in the drop down list) to fill in the following chart. The program isn't real precise so a little guesswork may be required. Try to use the first hour in which the sky brightens from its nighttime darkness as sunrise, and the first hour in which the sky arrives at its full nighttime darkness as sunset.

Tilt Angle of Earth	Minimum # daylight hours			Maximum # daylight hours		
	Sunrise	Sunset	# hours	Sunrise	Sunset	# hours
0°	6:00 am	6:00 pm	12	6:00 am	6:00 pm	12
23°	8:00 am	4:00 pm	8	4:00 am	8:00 pm	16
46°	never	never	zero	1:00 am	10:00 pm	21

9.   Suppose that you live at a latitude of 40.0° N. What is the elevation of the Sun above the southern horizon at noon at the time of the winter solstice? Explain your reasoning.

At noon on the date of the winter solstice, the Sun is 23.5° south of the celestial equator. Your latitude (40°) is the angular elevation of the north celestial pole above the northern horizon. Your latitude is also the angular distance, along the meridian, from the zenith to the celestial equator. So the Sun is 40° + 23.5° = 63.5° from the zenith, which is 90° − 63.5° = 26.5° above the southern horizon.

10.   What is the right ascension of a star that is on the meridian at midnight at the time of the autumnal equinox? Explain.

On the date of the autumnal equinox the sun is at exactly 12 h 0m 0s right ascension, and the vernal equinox (0h 0m 0s) crosses your meridian at midnight. Therefore, the the star must be on the same right ascension as the vernal equinox, 0h 0m 0s.

11.   Astronomers sometimes refer to lunar phases in terms of the age of the Moon. This refers to the time that has elapsed since the new moon phase. Thus, the age of a full moon is half of a 29.53-day synodic period, or approximately 15 days. Find the approximate age of (a) a waxing crescent moon; (b) a last quarter moon; (c) a waning gibbous moon.

The approximate age of a (a) waxing crescent moon is 3.75 days, (b) last quarter moon is 22.5 days, (c) waning gibbous moon is 18.75 days.

12.   Why is it warmer during the summer than it is during the winter?
      a. The Earth is closer to the Sun and the brighter sunshine warms us.
      b. The rays of the Sun are more direct and the days are longer.
      c. Summer sunlight contains more of the infrared light that warms the Earth.
      d. The yearly precession of the Earth's axis causes the days to lengthen in the summer.

13. When the Sun and Moon have the same right ascension, the phase of the Moon is _____ moon.

     a. a new
     b. a full
     c. a first quarter
     d. either a waxing or a waning gibbous

14. (a) The Moon moves noticeably over the space of a single night. To show this, calculate how long it takes the Moon to move through an angle equal to its own angular diameter (1/2°) against the background of stars. Give your answer in hours. (b) Through what angle (in degrees) does the Moon move during a 12-hour night? How many Moon diameters is this angle?

(a) The time it takes for the Moon to move **½** degree is: $t = \left(0.500°\right)\left(\dfrac{27.3 \text{ d}}{360°}\right)\left(\dfrac{24 \text{ h}}{1 \text{ d}}\right) = \boxed{0.910 \text{ h}}$

(b) In a 12-hour period the Moon moves through: $\theta = \omega t = \left(\dfrac{0.500°}{0.910 \text{ h}}\right)\left(12.0 \text{ h}\right) = \boxed{6.59°}$

    This angle is about 6.59°/0.50° = $\boxed{\text{13.2 Moon diameters}}$, and is greater than the separation of the pointer stars in the Big Dipper..

15. Suppose that the Earth moved a little faster around the Sun, so that it took a little less than one year to make a complete orbit. If the speed of the Moon's orbit around the Earth were unchanged, would the length of the sidereal month be the same, longer, or shorter than it is now? What about the synodic month? Explain your answers.

    If the Moon's orbital speed were the same, then the sidereal month would be the same. If the Earth moved faster in its orbit then the apparent angular movement of the Sun in one sidereal month would be greater, so it would take longer for the Moon to catch up to the Sun. This means that the synodic month would be longer than it is now.