CHAPTER 2: Patterns in the Sky—Motions of Earth

TRUE/FALSE

1. Constellations are arbitrary groupings of stars in the sky.

   ANS: T DIF: Easy REF: Section 2.1 TOP: 1Ii
   MSC: Factual

2. The meridian is half of an imaginary circle in the sky that passes through an observer's zenith and both celestial poles.

   ANS: T DIF: Easy REF: Section 2.2 TOP: 2Iiv
   MSC: Factual

3. Locations along the equator are the only place on Earth where you can see the entire celestial sphere (during the day or night) over the course of 24 hours.

   ANS: T DIF: Easy REF: Section 2.2 TOP: 2IIIi | 2IViii
   MSC: Factual

4. If a star rises due east on the horizon, it will set due west on the horizon six hours later.

   ANS: F DIF: Easy REF: Section 2.2 TOP: 2IVi
   MSC: Applied

5. For an observer in the Northern Hemisphere, as he or she looks north, stars travel in a clockwise direction around the north celestial pole over the course of the night.

   ANS: F DIF: Easy REF: Section 2.2 TOP: 2IVi | 2IVii
   MSC: Factual

6. Earth revolves around the Sun in the same direction Earth spins about its axis.

   ANS: T DIF: Easy REF: Section 2.3 TOP: 3Iii
   MSC: Factual

7. The seasons on Earth are caused by the change in distance between the Sun and Earth.

   ANS: F DIF: Medium REF: Section 2.3 TOP: 3IIIii | 3IIIiii
   MSC: Factual

8. The altitude of the Sun as it crosses the meridian changes during the year.

   ANS: T DIF: Medium REF: Section 2.3 TOP: 3IIIiv
   MSC: Factual

9. A person who lives at the equator will see the Sun directly overhead at noon every day of the year.

ANS: F DIF: Medium REF: Section 2.3 TOP: 3IIIiv
MSC: Applied

10. On the autumnal equinox, the lengths of both day and night are 12 hours.

ANS: T DIF: Easy REF: Section 2.3 TOP: 3IIIv
MSC: Factual

11. The longest day of the year in the Northern Hemisphere occurs on the summer solstice.

ANS: T DIF: Easy REF: Section 2.3 TOP: 3IIIvi
MSC: Factual

12. When in the New Moon phase, the moon will be visible in the eastern sky at sunrise.

ANS: T DIF: Medium REF: Section 2.4 TOP: 4Ii | 4IIiv
MSC: Applied

13. The fact that we always see the same side of the Moon indicates that the Moon does not rotate about an axis.

ANS: F DIF: Medium REF: Section 2.4 TOP: 4IIIii
MSC: Conceptual

14. When a solar eclipse occurs, the Sun lies between the Earth and Moon.

ANS: F DIF: Easy REF: Section 2.6 TOP: 6Iii
MSC: Conceptual

15. When a solar eclipse occurs, typically more people will witness it as a partial eclipse than as a total eclipse.

ANS: T DIF: Medium REF: Section 2.6 TOP: 6Iii | 6IIIiv
MSC: Factual

MULTIPLE CHOICE

1. There are _____ constellations in the entire sky.
   a. 12
   b. 13
   c. 88
   d. hundreds of
   e. thousands of

ANS: C DIF: Easy REF: Section 2.1 TOP: 1I
MSC: Factual

2. What defines the location of the equator on Earth?

a. the axis around which Earth rotates
b. where the ground is the warmest
c. the tilt of Earth's rotational axis relative to its orbit around the Sun
d. the orbit of Earth around the Sun
e. all of the above

ANS: A DIF: Easy REF: Section 2.2 TOP: 2Iii
MSC: Factual

3. If the star Polaris has an altitude of 35°, then we know that:
a. our longitude is +55°
b. our latitude is +55°
c. our longitude is −35°
d. our longitude is +35°
e. our latitude is +35°

ANS: E DIF: Medium REF: Section 2.2 TOP: 2Iii | 2Iviii
MSC: Applied

4. At a latitude of +50°, how far above the horizon is the north celestial pole located?
a. 0°
b. 40°
c. 50°
d. 90°
e. It is not visible at that latitude.

ANS: C DIF: Medium REF: Section 2.2 TOP: 2Iii | 2Iiii | 2Ivi
MSC: Applied

5. At what latitude is the north celestial pole located at your zenith?
a. 0°
b. +30°
c. +60°
d. +90°
e. This occurs at every latitude.

ANS: D DIF: Medium REF: Section 2.2 TOP: 2Iii | 2Iv | 2Ivi
MSC: Applied

6. At what latitude is the north celestial pole at your horizon?
a. 0°
b. +30°
c. +60°
d. +90°
e. This can never happen.

ANS: A DIF: Medium REF: Section 2.2 TOP: 2Iii | 2Iiii | 2Ivi
MSC: Applied

7. For a person who lives at a latitude of +40°, when is the Sun directly overhead at noon?
a. only on the summer solstice
b. only on the winter solstice

c. only on the vernal and autumnal equinoxes
d. never
e. always

ANS: D DIF: Medium REF: Section 2.3 TOP: 2Iii | 3IIIi
MSC: Applied

8. For a person living in Vancouver, Canada, at latitude of +49°, the Sun will reach a maximum height above the Southern horizon on winter solstice of
a. 41.0°
b. 17.5°
c. 25.5°
d. 37.0°
e. 64.5°

ANS: B DIF: Difficult REF: Section 2.3 TOP: 2Iii | 3IIIi | 3IIIvi
MSC: Applied

9. The meridian is defined as an imaginary circle on the sky on which lie the:
a. celestial equator and vernal equinox
b. north and south celestial poles
c. zenith and the north and south celestial poles
d. zenith and east and west directions
e. celestial equator and summer solstice

ANS: C DIF: Medium REF: Section 2.2 TOP: 2Iiv | 2Iv | 2Ivi
MSC: Factual

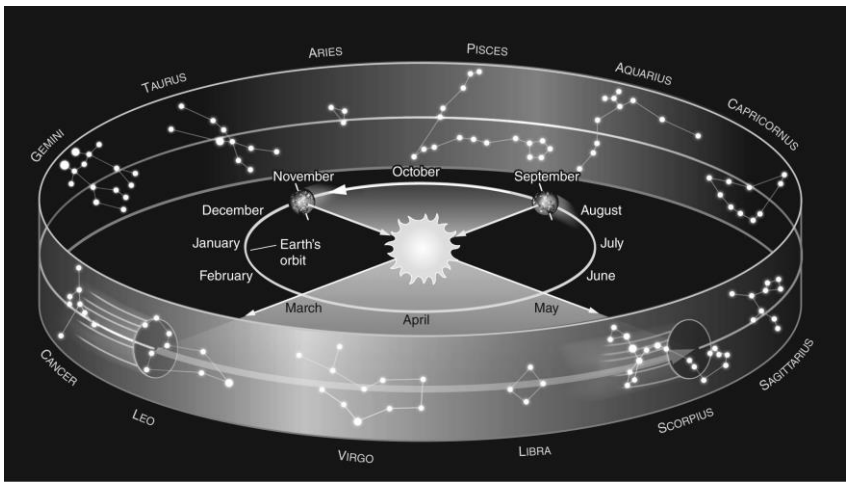


Figure 1

10. Assume you are observing the night sky from a typical city in the United States with a latitude of +40°. Using Figure 1, which constellation of the zodiac would be nearest to the meridian at midnight in mid-September?
a. Scorpius
b. Taurus
c. Pisces
d. Aquarius
e. Leo

ANS: D DIF: Medium REF: Section 2.3 TOP: 2Iiv | 2IIIi | 2IVi | 3Iii | 3IIiii
MSC: Applied

11. Assume you are observing the night sky from a typical city in the United States with a latitude of +40°. Using Figure 1, which constellation of the zodiac would be nearest to the meridian at 6 P.M. in mid-September?
    a. Scorpius
    b. Taurus
    c. Pisces
    d. Aquarius
    e. Leo

    ANS: A DIF: Difficult REF: Section 2.3 TOP: 2Iiv | 2IIIi | 2IVi | 3Iii | 3IIiii
    MSC: Applied

12. Assume you are observing the night sky from a typical city in the United States with a latitude of +40°. Using Figure 1, which constellation of the zodiac would be nearest to the meridian at 10 P.M. in mid-May?
    a. Aries
    b. Libra
    c. Capricornus
    d. Gemini
    e. Sagittarius

    ANS: B DIF: Difficult REF: Section 2.3 TOP: 2Iiv | 2IIIi | 2IVi | 3Iii | 3IIiii
    MSC: Applied

13. Using Figure 1, what time of the day or night will the zodiac constellation Gemini rise in March?
    a. 2 P.M.
    b. 8 P.M.
    c. 2 A.M.
    d. 8 A.M.
    e. noon

    ANS: A DIF: Difficult REF: Section 2.3 TOP: 2Iiv | 2IIIi | 2IVi | 3Iii | 3IIiii
    MSC: Applied

14. The direction directly overhead of an observer defines his or her:
    a. meridian
    b. celestial pole
    c. nadir
    d. circumpolar plane
    e. zenith

    ANS: E DIF: Easy REF: Section 2.2 TOP: 2Iv
    MSC: Factual

15. No matter where you are on Earth, stars appear to rotate about a point called the:
    a. zenith
    b. celestial pole
    c. nadir
    d. meridian

e. equinox

ANS: B DIF: Easy REF: Section 2.2 TOP: 2Ivi
MSC: Factual

16. The apparent path of the Sun across the celestial sphere over the course of a year is called the:
a. prime meridian
b. ecliptic
c. circumpolar plane
d. celestial equator
e. eclipse

ANS: B DIF: Easy REF: Section 2.2 TOP: 2Ivii
MSC: Factual

17. At what time does a full Moon rise?
a. 12 midnight
b. 12 noon
c. 6 A.M.
d. 6 P.M.
e. 3 P.M.

ANS: D DIF: Easy REF: Section 2.4
TOP: 2IIIi | 2IVi | 4Ii | 4Iii | 4IIii | 4IIiv MSC: Applied

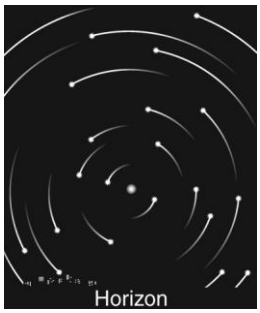
18. What time does a third-quarter Moon rise?
a. 12 midnight
b. 12 noon
c. 3 P.M.
d. 6 A.M.
e. 6 P.M.

ANS: A DIF: Medium REF: Section 2.4
TOP: 2IIIi | 2IVi | 4Ii | 4Iii | 4IIii | 4IIiv MSC: Applied

19. At which of the possible times below could the waxing gibbous moon be seen rising?
a. 3 P.M.
b. 9 A.M.
c. 11 P.M.
d. 5 A.M.
e. 8 P.M.

ANS: A DIF: Difficult REF: Section 2.4
TOP: 2IIIi | 2IVi | 4Ii | 4Iii | 4IIii | 4IIiv MSC: Applied

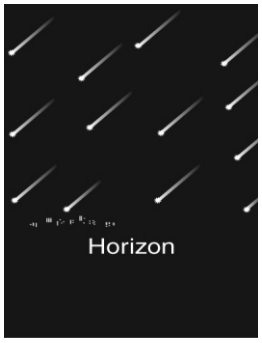
20. A friend takes a time-lapse picture of the sky, as shown below. What direction must your friend have been facing when the picture was taken?



a. north
b. east
c. south
d. west
e. directly overhead

ANS: A DIF: Medium REF: Section 2.2 TOP: 2IVi
MSC: Applied

21. A friend takes a time-lapse picture of the sky, as shown below. What direction must your friend have been facing when the picture was taken?



a. north
b. east
c. south
d. west
e. directly overhead

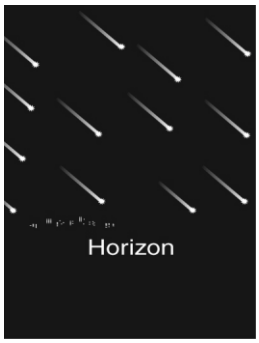
ANS: B DIF: Difficult REF: Section 2.2 TOP: 2IVi
MSC: Applied

22. A friend takes a time-lapse picture of the sky, as shown below. What direction must your friend have been facing when the picture was taken?

a. north
b. east
c. south
d. west
e. directly overhead

ANS: C DIF: Medium REF: Section 2.2 TOP: 2IVi
MSC: Applied

23. A friend takes a time-lapse picture of the sky, as shown below. What direction must your friend have been facing when the picture was taken?



a. north
b. east
c. south
d. west
e. directly overhead

ANS: D DIF: Difficult REF: Section 2.2 TOP: 2IVi
MSC: Applied

24. How far away on average is the Earth from the Sun?
a. 1 light-second
b. 1 light-minute
c. 1 astronomical unit
d. 1 light-hour
e. 1 light-year

ANS: C DIF: Easy REF: Section 2.3 TOP: 3Ii
MSC: Factual

25. You and a friend go outside to view the stars at midnight tonight. Six months later, you go outside to find the stars in exactly the same position in the sky as when you and your friend viewed them. What time is it? Assume you can see the stars at any time, day or night.
a. 6 A.M.
b. noon
c. 6 P.M.
d. midnight
e. This can never happen.

ANS: B DIF: Difficult REF: Section 2.3 TOP: 3IIi | 3IIii
MSC: Applied

26. If you go out at exactly 9 P.M. each evening over the course of one month, the position of a given star will move westward by tens of degrees. What causes this motion?
    a. the Earth's rotation on its axis
    b. the revolution of the Earth around the Sun
    c. the revolution of the Moon around the Earth
    d. the revolution of the Sun around the Earth
    e. the speed of the star through space

    ANS: B DIF: Easy REF: Section 2.3 TOP: 3IIi | 3IIii
    MSC: Applied

27. The ecliptic is defined by the motion of _____ in the sky.
    a. the Moon
    b. the Sun
    c. the planets
    d. Polaris
    e. the stars

    ANS: B DIF: Easy REF: Section 2.3 TOP: 3IIiii
    MSC: Factual

28. When the Northern Hemisphere experiences fall, the Southern Hemisphere experiences:
    a. spring
    b. summer
    c. fall
    d. winter

    ANS: A DIF: Easy REF: Section 2.3 TOP: 3IIIi
    MSC: Applied

29. When the Northern Hemisphere experiences summer, the Southern Hemisphere experiences:
    a. spring
    b. summer
    c. fall
    d. winter

    ANS: D DIF: Easy REF: Section 2.3 TOP: 3IIIi
    MSC: Applied

30. If the Earth's axis were tilted by 5°, instead of its actual tilt, how would the seasons be different than they are currently?
    a. The seasons would remain the same.
    b. Summers would be warmer.
    c. Winters would last longer.
    d. Winters would be warmer.
    e. Summers would last longer.

    ANS: D DIF: Medium REF: Section 2.3 TOP: 3IIIi | 3IIIii
    MSC: Factual

31. If the Earth's axis were tilted by 35°, instead of its actual tilt, how would the seasons be different than they are currently?
    a. The seasons would remain the same.

b. Summers would be colder.
c. Winters would be shorter.
d. Winters would be colder.
e. Summers would be shorter.

ANS: D DIF: Medium REF: Section 2.3 TOP: 3IIIi | 3IIIii
MSC: Factual

32. We experience seasons because:
a. the Earth's equator is tilted relative to the plane of the solar system
b. the Earth is closer to the Sun in summer and farther from the Sun in the winter
c. the length of the day is longer in the summer and shorter in the winter
d. the Earth moves with a slower speed in its orbit during summer and faster during winter
e. one hemisphere of Earth is closer to the Sun than the other hemisphere during the summer

ANS: A DIF: Medium REF: Section 2.3 TOP: 3IIIii
MSC: Applied

33. Earth is closest to the Sun when the Northern Hemisphere experiences:
a. spring
b. summer
c. fall
d. winter

ANS: D DIF: Difficult REF: Section 2.3 TOP: 3IIIii
MSC: Factual

34. During which season (in the Northern Hemisphere) could you see the Sun rising from the furthest north?
a. winter
b. spring
c. summer
d. fall
e. The Sun always rises directly in the east.

ANS: C DIF: Medium REF: Section 2.3 TOP: 3IIIiv
MSC: Applied

35. The day with the smallest number of daylight hours over the course of the year for a person living in the *Northern* Hemisphere is the:
a. summer solstice (June 1)
b. vernal equinox (March 21)
c. winter solstice (Dec. 22)
d. autumnal equinox (Sept. 23)
e. The number of daylight hours is always the same.

ANS: C DIF: Easy REF: Section 2.3 TOP: 3IIIvi
MSC: Applied

36. The day with the smallest number of daylight hours over the course of the year for a person living in the *Southern* Hemisphere is the:
a. summer solstice (June 1)
b. vernal equinox (March 21)

c. winter solstice (Dec. 22)
d. autumnal equinox (Sept. 23)
e. The number of daylight hours is always the same.

ANS: A DIF: Medium REF: Section 2.3 TOP: 3IIIvi
MSC: Applied

37. On which day of the year does the Sun reach its northernmost point in the sky?
a. vernal equinox
b. summer solstice
c. autumnal equinox
d. winter solstice
e. The sun always reaches the same altitude.

ANS: B DIF: Easy REF: Section 2.3 TOP: 3IIIvi
MSC: Factual

38. The Earth's rotational axis precesses in space and completes one revolution every:
a. 200 years
b. 1,800 years
c. 7,300 years
d. 26,000 years
e. 51,000 years

ANS: D DIF: Easy REF: Section 2.3 TOP: 3IVi
MSC: Factual

39. Which of the following stars will be the North Star in 12,000 years?
a. Polaris
b. Deneb
c. Vega
d. Thuban
e. Sirius

ANS: C DIF: Medium REF: Section 2.3 TOP: 3IVii
MSC: Factual

40. In regard to the phase of the Moon, the term *waxing* means:
a. less than half-illuminated
b. more than half–illuminated
c. becoming smaller
d. increasing in brightness
e. decreasing in brightness

ANS: D DIF: Easy REF: Section 2.4 TOP: 4Ii
MSC: Factual

41. If you see a full moon tonight, how long would you have to wait to see the next full moon?
a. 1 week
b. 2 weeks
c. 3 weeks
d. 4 weeks
e. 5 weeks

ANS: D DIF: Easy REF: Section 2.4 TOP: 4Ii | 4IIii
MSC: Factual

42. If a person on Earth currently views the Moon in a waxing crescent phase, in what phase would the Earth appear to a person on the Moon?
    a. waxing crescent
    b. waxing gibbous
    c. waning gibbous
    d. waning crescent
    e. new

    ANS: C DIF: Difficult REF: Section 2.4 TOP: 4Ii | 4Iii
    MSC: Applied

43. If tonight the Moon is in the waxing gibbous phase, in three days the Moon will most likely be in the:
    a. new phase
    b. full phase
    c. third-quarter phase
    d. first-quarter phase
    e. waxing crescent phase

    ANS: B DIF: Easy REF: Section 2.4 TOP: 4Ii | 4Iii | 4IIii
    MSC: Applied

44. If there is a full moon out tonight, approximately how long from now will it be in the third-quarter phase?
    a. three to four days
    b. one week
    c. two weeks
    d. three weeks
    e. one month

    ANS: B DIF: Easy REF: Section 2.4 TOP: 4Ii | 4Iii | 4IIii
    MSC: Applied

45. Which of the following is FALSE?
    a. Everyone on Earth observes the same phase of the Moon on a given night.
    b. The phases of the Moon cycle with a period that is longer than its sidereal period.
    c. In some phases, the Moon can be observed during the day.
    d. The observed phase of the Moon changes over the course of one night.
    e. A full Moon can be seen on the eastern horizon at sunset.

    ANS: D DIF: Easy REF: Section 2.4 TOP: 4Iii | 4IIi | 4IIii | 4IIiii
    MSC: Applied

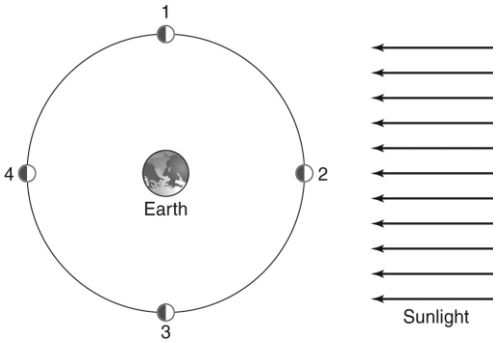


Figure 2

46. In Figure 2, at which position must the moon be located in order for a lunar eclipse to occur?
    a. 1
    b. 2
    c. 3
    d. 4

    ANS: D DIF: Easy REF: Section 2.6 TOP: 4Iii | 6Ii
    MSC: Conceptual

47. In Figure 2, at which position must the moon be located in order for a solar eclipse to occur?
    a. 1
    b. 2
    c. 3
    d. 4

    ANS: B DIF: Easy REF: Section 2.6 TOP: 4Iii | 6Iii
    MSC: Conceptual

48. During which lunar phase do solar eclipses occur?
    a. new
    b. first quarter
    c. full
    d. third quarter

    ANS: A DIF: Easy REF: Section 2.6 TOP: 4Iii | 6Iii
    MSC: Conceptual

49. The Moon's sidereal period is 2.2 days shorter than the period during which the Moon's phases change because:
    a. the Moon always keeps the same side turned toward the Earth
    b. the Earth must rotate so an observer can see the Moon
    c. the Moon's orbit is tilted with respect to the Earth's rotational axis
    d. the Earth moves significantly in its orbit around the Sun during that time
    e. the Moon's orbital speed varies

    ANS: D DIF: Medium REF: Section 2.4 TOP: 4IIiii
    MSC: Conceptual

50. The Moon undergoes synchronous rotation, and as a consequence the:
    a. rotational period of the Moon equals the orbital period of the Moon around the Earth
    b. rotational period of the Moon equals the rotational period of the Earth
    c. rotational period of the Moon equals the orbital period of the Earth around the Sun
    d. orbital period of the Moon around the Earth equals the rotational period of the Earth
    e. Moon does not rotate as it orbits the Earth

    ANS: A DIF: Easy REF: Section 2.4 TOP: 4III
    MSC: Conceptual

51. Leap years occur because:
    a. the Earth's orbital period around the Sun is decreasing
    b. the Earth's orbital period is 365.24 days
    c. the Gregorian calendar contains only 11 months
    d. the Earth speeds up in its orbit when it comes closest to the Sun
    e. a calendar month is not the same as a lunar month

    ANS: B DIF: Easy REF: Section 2.5 TOP: 5Ii
    MSC: Conceptual

52. How often do leap years occur?
    a. almost every 3 years
    b. almost every 4 years
    c. almost every 5 years
    d. almost every 8 years
    e. almost every 10 years

    ANS: B DIF: Easy REF: Section 2.5 TOP: 5Ii
    MSC: Factual

53. How often would we have leap years if Earth's orbital period were 365.1 days?
    a. every year
    b. every 2 years
    c. every 4 years
    d. every 10 years
    e. We would not need to have leap years.

    ANS: D DIF: Medium REF: Section 2.5 TOP: 5Ii
    MSC: Applied

54. A partial lunar eclipse occurs when:
    a. the Sun appears to go behind the Moon
    b. the Moon passes through part of the Earth's shadow
    c. the Moon shadows part of the Sun
    d. the Earth passes through part of the Moon's shadow
    e. the Moon passes through part of the Sun's shadow

    ANS: B DIF: Easy REF: Section 2.6 TOP: 6Ii | 6IIi
    MSC: Conceptual

55. If you are lucky enough to see a total solar eclipse, you must be standing in the:
    a. Moon's umbra
    b. Moon's penumbra
    c. Earth's umbra
    d. Earth's penumbra
    e. Sun's umbra

    ANS: A DIF: Medium REF: Section 2.6 TOP: 6Iii | 6II
    MSC: Applied

56. If you are observing a partial solar eclipse, you must be standing in the:

a. Moon's umbra
b. Moon's penumbra
c. Earth's umbra
d. Earth's penumbra
e. Sun's umbra

ANS: B DIF: Medium REF: Section 2.6 TOP: 6Iii | 6II
MSC: Applied

57. A solar-powered spacecraft is traveling through the Moon's shadow. Which part(s), if any, of the Moon's shadow will cause the spacecraft to completely lose power?
a. umbra
b. penumbra
c. annulus
d. both umbra and penumbra
e. The spacecraft will never lose power.

ANS: A DIF: Medium REF: Section 2.6 TOP: 6IIii | 6IIiii
MSC: Applied

58. Solar and lunar eclipses are rare because:
a. the Moon's orbital plane is tipped by 5.2° relative to the plane defined by the Earth's equator
b. the Moon's orbital plane is tipped by 5.2° relative to the Earth's orbital plane
c. the Moon's orbital plane is tipped by 23.5° relative to the plane defined by the Earth's equator
d. the Moon's orbital plane is tipped by 23.5° relative to the Earth's orbital plane
e. the Moon's orbital plane is tipped by 5.2° relative to the galactic plane

ANS: B DIF: Medium REF: Section 2.6 TOP: 6IIIi | 6IIIiii
MSC: Conceptual

59. Approximately how often do lunar eclipses occur?
a. twice every year
b. three times every year
c. once per month
d. twice every 11 months
e. once every 11 years

ANS: D DIF: Difficult REF: Section 2.6 TOP: 6IIIiii
MSC: Factual

SHORT ANSWER

1. On what place(s) on Earth can you stand and have the celestial equator be at the same altitude for all 360° of its circumference?

ANS:
You can stand at either the North Pole or the South Pole.

DIF: Medium REF: Section 2.2 TOP: 2Ii | 2Iiii | 2Ivi
MSC: Applied

2. For an observer in Seattle, Washington, which is located at latitude = +47°, what is the lowest possible altitude one might see the Sun on the meridian over the course of the year? Approximately what time of the day and year will this occur?

   ANS:
   For an observer in Seattle, Washington, the celestial equator will be at an altitude of 90° − 47° = 43° above the southern horizon. The Sun will be located at its southern most position on the celestial sphere on the winter solstice, which is 23.5° south from the celestial equator. Therefore, the Sun will be on the meridian at noon on the winter solstice with an altitude of 43° − 23.5° = 19.5° above the southern horizon.

   DIF: Difficult REF: Section 2.2 TOP: 2Iii | 2Iiii | 3IIIvi
   MSC: Applied

3. Draw a dome representing the visible sky. Label the horizon, meridian, zenith, and each of the four cardinal directions (north, east, south, and west).

   ANS:
   The drawing should look like a dome, with the ground portion labeled as the horizon, the topmost part of the dome labeled as the zenith, and the cardinal directions labeled on the horizon with north, east, south, and west at 90 degrees from each other, clockwise. Finally, the meridian should be a line drawn from the north, through the zenith, to the south.

   DIF: Medium REF: Section 2.2 TOP: 2Ii | 2Iiii | 2Iiv |2Iv
   MSC: Factual

4. The center of the Milky Way lies approximately 30° south of the celestial equator. From what latitudes on the Earth is it impossible to view the center of our galaxy?

   ANS:
   At latitudes > 90° − 30° = 60°, it would be impossible to see the center of our galaxy because it would lie below the horizon.

   DIF: Medium REF: Section 2.1 TOP: 2Ii MSC: Applied

5. The position of the autumnal equinox lies at the intersection of which two great celestial circles on the celestial sphere?

   ANS:
   The autumnal equinox lies at the intersection of the celestial equator and the ecliptic.

   DIF: Difficult REF: Section 2.3 TOP: 2Ii | 2Ivii | 3IIIv
   MSC: Factual

6. How is the observed height of Polaris above the horizon related to an observer's latitude? (Hint: Consider three cases of observers located at the equator, the North Pole, and latitude = +45°.)

   ANS:

The observed height of Polaris above the horizon is equal to an observer's latitude. For an observer at the equator (latitude = 0°), Polaris is on the horizon. For an observer at the North Pole (latitude = +90°), Polaris is at the zenith or 90° above the horizon. For an observer at latitude = +45°, Polaris is 45° above the horizon.

DIF: Medium REF: Section 2.2 TOP: 2Iii | 2Iiii | 2Iviii
MSC: Applied

7. If you are standing on the equator and shoot a cannonball directly north, where would you expect it to land?

ANS:
The cannonball would land to the northeast of your position. Since you are standing on the equator, you have the fastest ground speed of any location on Earth. Once the cannonball is fired, it is given a velocity in the northern direction. However, the cannonball retains the ground speed of the equator also. Since the ground speed of the northern latitudes is lower than that of the equator, the cannonball will appear to travel northeast instead of straight north!

DIF: Difficult REF: Section 2.2 TOP: 2II MSC: Conceptual

8. Earth has an average radius of approximately 6.4×10^3 km. What is the average speed, in units of km/s, of the ground at the Earth's equator due to the daily rotation of Earth if there are 8.64×10^4 seconds per day?

ANS:
Here the students need to convert the radius of Earth to its circumference: $C = 2\pi r = 2 \times 3.14159 \times 6.4 \times 10^3 = 4.02 \times 10^4$ km. Divide this distance by 8.64×10^4 s, and we get a speed of 0.465 km/s = 1,676 km/hr.

DIF: Difficult REF: Section 2.2 TOP: 2IIIi MSC: Applied

9. Consider an observer located on the equator. If the observer sees a star directly overhead at 10 P.M., where will that star be located in the night sky at 3 A.M.?

ANS:
The star will be visible low on the western horizon.

DIF: Easy REF: Section 2.2 TOP: 2IVi | 2IViii MSC: Applied

10. Consider an observer located on the equator. If the observer sees a star directly overhead at 8 P.M., where will that star be located in the night sky at midnight? How far above the horizon will it be or will it have set?

ANS:
The star will move westward by an amount that is equal to (12 hr − 8 hr) × 360°/24 hr = 60°, and the star will be 90° − 60° = 30° above the western horizon.

DIF: Medium REF: Section 2.2 TOP: 2IVi | 2IViii MSC: Applied

11. Earth experiences seasons due to the tilt of its axis. What are two consequences of this tilt that contribute to the seasons?

    ANS:
    (1) Variation in the length of daylight
    (2) Variation in the directness of the Sun's rays

    DIF: Medium REF: Section 2.3 TOP: 3IIIii MSC: Applied

12. What would be the effect on the seasons if the tilt of the Earth's axis were 10° rather than 23.5°?

    ANS:
    If the tilt of the Earth's axis were smaller, there would be a less dramatic temperature shift between the seasons because the angle of the Sun's rays would vary less and the length of day/night would be more equal throughout the year.

    DIF: Easy REF: Section 2.3 TOP: 3IIIii | 7Ii MSC: Applied

13. What makes the equinoxes and solstices special?

    ANS:
    The equinoxes occur when the Sun is directly above the equator; the entire world experiences a 12-hour day and a 12-hour night. The solstices occur when the Sun is farthest from the equator (north or south). On these days, one hemisphere experiences its longest day and shortest night, while the other hemisphere experiences its shortest day and longest night.

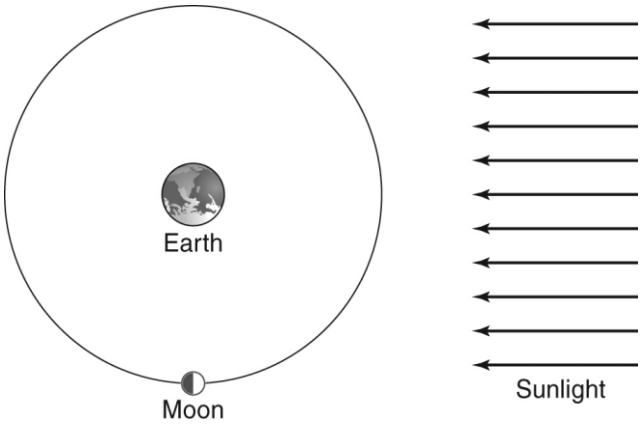
    DIF: Easy/Medium REF: Section 2.3 TOP: 3IIIv | 3IIIvi
    MSC: Factual

14. If the Moon was full three days ago, what phase will it be in tonight, and when will it rise and set?

    ANS:
    The Moon's phase cycles on a 29.5-day period. Therefore, the Moon tonight will be approximately halfway between the full and third-quarter phases, and thus it will be in the waning gibbous phase. It will be on an observer's eastern horizon and rising halfway between 6 P.M. and midnight, which is 9 P.M. It will set 12 hours later at 9 A.M.

    DIF: Medium REF: Section 2.4 TOP: 4Ii | 4Iii | 4IIiv
    MSC: Applied

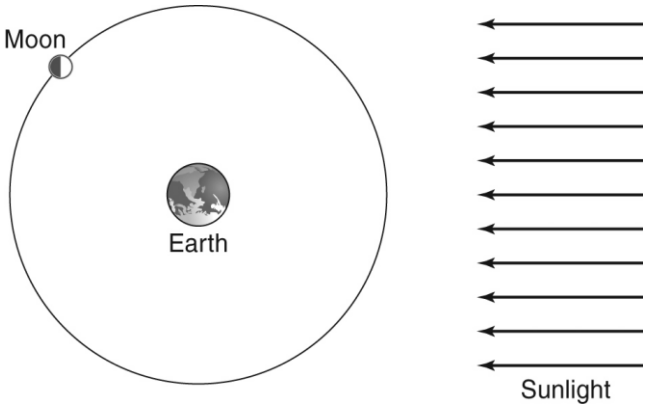
15. Based on the location of the moon in the diagram below, draw a picture of how the moon would appear to an observer located on Earth.



ANS:
The drawing should show a third-quarter moon, where the left half of the moon's face will be lit up and the right half will be in darkness.

DIF: Medium REF: Section 2.4 TOP: 4Iii MSC: Conceptual

16. Based on the location of the moon in the diagram below, draw a picture of how the moon would appear to an observer located on Earth.



ANS:
The drawing should show a waxing gibbous moon, where more than half of the moon's right face will be lit up and less than half of the left face will be in darkness.

DIF: Difficult REF: Section 2.4 TOP: 4Iii MSC: Conceptual

17. As the month passes, the Moon appears to rise later in the day or night when compared to the previous day. Explain why this happens.

ANS:
In general, objects appear to rise and set due to Earth's rotation. While Earth rotates once every 24 hours, the Moon also orbits around Earth roughly once a month in the same direction as Earth's rotation. Therefore, over 24 hours, the Moon has moved slightly from its original position, and Earth has to rotate a little more before the Moon appears to rise again the next day.

DIF: Medium REF: Section 2.4 TOP: 4IIiv MSC: Applied

18. Explain why we always see the same side of the Moon from Earth.

    ANS:
    The amount of time it takes for the Moon to rotate once about its axis is exactly equal to the amount of time it takes to orbit once around Earth.

    DIF: Easy REF: Section 2.4 TOP: 4IIIii MSC: Conceptual

19. How does today's Gregorian calendar differ from the calendars of more ancient civilizations, such as the Chinese, the Egyptians, and the Babylonians?

    ANS:
    The Gregorian calendar is based on the tropical year, based on the motion of the Earth around the Sun. The others are lunar calendars based on the motion of the Moon around the Earth. The Gregorian calendar also includes leap years to avoid the shifting of the seasons due to the fact that the Earth orbits the Sun in 365.24 days.

    DIF: Medium REF: Section 2.5 TOP: 5Ii | 5II MSC: Factual

20. Draw a picture below showing the Moon's location relative to the Earth and the Sun during a lunar eclipse.

    ANS:
    The Moon, Earth, and Sun should all be drawn in a straight line with the Earth in between the Moon and the Sun.

    DIF: Medium REF: Section 2.6 TOP: 6Ii MSC: Applied

21. Draw a picture below showing the Moon's location relative to the Earth and the Sun during a solar eclipse.

    ANS:
    The Moon, Earth, and Sun should all be drawn in a straight line with the Moon in between the Earth and the Sun.

    DIF: Medium REF: Section 2.6 TOP: 6Iii MSC: Applied

22. Explain why the eclipse seasons occur roughly twice every 11 months, rather than twice per year.

    ANS:
    This happens because the plane of the Moon's orbit slowly wobbles, completing one full "wobble" every 18.6 years. Because the wobble is in the opposite direction from the Moon's orbit, the eclipse seasons occur less than six months apart.

    DIF: Difficult REF: Section 2.6 TOP: 6IIIi | 6IIIii | 6IIIiii
    MSC: Applied