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Chapter 1: Discovering the Night Sky

Section: Introduction

1. Which one of these is NOT a recent astronomical discovery?

- A) the discovery of life on other planets
- B) the discovery of planets around other stars
- C) sending a spacecraft through Saturn's rings
- D) landing a spacecraft on an asteroid

ans: A

Section: 1-1

2. The average distance from Earth to the Sun, 149,600,000 km, can be written in scientific notation as

- A) 1.496×10^8 km.
- B) 1.496×10^6 km.
- C) 1.496×10^9 km.
- D) 1.496×10^7 km.

ans: A

3. The diameter of the hydrogen atom, 0.000 000 000 11 m, can be written in scientific notation as

- A) 1.1×10^{-8} m.
- B) 1.1×10^{-10} m.
- C) 1.1×10^{-9} m.
- D) 1.1×10^{-11} m.

ans: B

4. The mass of the electron, 0.000,000,000,091 kg, can be written in scientific notation as

- A) 0.91×10^{-11} kg.
- B) 9.1×10^{-12} kg.
- C) 9.1×10^{-11} kg.
- D) 9.1×10^{-10} kg.

ans: C

5. The mean distance of Saturn from the Sun, 1,427,000,000 km, can be written in scientific notation as

- A) 1.427×10^6 km.
- B) 0.1427×10^9 km.
- C) 1.427×10^7 km.
- D) 1.427×10^9 km.

ans: D

6. There are 1000 mm in 1 meter. This means that a distance of 10 mm is

- A) 1×10^{-4} m.
- B) 1×10^{-2} m.
- C) 1×10^{-1} m.
- D) 1×10^{-3} m.

ans: B

7. 0.034 meter is

- A) 3.4 mm.
- B) 0.34 mm.
- C) 340 mm.
- D) 34 mm.

ans: D

8. $10^2 \times 10^5 =$

- A) 1,000,000
- B) 1,000,000,000
- C) 10,000,000
- D) 10,000

ans: C

9. 10^0 (10 to the power 0) =

- A) 0
- B) 10
- C) undetermined; not a real number
- D) 1

ans: D

10. The number 50,000 is written in scientific notation as

- A) 5×10^4 .
- B) 5×10^5 .
- C) $(50) \times 10^{-3} = 5 \times 10^{-2}$.
- D) 5×10^3 .

ans: A

11. $10^{-3} \times 10^3 =$

- A) 1/100
- B) 0
- C) 10,000
- D) 1

ans: D

12. $(3 \times 10^4)^4 =$

- A) 8.1×10^{17}
- B) 1.2×10^{17}
- C) 9×10^{16}
- D) 8.1×10^{16}

ans: A

13. $(1/2)^4 =$
A) 0.5
B) 6.25×10^{-2}
C) 16
D) 0.125

ans: B

14. $(0.5)^3 =$
A) 0.125
B) 125
C) 1.25×10^{-2}
D) 1.5

ans: A

15. $10^4 \times 10^8 =$
A) 10^4
B) 10^{12}
C) 10^{14}
D) 10^{32}

ans: B

16. $10^8/10^9 =$
A) 10^1
B) 10^{17}
C) 10^{72}
D) 10^{-1}

ans: D

17. $(8.0 \times 10^5)/(2.0 \times 10^3) =$
A) 0.5×10^2 or 50
B) 400
C) 16×10^{15}
D) 4×10^{-2}

ans: B

18. $10^5/10^5 =$
A) 1
B) 10^{12}
C) 0
D) 10

ans: A

19. $(1.5 \times 10^4) \times (1.5 \times 10^{-4}) =$

A) 1.5×10^0

B) 21.25

C) 12.5

D) 3.0

ans: B

20. One-billionth divided by one-millionth is equal to

A) 10^{-15}

B) 10^{15}

C) 10^{-3}

D) 10^3

ans: C

21. $(2 \times 10^3)^3 =$

A) 6×10^6

B) 8×10^6

C) 6×10^9

D) 8×10^9

ans: D

22. By what approximate factor, in scientific notation, is a human being (height about 2 m) larger than the nucleus of a hydrogen atom, or proton (diameter about 10^{-15} m)?

A) 2×10^{13}

B) 2×10^{30}

C) 2×10^{-15}

D) 2×10^{15}

ans: D

23. By how many powers of ten is the diameter of the Sun (1.4×10^5 km) greater than the length of a beetle (14 mm)?

A) 10

B) 8

C) 11

D) 5

ans: A

24. In this age of space exploration, man has now traveled to the Moon. By approximately how

many orders of magnitude (powers of ten) was the distance of this journey greater than that of Columbus when he traveled from the Old World to the Americas?

- A) 21 orders of magnitude, or 10^{21}
- B) 6 orders of magnitude, or 10^6
- C) 10 orders of magnitude, or 10^{10}
- D) Less than one order of magnitude

ans: A

25. What is 10^{16} divided by a million and multiplied by a hundred?

- A) 10^{12} .
- B) 10^{10} .
- C) 10^{-6} .
- D) 10^{-10} .

ans: A

Section: 1-2

26. If there are about 6000 stars in the entire sky that can be seen by the unaided human eye, about how many stars would be seen at a particular instant on a given dark night from a single location with an uninterrupted distant horizon?

- A) 3000
- B) 6000
- C) only a small fraction of the 6000, say 1000, because the rest are hidden by the Earth
- D) It depends on the observer's latitude; observers at the poles will see 6000, while equatorial observers will see only one-half of this number, or 3000.

ans: A

27. The constellation Orion is

- A) a pattern of stars commonly seen to depict an ancient hunter.
- B) an entire region of the sky, bounded by Gemini, Taurus, Eridanus, Lepus, and Monoceros.
- C) one of 125 regions into which the entire sky is divided.
- D) an asterism.

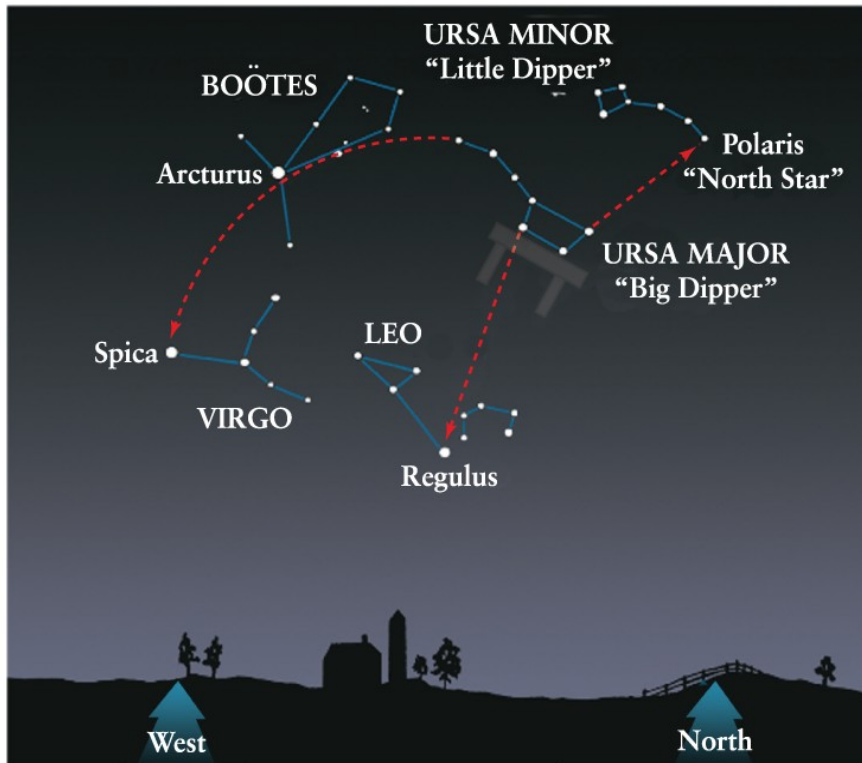
ans: B

28. The constellation whose stars are used as pointers to the north celestial pole in the northern hemisphere at this time in history is

- A) Ursa Minor, the Little Bear, containing the bright star Polaris.
- B) Leo the Lion, containing the bright star Regulus.
- C) Bootes the Shepherd, containing the bright star Arcturus.
- D) Ursa Major, the Big Dipper.

ans: D

29. If the stars Polaris and Arcturus are seen to be 71° apart, as shown in Figure 1-5, how far away from Polaris is the closest star in Ursa Major?



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- A) 0.25°
- B) 2.5°
- C) 25°
- D) 250°

ans: C

30. If one follows a line through the “pointer stars” (the two stars in the bowl of the Big Dipper farthest from the handle) away from the open end of the dipper, the first moderately bright star the observer comes to is

- A) Polaris, the North Star.
- B) Spica, in Virgo.
- C) Arcturus, in Boötes.
- D) Vega, in Lyra.

ans: A

31. If one follows the arc of the handle of the Big Dipper away from the dipper, the first moderately bright star one comes to is

- A) Polaris, the North Star.
- B) Spica, in Virgo.
- C) Arcturus, in Boötes.
- D) Vega, in Lyra.

ans: C

32. Are the constellations seasonal?

- A) No. If a person waits long enough, that person can see all the constellations on any clear night of the year.
- B) Yes. On a summer night all the constellations a person can see are different from the constellations that person can see on a winter night.
- C) Yes. On a summer night many of the constellations a person can see are different from the constellations that person can see on a winter night. But there are some constellations the person can see all year long.
- D) Yes. As the year progresses, the constellations change their positions with respect to each other, so every night brings a different mixture of summer and winter constellations.

ans: C

33. If one follows Orion's belt as it slopes down to the left, the first bright star one comes to is

- A) Spica, in Virgo.
- B) Polaris, the North Star.
- C) Sirius, in Canis Major.
- D) Vega, in Lyra.

ans: C

34. The bright star at the base of the backward question mark that forms the head of Leo the Lion is

- A) Arcturus.
- B) Regulus.
- C) Rigel.
- D) Fomalhaut.

ans: B

35. The bright stars Vega, Deneb, and Altair form

- A) the summer triangle.
- B) the winter triangle.
- C) the Big Dipper.
- D) Orion the Hunter.

ans: A

36. If a person faces Polaris, the North Star, that person is facing north;

- A) east is to their right and west is to their left, but only if they are in the northern hemisphere.
- B) east is to their right and west is to their left, whether they are in the northern hemisphere or not.
- C) west is to their right and east is to their left, but only if they are in the northern hemisphere.

D) west is to their right and east is to their left, whether they are in the northern hemisphere or not.

ans: B

37. The constellation whose stars are used as pointers to the north celestial pole in the northern hemisphere is

- A) Leo the Lion, containing the bright star Regulus.
- B) Ursa Major, the Big Dipper.
- C) Ursa Minor the Little Bear, containing the bright star Polaris.
- D) Bootes the Shepherd, containing the bright star Arcturus.

ans: B

38. The summer triangle, a group of three bright stars in the summer sky, consists of Deneb, Altair, and

- A) Betelgeuse.
- B) Vega.
- C) Pollux.
- D) Polaris.

ans: B

39. Polaris is the name for the bright star almost directly in line with the north polar axis of Earth. What is the name of the bright star almost directly in line with the south polar axis of Earth?

- A) Fomalhaut
- B) Canopus
- C) Alpha Centauri
- D) There is no bright star almost directly in line with Earth's south polar axis.

ans: D

Section: 1-3

40. The constellations

- A) are 88 in number and cover the entire sky.
- B) that the ancients imagined are constantly being augmented by newly invented constellations as new stars are being discovered.
- C) are of historical interest only and play no role at all in modern astronomy.
- D) consist of groups of stars that are all about the same distance from us.

ans: A

41. In modern astronomy, the constellations are

- A) specific patterns of stars that point to certain directions that are useful for navigation.
- B) 13 specific regions of stars through which the planets and Moon appear to move in the sky.
- C) a small number of well-defined and separate groups of stars in the sky.
- D) 88 nonoverlapping sky regions, covering the whole sky.

ans: D

42. If a modern astronomer describes a faint star as being in the constellation Cygnus, the Swan, the star is

- A) somewhere within a particular region of sky having definite boundaries.
- B) inside the solar system.
- C) in a distant galaxy located in a particular direction from Earth.
- D) one of a set of stars that make up a particular “picture,” in this case a swan, in the sky.

ans: A

43. Which of these statements correctly describes the relationship between stars and constellations?

- A) Only stars close to the ecliptic (Earth’s orbital plane) are located in constellations.
- B) Every star is located in a constellation.
- C) Only the brighter stars are in constellations.
- D) Only those stars that were visible to the ancient Greeks are located in constellations.

ans: B

44. If a star is described as being in the constellation Leo, a modern astronomer knows that it is

- A) one of a few individual bright stars making up a crude picture (of a lion) in the sky.
- B) in a specific region of the sky bounded by definite lines of right ascension and declination.
- C) somewhere within the image of a lion in the sky, which itself is outlined by bright stars.
- D) somewhere in a particular region of the sky, having definite boundaries.

ans: D

45. Over what typical time scale will the particular pattern of stars in a specific constellation

appear to change, as viewed from Earth, because of celestial motions?

- A) a human lifetime, because of motions of individual stars
- B) millions of years because stars move very slowly with respect to each other
- C) a few hours because of Earth's rotation
- D) a year because of Earth's orbital motion

ans: A

46. How much of the overall sky is north of the celestial equator?

- A) less than one-half because of the tilt of the equator to the ecliptic plane
- B) more than one-half because of the precession of the poles
- C) exactly one-half
- D) all of it, by definition

ans: C

47. The declination of a star in the sky is defined as the angle between the

- A) position of the center of the Galaxy and the star, measured along the galactic plane.
- B) celestial equator and the star, measured along a great circle passing through both celestial poles.
- C) Sun and the star, measured along the ecliptic plane.
- D) great circle passing through the star and both celestial poles and the equivalent great circle through the vernal equinox, measured along the celestial equator.

ans: B

48. The celestial equator is defined as the

- A) line in the sky that is perpendicular to Earth's spin axis.
- B) line traced in the sky by the Moon each month against the background stars.
- C) line traced in the sky by the Sun over 1 year against the background stars.
- D) band of constellations through which the Sun and Moon move in the sky.

ans: A

49. A comet that is moving southward from the north celestial pole toward the equator can be described as having its

- A) declination decrease with time.
- B) right ascension decrease with time.
- C) right ascension increase with time.
- D) declination increase with time.

ans: A

50. The celestial coordinate system of declination and right ascension

- A) can be used to assign coordinates to any direction in the sky.
- B) is an extension of the latitude-longitude system used on Earth. The celestial equator is an

extension of Earth's equator, and the location for the zero of right ascension is an extension of the prime meridian through Greenwich, England.

C) rotates along with Earth.

D) is centered at the Sun rather than at Earth.

ans: A

51. The right ascension of a star is one coordinate of its position, measured along the

A) observer's meridian.

B) celestial equator.

C) observer's horizon.

D) ecliptic.

ans: B

Section: 1-4

52. The alt-azimuth coordinate system, as defined in the text, is useful

- A) everywhere on Earth.
- B) only in the northern hemisphere.
- C) only in wintertime.
- D) only in a planetarium, not in the real sky.

ans: B

53. What are the alt-azimuth coordinates of Polaris, the North Star?

- A) 0° , 0°
- B) 90° , 0°
- C) 90° , any azimuth
- D) The answer depends on where the observer is on Earth.

ans: D

54. The alt-azimuth coordinates measured for Polaris are 37° , 0° . From what latitude are observing?

- A) 37° N
- B) 37° , N or S
- C) 53° N
- D) It is not possible to determine the answer from the information given.

ans: A

55. The alt-azimuth coordinates an observer measures for Polaris are 37, 0. From what longitude was this observation made?

- A) 37 N
- B) 37, N or S
- C) 53 N
- D) It is not possible to determine the answer from the information given.

ans: D

56. How do the alt-azimuth coordinates of a star compare with the R.A., Dec. coordinates of that same star?

- A) Both sets of coordinates change over the course of a single night.
- B) The R.A. and Dec. coordinates change over the course of a single night, but the alt-azimuth coordinates do not.
- C) The alt-azimuth coordinates change over the course of a single night, but the R.A. and Dec. coordinates do not.
- D) Neither set of coordinates changes over the course of a single night.

ans: C

57. Which of these lines or points is always directly overhead, no matter the location on Earth?

- A) celestial equator
- B) ecliptic
- C) zenith
- D) 90° north declination

ans: C

58. From any location on Earth, the zenith defines a direction

- A) vertically above the North Pole.
- B) vertically above an observer.
- C) toward the Sun at noon.
- D) vertically above a point on the equator.

ans: B

59. Which of these directions does NOT always remain fixed in place relative to an observer's horizon?

- A) one of the points where the celestial equator contacts the horizon
- B) summer solstice
- C) zenith
- D) north celestial pole

ans: B

60. Which of these points remains fixed in the sky relative to an observer's horizon over a time scale of 100 years?

- A) direction to a distant star (e.g., Betelgeuse, in Orion)
- B) north celestial pole
- C) winter solstice
- D) vernal equinox

ans: B

61. Which of these directions remains fixed in the sky relative to an observer's horizon?

- A) direction toward the Sun at noon, over 1 year
- B) autumnal equinox
- C) zenith
- D) direction toward the Moon at noon, over 1 month

ans: C

62. If an observer points toward the zenith today and points there again 45 days later, they will have pointed twice in the same direction relative to

- A) the horizon.

- B) the Sun.
- C) the Moon.
- D) the fixed stars.

ans: A

63. Right ascension of a star is a measure of

- A) the time of its rising in the eastern sky.
- B) its position above the observer's horizon, measured from the horizon.
- C) its position north or south of the celestial equator, along a great circle passing through the north and south celestial poles.
- D) the great circle joining north and south celestial poles upon which it is located, the position of which is measured along the celestial equator.

ans: D

64. In the system of celestial coordinates that matches latitude and longitude on Earth, which is the coordinate that is equivalent to longitude?

- A) declination
- B) elongation angle
- C) precession
- D) right ascension

ans: D

65. In the system of celestial coordinates that matches latitude and longitude upon Earth, which is the coordinate that is equivalent to latitude?

- A) precession
- B) elongation angle
- C) declination
- D) right ascension

ans: C

66. The zero point of the celestial coordinate known as right ascension (R.A.) is defined to be the

- A) intersection of the Milky Way with the celestial equator.
- B) point where the Sun crosses the celestial equator moving northward in its path across the sky.
- C) point where the Sun crosses the celestial equator moving southward in its path across the sky.
- D) intersection of the celestial equator with the projection of Earth's equator on the sky.

ans: B

67. Two celestial coordinates that together describe a star's position precisely in the sky are

- A) longitude and latitude.
- B) sidereal time and latitude.
- C) right ascension and declination.

D) right ascension and sidereal time.

ans: C

68. The difference in declination angles between the north and south celestial poles is

A) variable, depending on the season.

B) 23.5° .

C) 90° .

D) 180° .

ans: D

69. What is the equivalent angle along the celestial equator of 1 hour in the right ascension coordinate direction?

A) 30°

B) variable, depending on the declination of the star but not greater than 15°

C) 1°

D) 15°

ans: D

70. The angle between zenith and horizon is

A) 57.3° .

B) 90° .

C) 45° .

D) 180° .

ans: B

Section: 1-5

71. The ecliptic can be defined as the

- A) extension of Earth's equator onto the sky.
- B) plane that is perpendicular to Earth's spin axis.
- C) path traced out by the Moon in the sky in 1 month against the background stars.
- D) path traced out by the Sun in the sky over 1 year against the background stars.

ans: D

72. In which direction does the Sun appear to move along the ecliptic over the course of a year, relative to the background stars?

- A) west
- B) northwest
- C) southwest
- D) east

ans: D

73. If an observer could watch the Sun moving day by day against the background stars, it would follow

- A) the ecliptic.
- B) no specific or fixed path because Earth's tilt axis varies through the year, although it would remain within the zodiac.
- C) the celestial equator.
- D) a great circle crossing the celestial equator at right angles.

ans: A

74. The plane of the ecliptic intersects the celestial equator

- A) everywhere because these are two different names for the same plane.
- B) at two points, the summer and winter solstices.
- C) at two points, the vernal and autumnal equinoxes.
- D) along the prime meridian.

ans: C

75. If Earth lay on its side with its rotation in the plane of the ecliptic but rotated at the same rate it does now,

- A) there would be points on the surface that would constantly receive sunlight.
- B) there would still be equinox positions in Earth's orbit.
- C) one pole would constantly experience summer while the other experienced perpetual winter.
- D) there would be permanent ice caps.

ans: B

76. The Sun's apparent path across the sky against the background stars (which would be seen if the sunlit sky were not light) is known as the

- A) celestial meridian.
- B) celestial equator.
- C) great circle.
- D) ecliptic.

ans: D

77. The ecliptic crosses the celestial equator

- A) at two points, known as equinoxes.
- B) on the meridian.
- C) at two points, known as solstices.
- D) at one point only, known as the vernal equinox.

ans: A

78. In angular measurements used in astronomy, the number of degrees in a semicircle is how many times the number of degrees in a right angle?

- A) six
- B) one
- C) four
- D) two

ans: D

79. What is the Moon's approximate diameter if it subtends about 30 arcminutes in the sky and is at about 400,000 km from Earth at the time of observation?

- A) 350 km
- B) 35,000 km
- C) 3500 km
- D) 60 km

ans: C

80. If the Moon's diameter is approximately 3500 km, what angle will this diameter subtend if the Moon is observed when it is at a distance of about 400,000 km from Earth?

- A) 0.009°
- B) 30 arcminutes
- C) 30°
- D) 30 arcseconds

ans: B

81. Astronauts on the Moon look back at Earth, a distance of about 400,000 km. If the cities of Washington, D.C., and New York are separated by about 300 km, what will the angle between

them be when viewed from the Moon?

- A) 1.3°
- B) 1300°
- C) 2.5°
- D) 2.5 arcminutes

ans: D

82. The Moon's angular diameter in the sky is measured to be 0.5° . From this measurement, one can find the

- A) bulk density of the Moon (the average number of kilograms per cubic meter of Moon material) if one knows its distance from Earth.
- B) diameter of the Moon in kilometers if one knows the Moon's distance.
- C) diameter of the Moon in kilometers even if one has no other information about the Moon.
- D) distance to the Moon even if one has no other information about the Moon.

ans: B

83. Astronauts on the Moon look back at Earth, whose diameter is about 12,800 km. Because the Earth–Moon distance is about 400,000 km and the Moon's diameter is about 3500 km, how much bigger or smaller will Earth appear in their sky than the Moon does in the sky?

- A) the same, obviously
- B) 114 times
- C) 3.7 times
- D) 0.27 times

ans: C

84. The number of degrees in a semicircle is

- A) 57.3.
- B) 180.
- C) 90.
- D) 360.

ans: B

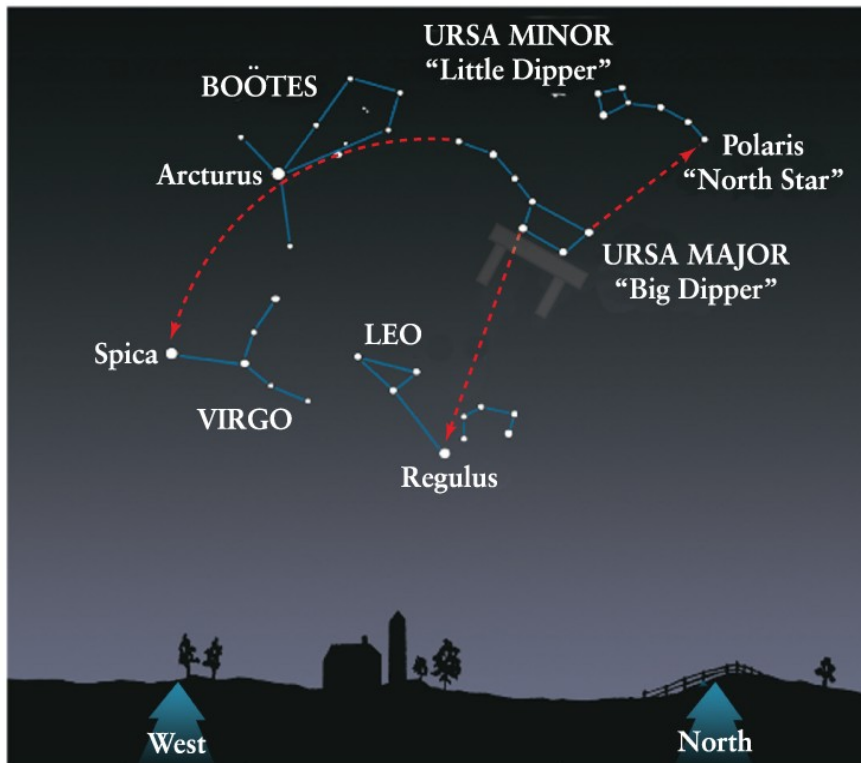
85. What fraction of a full circle is the angle of 60° between the line from the Sun to Jupiter and the line from the Sun to a Trojan group of asteroids?

- A) $1/6$
- B) $1/2$
- C) $1/3$
- D) $1/5$

ans: A

86. The so-called “pointer stars” in Ursa Major, the Big Dipper, are separated by about 5 degrees

on the sky. How many Moon diameters would fit between them? See Figure 1-5 for a diagram of these stars in context.



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- A) 5
- B) 10
- C) 15
- D) 2

ans: B

87. An arcsecond is a measure of

- A) the time between oscillations of a standard clock, the American Reference Clock (ARC).
- B) length along the circumference of a circle.
- C) angle.
- D) the time Earth takes to move through 1° along its orbit.

ans: C

88. 1 arcsecond is equal to

- A) $1/3600^\circ$.
- B) $1/60^\circ$.
- C) $1/360$ of a full circle.
- D) $1/60$ of a full circle.

ans: A

89. 1 arcminute is equal to

- A) 1/60 of a full circle.
- B) 1/60 arcsecond.
- C) $1/3600^\circ$.
- D) $1/60^\circ$.

ans: D

90. The number of arcseconds in 1° is

- A) 2.06×10^5 .
- B) 360.
- C) 3600.
- D) 60.

ans: C

91. Which of these statements about angle is correct?

- A) 180 arcminutes is one-half of a full circle.
- B) 15 arcminutes is 1 arcsecond.
- C) 15 arcminutes is 1° .
- D) 25 arcminutes is 1° .

ans: C

92. The Crab has a diameter of about 10 light-years and is at a distance of 6300 light-years. What angle will this supernova remnant subtend in the sky?

- A) 630 arcseconds
- B) 32.7 arcseconds
- C) 1.6×10^{-3} arcseconds
- D) 5.5 arcminutes

ans: D

93. When viewed from Earth on a particular night, Jupiter subtends an angle of 42 arcseconds. This angle is

- A) more than 1° .
- B) less than 0.5 arcminute.
- C) more than 1 arcminute but less than 1° .
- D) about 1 arcminute.

ans: D

94. If Venus has an angular diameter of 30 arcseconds when viewed from Earth at a particular time, how does this angular diameter compare with the typical angular diameter of the Moon?

- A) 60 times smaller
- B) 60 times larger
- C) 1/30 as large
- D) 3600 times smaller

ans: A

95. The angle subtended at an observer by a city transit bus (length 9 m) at a distance of 1000 m is close to

- A) $1000/9$, or 111.1 arcseconds.
- B) $\frac{1}{2}$ of a degree.
- C) 9000 arcminutes.
- D) $9/1000$, or 0.009 arcseconds.

ans: B

Section: 1-6

96. For an observer at a fixed location on Earth, the angle between the north celestial pole and an observer's horizon depends on the

- A) observer's longitude (east or west of Greenwich).
- B) time of day.
- C) time of year.
- D) observer's latitude (north or south of the equator).

ans: D

97. The angle between an observer's horizon and the north celestial pole is governed by

- A) longitude.
- B) local time.
- C) latitude.
- D) sidereal time.

ans: C

98. From a location in the northern hemisphere, the pole star always appears at an angle above the northern horizon equal to

- A) 180° plus the longitude of the location.
- B) the latitude of the location.
- C) the longitude of the location.
- D) 90° minus the latitude of the location.

ans: B

99. The elevation angle between the northern horizon of a fixed observer and the north celestial pole is

- A) equal to the right ascension of the vernal equinox.
- B) equal to the observer's longitude.
- C) a variable value, depending on the time of year.
- D) equal to the observer's latitude.

ans: D

100. The system of declination and right ascension is similar to the system of latitude and longitude used on the surface of Earth. In the Earth system, the zero of longitude is called the

- A) prime meridian.
- B) international date line.
- C) great circle.
- D) terminator line.

ans: A

101. The daily and annual rhythms of the sky and Earth arise from all of these celestial motions EXCEPT

- A) Earth's spin around its axis.
- B) Earth's orbit around the Sun.
- C) Moon's spin around its axis.
- D) Moon's orbit around Earth.

ans: C

102. The nightly motion of objects across the sky from horizon to horizon is caused by the

- A) motion of the solar system around the Galaxy.
- B) revolution of Earth around the Sun.
- C) rotation of the whole celestial sphere of stars around the fixed Earth.
- D) rotation of Earth on its axis.

ans: D

103. If Earth's revolution around the Sun were reversed in direction, observers would find

- A) constellations of the northern and southern hemispheres would be reversed.
- B) the stars would set about 4 minutes earlier each day than they did the day before.
- C) the summer and winter constellations would be reversed.
- D) stars would rise in the west and set in the east.

ans: B

104. If an observer starts at Earth's South Pole and moves northward, at what latitude would Polaris first become visible?

- A) It would always be visible.
- B) 66.5°S
- C) 23.5°S
- D) at the equator

ans: D

105. If an observer is at the North Pole, how would that person describe the angle with the horizon made by stars as they rise and set?

- A) It is perpendicular to the horizon.
- B) It is variable but never more than 23.5.
- C) It is variable but never more than 66.5.
- D) The stars do not rise and set when viewed from the North Pole but instead move parallel to the horizon.

ans: D

106. If an observer is at the equator, how would they describe the angle with the horizon made by stars as they rise and set?

- A) It is perpendicular to the horizon.
- B) It is variable but never more than 23.5.
- C) It is variable but never more than 66.5.
- D) The stars do not rise and set when viewed from the equator but instead move parallel to the horizon.

ans: A

107. An observer measures the angle with the horizon made by stars as they rise and set. As the observer moves northward from the equator, this angle

- A) remains the same.
- B) decreases from 90 to zero.
- C) increases from zero to 90.
- D) first increases until it get to middle latitudes and then decreases again.

ans: B

108. An observer measures the angle made by stars as they rise and set. As the observer moves northward from the South Pole, this angle

- A) remains the same.
- B) decreases from 90 to zero.
- C) decreases from zero to 90
- D) increases from zero to 90 at the equator and then decreases.

ans: D

109. If observed carefully night by night, a particular star will be seen to rise

- A) at a different time every night, sometimes earlier, sometimes later than a specified time, because of Earth's differing orbital speed.
- B) about 4 minutes earlier every night.
- C) about 4 minutes later every night.
- D) at the same time every night.

ans: B

110. Any star (except the Sun), when viewed from low latitudes and mid-latitudes, will rise in the east about

- A) 1 hour later each evening.
- B) 4 minutes earlier each evening.
- C) 4 minutes later each evening.
- D) the same time each evening.

ans: B

111. A particular star is seen to cross the horizon at 10:00 P.M. (22:00 hours) on a particular night. When would this star cross the horizon on the next night, from the same location?

- A) This star will not rise the next night and will be seen again only after 1 year.
- B) 10:04 P.M.
- C) 10:00 P.M.
- D) 9:56 P.M.

ans: D

112. On December 1 at 10:00 P.M., the bright star Procyon will just be rising on the eastern horizon. When would this star rise on Christmas Day (24 days later)?

- A) 11:36 P.M.
- B) 8:24 P.M.
- C) 9:36 P.M.
- D) 10 P.M.

ans: B

113. The bright star Procyon is seen to rise on the eastern horizon at 10:00 P.M. on December 1. At approximately what time will this star rise one week later, on December 8?

- A) 10:00 P.M.
- B) 9:53 P.M.
- C) 9:32 P.M.
- D) 10:28 P.M.

ans: C

114. How long will it take, in solar time, for the Big Dipper, to return to the same position in an observer's sky?

- A) 24 hours 4 minutes
- B) 23 hours 56 minutes
- C) 365 days
- D) 24 hours exactly

ans: B

115. The direction of Earth's rotation about its axis is the same as the direction of its revolution about the Sun. How does a solar day compare to a sidereal day on Earth?

- A) A solar day is always longer.
- B) A sidereal day is always longer.
- C) A solar day and a sidereal day are always the same length.
- D) A sidereal day is longer when Earth is farther from the Sun (northern summer), but a solar day is longer when Earth is closer to the Sun (northern winter).

ans: A

116. A solar day is the time it takes Earth to rotate on its axis between two consecutive solar positions (for example, high noon to high noon or sunset to sunset). A sidereal day is the time it

takes Earth to rotate on its axis between two consecutive positions of a distant star (Vega on the eastern horizon to Vega again on the eastern horizon). Which is longer?

- A) A solar day is always longer.
- B) A sidereal day is always longer.
- C) A solar day and a sidereal day are always the same length.
- D) A sidereal day is longer when Earth is farther from the Sun (northern summer), but a solar day is longer when Earth is closer to the Sun (northern winter).

ans: A

117. If the direction of Earth's rotation about its axis were reversed but the direction of its revolution around the Sun remained the same, the sidereal day would be

- A) 4 minutes shorter than a solar day, as it is now.
- B) 4 minutes longer than a solar day.
- C) the same length as a solar day.
- D) 8 minutes shorter than a solar day.

ans: B

118. If both the direction of Earth's rotation about its axis and the direction of its revolution around the Sun were reversed, the length of a sidereal day would be

- A) 4 minutes shorter than a solar day, as it is now.
- B) 4 minutes longer than a solar day.
- C) the same length as a solar day.
- D) 8 minutes shorter than a solar day.

ans: A

119. Would a calendar based on a sidereal day be satisfactory?

- A) No. Noon on the clock would become earlier than the high point of the Sun by 4 minutes each day until eventually it would occur in the middle of the night.
- B) No. Noon on the clock would become later than the high point of the Sun by 4 minutes each day until eventually it would occur in the middle of the night.
- C) No. The seasons would be reversed.
- D) Yes, but, we would have to add an extra day every year.

ans: A

120. The time interval from seeing the bright star Regulus rise over the eastern horizon until it rises again the following evening is

- A) a solar day.
- B) a sidereal day.
- C) neither a solar day nor a sidereal day.
- D) both a solar day and a sidereal day because these are the same for objects other than the Sun.

ans: B

121. Which way does an observer move with respect to the stars because of the rotation of Earth?
- A) westward
 - B) southward
 - C) northward
 - D) eastward

ans: D

122. The MOST readily observed east-to-west motion of objects in the night sky is caused by the
- A) relative motions of stars with respect to each other in the sky.
 - B) rotation of Earth on its axis.
 - C) rotation of the whole universe around a fixed axis near the Great Attractor.
 - D) revolution of Earth in its orbit around the Sun.

ans: B

123. The pattern of stars that is visible from one position on Earth gradually shifts from east to west across the sky over one night. This shift is caused by
- A) the motion of Earth around the Sun.
 - B) the rotation of Earth about its own north-south axis.
 - C) individual motions of the stars themselves with respect to the more distant galaxies.
 - D) precession of the spin axis of Earth.

ans: B

124. The MOST easily observed motions in the night sky are produced by the
- A) rotation of Earth on its axis.
 - B) revolution of Earth around the Sun.
 - C) motion of the planets along their orbits around the Sun.
 - D) motion of stars with respect to each other in the sky.

ans: A

125. The phrase “diurnal motion” refers to the
- A) slow change in position of the constellations from east to west from night to night, resulting in different constellations being visible at 11 P.M. in May than at 11 P.M. in December.
 - B) change in position of the Moon in the sky as it runs through its phases over the course of 1 month.
 - C) apparent motion of the Sun along the ecliptic over the course of 1 year.
 - D) gradual motion of the constellations from east to west across the sky each night, resulting in different constellations being visible at 4 A.M. than at 10 P.M. on any given night.

ans: D

126. Over the course of one night, an observer at any given location on Earth sees the

constellations gradually shift across the sky from east to west. This is caused primarily by the

- A) inherent rotation of the universe.
- B) rotation of Earth around its own axis.
- C) precession of the spin axis of Earth.
- D) orbital motion of Earth around the Sun.

ans: B

127. If an observer watches (or photographs) stars near the north celestial pole for a period of several hours, in what basic pattern do they appear to move?

- A) spirals, as the stars move while Earth rotates
- B) ellipses, with the North Pole at one focus
- C) almost straight lines, rising from the horizon toward the zenith
- D) circles, with the north celestial pole at the center

ans: D

128. When observers watch the nighttime sky, they find that

- A) the stars and constellations remain fixed in the sky, not rising or setting in a time as short as one night because they are so far away.
- B) most stars and constellations slowly rise in the east and set in the west.
- C) most stars and constellations slowly rise in the west and set in the east.
- D) all stars and constellations reach their highest point in the sky at midnight.

ans: B

129. As an observer moves toward increasing latitude, the number of circumpolar stars

- A) increases if the location of the observer is east of the prime meridian but decreases if the location is west of this meridian.
- B) remains approximately constant.
- C) decreases.
- D) increases.

ans: D

130. An observer in the southern hemisphere will see increasing numbers of circumpolar stars as the observer's

- A) longitude decreases while she moves along a line of constant latitude.
- B) latitude increases while she moves along a line of constant longitude.
- C) latitude decreases while she moves along a line of constant longitude.
- D) longitude increases while she moves along a line of constant latitude.

ans: B

131. Why do observers see Cassiopeia sometimes right side up and sometimes upside down?

- A) The stars physically move in space, completing a circle around Polaris once each 24 hours.

- B) The stars physically move in space, completing a circle around Polaris once each year.
- C) Viewed from Earth, all of the northern circumpolar constellations complete a circle around Polaris once every 24 hours (because of Earth's spin).
- D) to teach her humility

ans: C

132. The north circumpolar constellations

- A) do not appear to rotate around Polaris but instead move across the sky in a straight line like the other stars.
- B) appear to circle Polaris, but only every 24 hours.
- C) appear to circle Polaris, but only in annual motion, once per year.
- D) appear to circle Polaris both in daily motion and in annual motion.

ans: D

133. Over the duration of a given night, some stars will be observed to pass through (from one side to the other of) the

- A) zodiac.
- B) celestial equator.
- C) zenith.
- D) vernal equinox.

ans: C

134. Which way do observers move with respect to the background stars because of the revolution of Earth in its orbit around the Sun?

- A) westward
- B) northeastward
- C) northwestward
- D) eastward

ans: D

135. As Earth rotates, the point above the head of a person standing on the equator (the person's zenith) sweeps out

- A) the celestial equator.
- B) a variable path across the sky within the region of the zodiac, crossing the celestial equator at some point.
- C) the ecliptic plane.
- D) a great circle path between the North Pole and South Pole.

ans: A

136. An observer is studying the horizon from somewhere in the northern hemisphere, and he sees that the stars are setting, following a slanted path from the observer's upper right to the

horizon on their left. Which horizon are they facing?

- A) east
- B) west
- C) east in the winter, west in the summer
- D) west in the winter, east in the summer

ans: B

137. An observer is studying the horizon from somewhere in the southern hemisphere, and he sees that the stars are setting, following a slanted path from the observer's upper right to the horizon on his left. Which horizon is he facing?

- A) east
- B) west
- C) east in the winter, west in the summer
- D) west in the winter, east in the summer

ans: B

138. The time that elapses before the Sun returns to the same point in space in the solar system compared to the background stars in the sky is 1

- A) solar day.
- B) Gregorian year.
- C) tropical year.
- D) sidereal year.

ans: D

139. From the east coast of the United States, an observer sees a star rising above the horizon. At the same instant their friend on the west coast finds that this star

- A) is just rising.
- B) is just setting.
- C) rose a few hours earlier.
- D) has not yet risen.

ans: D

140. An observer is standing at a position 45° north of the equator and views the stars rising above the horizon. They will move in a direction that makes a slant with the horizon. The direction of this slanted path is from the horizon to the

- A) northwest.
- B) northeast.
- C) southwest.
- D) southeast.

ans: C

141. In astronomy, what is the difference between “revolution” and “rotation”?

- A) Revolution refers to motion of one body about another, whereas rotation refers to the motion of one body about its own axis.
- B) Rotation refers to motion of one body about another, whereas revolution refers to the motion of one body about its own axis.
- C) The two words have the same meaning and are used interchangeably.
- D) Revolution refers to the motion of large objects like stars and planets, whereas rotation is reserved for smaller bodies like electrons in atoms.

ans: A

142. The true orbital period of Earth around the Sun, defined as the time taken to complete one orbit with respect to the background stars, is 1

- A) sidereal year.
- B) Gregorian year.
- C) tropical year.
- D) solar day.

ans: A

Section: 1-7

143. If the daytime sky were not so bright, how fast would an observer see the Sun move across it with respect to the stars as it moves through one full circle in 1 year?

- A) about 1° per day
- B) about 15° per hour
- C) The Sun would never appear to move with respect to the stars in the sky.
- D) exactly 24° per day or 1° per hour

ans: A

144. Because of the tilt of Earth's spin axis to the plane of Earth's orbit (the ecliptic plane), sunrise in the winter months in the mid-latitude northern hemisphere occurs in which direction in the observer's sky?

- A) southeast
- B) northeast
- C) The Sun always rises due west.
- D) southwest

ans: A

145. The Sun rises due east in the sky when viewed from any site on Earth's equator

- A) at midsummer and midwinter.
- B) every day of the year.
- C) on the first day of summer and the first day of winter.
- D) only on the first day of spring and the first day of fall.

ans: D

146. If an observer sees the Sun rising due east of their position, the date must be the

- A) summer solstice.
- B) autumnal equinox.
- C) vernal equinox.
- D) equinox—either one.

ans: D

147. In the middle of a winter season an observer sees the Sun rising well south of due east. The person must be located

- A) in the northern hemisphere.
- B) in the southern hemisphere.
- C) at the equator.
- D) in either the northern or southern hemisphere.

ans: D

148. In the middle of their summer season an observer sees the Sun rising well north of due east. The person must be located

- A) in the northern hemisphere.
- B) in the southern hemisphere.
- C) at the equator.
- D) in either the northern or southern hemisphere.

ans: D

149. For a particular observer in the northern hemisphere, a given star in the sky will reach its highest point when it passes through the

- A) celestial equator.
- B) zodiac.
- C) ecliptic plane.
- D) great circle passing through the north celestial pole and the zenith

ans: D

150. A given star will reach its highest point in the sky for a particular observer in the southern hemisphere when it passes through the

- A) ecliptic plane.
- B) zodiac.
- C) celestial equator.
- D) great circle passing through the south celestial pole and the zenith

ans: D

151. Where would an observer have to be to see the south celestial pole on the horizon?

- A) about 1° away from the South Pole, to allow for Earth's precession
- B) at the South Pole of Earth
- C) at the North Pole of Earth
- D) on the equator

ans: D

152. An observer on the equator will be able to see what fraction of the overall sky over a period of 1 year?

- A) 50%
- B) 100%
- C) a variable amount, depending on the person's longitude
- D) somewhat less than 100%, except in a leap year

ans: B

153. Over the period of 1 complete year, an observer at the South Pole would be able to see what fraction of the overall sky?

- A) 50%
- B) 100%
- C) somewhat less than 50%, except in a leap year
- D) a variable amount, depending on the observer's longitude

ans: A

154. From Earth's North Pole,

- A) the whole of the celestial sphere is visible at some time during the year.
- B) only stars that are within 66.5° of the north celestial pole can be seen.
- C) only half the celestial sphere can be seen on any clear night.
- D) only stars that are 23.5° above the celestial equator can be seen.

ans: C

155. Where would an observer have to be to see the north celestial pole directly overhead (i.e., at the zenith)?

- A) on the equator
- B) at the North Pole of Earth
- C) at a position about 1° away from Earth's South Pole, to account for precession
- D) at the South Pole of Earth

ans: B

156. If an observer were standing on the equator, which of these positions in the sky would pass through their zenith at some time in one 24-hour period?

- A) north celestial pole, which is the perpendicular to the celestial equator
- B) position of the Sun at summer solstice
- C) vernal equinox, or 0 hours right ascension, 0° declination
- D) ecliptic pole, or perpendicular to the ecliptic plane

ans: C

157. The constellation Pisces the Fish is high in the sky at midnight on the autumnal equinox. When is the next time Pisces is high in the sky at midnight?

- A) 12 hours later
- B) 6 months later
- C) 12 months later
- D) vernal equinox

ans: C

158. The star grouping Leo (the Lion) extends for about 30° along a region close to the celestial equator. At low latitudes to mid-latitudes, roughly how long will it take Leo to rise above the horizon?

- A) 6 hours

- B) 2 hours
- C) 30 minutes
- D) 30 seconds

ans: B

159. The Sun appears to be about $1/2^\circ$ in diameter. On the equator, approximately how long does it take for the Sun to set, from first contact with the horizon to complete disappearance below the horizon?

- A) 2 seconds
- B) about 1 hour
- C) 4 minutes
- D) 2 minutes

ans: D

160. When viewed from Earth, Venus subtends an angle of about 1 arcminute ($1/60^\circ$) when it is at the closest point to Earth in its orbit. If we are watching Venus set in the west over a clear horizon (e.g., ocean), how long would Venus take from the time it first reached the horizon to completely disappear below the horizon?

- A) almost instantaneous (much less than 1 second)
- B) 1 second
- C) about 4 minutes
- D) about 4 seconds

ans: D

161. Which one of these statements is correct about the behavior of an observer's zenith (the vertical direction directly overhead) over a period of 1 year if the observer were standing on Earth's equator?

- A) The angle between the zenith and Earth's spin axis will vary between $+23.5^\circ$ and -23.5° over this period.
- B) The zenith will always be perpendicular to Earth's spin axis.
- C) The zenith will always remain at a fixed angle of 23.5° to the spin axis of Earth.
- D) The zenith will always be parallel to Earth's spin axis.

ans: B

162. Suppose Earth's tilt with respect to the ecliptic plane were 25° instead of $23\frac{1}{2}^\circ$. What difference would this make? Which statement below is NOT true?

- A) Summer and winters would be more severe.
- B) The dates of vernal and autumnal equinox would change.
- C) The declinations of stars would change.
- D) The slant angle at which stars would set at a given latitude would not change.

ans: B

163. How many constellations does the zodiac pass through?

- A) 10
- B) 12
- C) 13
- D) 15

ans: C

164. Which one of these is NOT a zodiac constellation?

- A) Pisces
- B) Cancer
- C) Ophiuchus
- D) Cygnus

ans: D

165. Since antiquity astronomers have counted 12 zodiac constellations. But during the past century this number has increased to 13. What caused this change?

- A) Precession has caused the path of the Sun to shift against the background of the stars.
- B) The boundaries of the constellations have been redefined.
- C) Proper motions of stars have caused the constellations to shift.
- D) New constellations have been invented within the past century.

ans: B

166. If the Sun passes directly overhead at a location on at least 1 day per year, then that location

- A) must be within 66° of the equator.
- B) must be somewhere within 23.5° of the equator.
- C) could be anywhere because this event occurs at least once per year at any location on Earth.
- D) must be exactly on the equator.

ans: B

167. What will be the elevation angle of the Sun above the horizon at midday on June 21 every year at latitude 66.5° S?

- A) 90° , in the zenith
- B) 23.5°
- C) The Sun will not appear above the horizon at all on this date at this location.
- D) 0°

ans: D

168. If an observer could see background stars in the daytime, the Sun would

- A) appear to move eastward against them at a rate of 15° per day.
- B) appear to move westward against them at a rate of 1° per day.

- C) remain stationary against them.
- D) appear to move eastward against them at a rate of 1° per day.

ans: D

169. The tilt angle of Earth's spin axis to the direction perpendicular to the ecliptic (known as the ecliptic pole)

- A) is 90° and fixed.
- B) varies rapidly through the year from $+23.5^\circ$ to -23.5° .
- C) is 23.5° and fixed.
- D) is 0° and fixed because this defines the ecliptic plane.

ans: C

170. Over an interval of 6 months, the tilt of Earth's spin axis with respect to the background stars will change by

- A) 0° .
- B) 23.5° .
- C) 47° .
- D) 180° .

ans: A

171. What was the declination of the Sun on March 21 this year?

- A) It would have no unique value but could be any angle between $+23.5^\circ$ and -23.5° .
- B) 23.5°
- C) 0°
- D) 180°

ans: C

172. What was the approximate declination of the Sun on June 21 this year?

- A) -23.5°
- B) 90°
- C) 0°
- D) $+23.5^\circ$

ans: D

173. What was the approximate declination of the Sun on September 22 this year?

- A) $+23.5^\circ$
- B) $+90^\circ$
- C) 180°
- D) 0°

ans: D

174. On December 21 of this year, the Sun will be at what declination angle?

- A) 90°
- B) $+23.5^\circ$
- C) 0°
- D) -23.5°

ans: D

175. What was the approximate value of the right ascension of the Sun this year on March 21?

- A) no particular value because it can vary between 0 hours and 24 hours
- B) 0 hours 0 minutes
- C) 12 hours 0 minutes
- D) 1 hour 0 minutes

ans: B

176. What will the right ascension of the Sun be on June 21 of this year?

- A) 6 hours 0 minutes
- B) 0 hours 0 minutes
- C) 12 hours 0 minutes
- D) 18 hours 0 minutes

ans: A

177. What was the approximate value of right ascension of the Sun this year on December 21?

- A) 6 hours 0 minutes
- B) 0 hours 0 minutes
- C) 18 hours 0 minutes
- D) 12 hours 0 minutes

ans: C

178. The change in the right ascension of the Sun between June 21 and September 22 is approximately

- A) 0 hours 0 minutes.
- B) 18 hours 0 minutes.
- C) 6 hours 0 minutes.
- D) 12 hours 0 minutes.

ans: C

179. The change in the right ascension of the Sun between June 21 and December 21 is approximately

- A) 18 hours 0 minutes.
- B) 0 hours 0 minutes.

- C) 6 hours 0 minutes.
- D) 12 hours 0 minutes.

ans: D

180. The change in the declination of the Sun between December 21 and June 21 is approximately

- A) 180° .
- B) 47° .
- C) 23.5° .
- D) 90° .

ans: B

181. The change in the declination of the Sun between March 21 and June 21 is approximately

- A) 90° .
- B) 47° .
- C) 180° .
- D) 23.5° .

ans: D

182. The declination of the Sun on September 21 compared to that on March 21 is

- A) 47° greater.
- B) about the same.
- C) 23.5° less.
- D) 23.5° greater.

ans: B

183. If Earth's spin axis were perpendicular to the plane of its orbit (the ecliptic), seasonal variations on Earth would

- A) be nonexistent.
- B) remain the same as they are at present.
- C) have the same severity, but each season would last twice as long.
- D) be much more severe.

ans: A

184. Earth would NOT have seasons if

- A) its equatorial plane were perpendicular to its orbital plane.
- B) its axis of rotation were perpendicular to its equatorial plane.
- C) the observer's vertical axis (zenith) were perpendicular to Earth's orbital plane.
- D) its axis of rotation were perpendicular to its orbital plane.

ans: D

185. The reason Earth experiences seasons is that

- A) Earth's rotation axis is not perpendicular to the ecliptic.
- B) Earth's rotation axis is not perpendicular to the ecliptic, and the direction in which this axis points changes with time.
- C) Earth is closer to the Sun during part of the year.
- D) the Moon pulls on Earth from a distance that varies over the year.

ans: A

186. Seasonal variations on a planet's surface are caused by

- A) clouds that periodically form and disappear as the planet orbits the Sun.
- B) the tilt of the planet's spin axis with respect to the perpendicular to its orbital plane.
- C) volcanoes that erupt periodically because of tidal interactions and obscure the atmospheres of planets.
- D) the variation of the planet's distance from the Sun during its passage along its elliptical orbit.

ans: B

187. One essential condition for "seasons" to occur on a planet is that the planet's

- A) equator is tilted with respect to its orbital plane.
- B) distance from the Sun varies.
- C) atmosphere is thick.
- D) axis is perpendicular to its orbital plane.

ans: A

188. Summertime in the northern hemisphere is when

- A) sunlight heats the atmosphere more when passing through a longer path when the Sun is at an oblique angle.
- B) the clearest skies occur because of climate changes, leading to greater surface heating of Earth.
- C) Earth is closest to the Sun in its elliptical orbit.
- D) sunlight falls more directly on this hemisphere, heating it more than average.

ans: D

189. Summertime in the northern hemisphere is when the

- A) Sun is closest to Earth.
- B) Sun is closest to the ecliptic.
- C) Moon is closest to Earth.
- D) northern hemisphere is tilted toward the Sun.

ans: D

190. In the southern hemisphere, summertime occurs when

- A) sunlight falls more directly on this hemisphere, heating it more than at other times of the year.
- B) Earth's equator is parallel to the plane of its orbit.
- C) sunlight falls less directly on this hemisphere, spreading the heat out over a greater area and thereby heating it more.
- D) Earth is farthest from the Sun in its elliptical orbit.

ans: A

191. Winter in the northern hemisphere occurs when

- A) Earth is farthest from the ecliptic plane.
- B) Earth's axis is at its largest angle with respect to the ecliptic plane because of precession.
- C) Earth is farthest from the Sun in the elliptical orbit.
- D) sunlight falls most obliquely on that region of Earth.

ans: D

192. When the northern hemisphere is experiencing winter, the

- A) Earth is closer to the Sun than it is during northern summer.
- B) Earth is farther from the Sun than it is during the northern summer.
- C) Earth is the same distance from the Sun as it is the rest of the year because Earth's orbit is circular with the Sun in the center.
- D) southern hemisphere is experiencing winter also.

ans: A

193. If an observer at a location north of the equator tracks the Sun's position on the horizon as it rises each morning throughout the year, the observer will find that the

- A) Sun always rises in the same place.
- B) Sun rises due east only at summer solstice.
- C) rising position moves progressively northward from December through June.
- D) rising position moves progressively southward from December through June.

ans: C

194. The lowest amount of solar energy per square meter is incident on the surface of Earth in the northern hemisphere on or about

- A) December 21, the beginning of winter.
- B) March 21, the end of winter.
- C) September 21, the beginning of fall or autumn.
- D) January 5, midwinter.

ans: A

195. At what time of the year will the shadow of a vertical pole (a sundial) at any site in the northern hemisphere be the shortest?

- A) noon, December 21, at the beginning of winter

- B) noon, June 21, at the beginning of summer
- C) noon, August 5, midsummer
- D) dawn, June 21, at the beginning of summer

ans: B

196. At what time of the year in the northern hemisphere will a particular object's shadow in sunlight at midday be shortest?

- A) midwinter, in early January
- B) midsummer, about August 5
- C) first day of summer, about June 21
- D) first day of spring, about March 21

ans: C

197. At what average speed does the Sun appear to move across the sky with respect to the stars in order to move through one full circle in 1 year?

- A) about 13° per day
- B) about 1° per day
- C) The Sun never appears to move with respect to the stars in the sky.
- D) about 24° per day, or very close to 1° per hour

ans: B

198. How would the Sun appear to move in the sky if an observer were at the South Pole on a midsummer day?

- A) It would appear halfway above the horizon and maintain this position for a full 24 hours.
- B) It would appear to move parallel to the horizon at an elevation angle of about 23.5° for a full 24 hours.
- C) It would appear never to reach above the horizon—the South Pole is always in darkness.
- D) It would appear to rise in the east, reach an elevation angle of about 23.5° at midday, and set in the west 12 hours later.

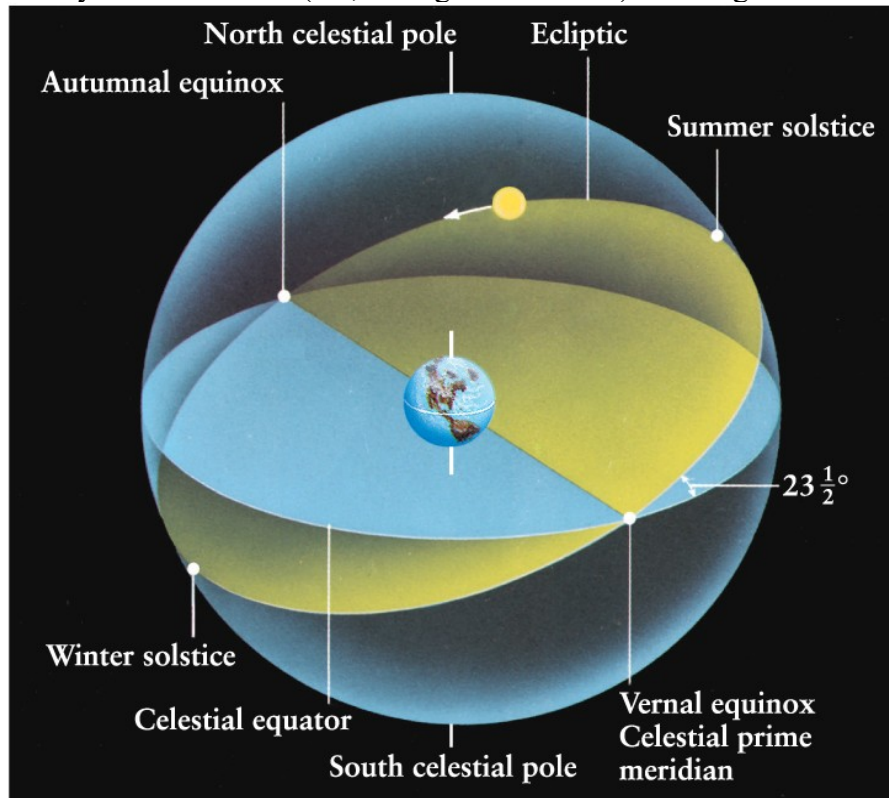
ans: B

199. What would the position and motion of the Sun be on December 21 from the South Pole?

- A) It would move completely around the sky in 24 hours while maintaining an angle of 23.5° above the horizon.
- B) It would remain below the horizon for the whole 24 hours.
- C) It would pass across the sky from the horizon at midnight to reach an angle of 23.5° above the horizon at midday and then return to the horizon.
- D) It would rise in the east at 6 A.M. and set in the west at 6 P.M., reaching 47° above the horizon at midday.

ans: A

200. For an observer standing on the equator, which of these positions in the sky would pass directly over their head (i.e., through their zenith)? See Figure 1-17.



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- A) position of the Sun at summer solstice
- B) ecliptic pole, or the perpendicular to the direction of the ecliptic plane
- C) north celestial pole, or the perpendicular to the direction of the celestial equator
- D) vernal equinox, or the zero point of right ascension on the celestial equator

ans: D

201. For an observer standing at latitude 10° N, how many times during the year will the Sun pass precisely through a point directly overhead, the zenith?

- A) Twice
- B) Never
- C) Once
- D) every day for a half a year

ans: A

202. Where on Earth would an observer have to stand for the Sun to pass directly overhead (i.e., pass through zenith) at some time during the year?

- A) within the Arctic Circle
- B) in the tropics, or within $\pm 23.5^\circ$ of the equator

- C) There is no restriction because this happens at any latitude at some time during the year.
- D) only on the equator, nowhere else

ans: B

203. Where would an observer have to be in either the northern or southern hemisphere for the Sun to remain below the horizon for a 24-hour period for at least part of a year?

- A) Nowhere, because the Sun is always visible at some time of the day everywhere on Earth
- B) above about 66.5° latitude
- C) above about 23.5° latitude
- D) only at 90° , or exactly at the poles

ans: B

204. What is the lowest latitude above which one would see the Sun for a full 24 hours on at least one day per year?

- A) 23.5°
- B) 90°
- C) 52°
- D) 66.5°

ans: D

205. From Earth's North Pole, how long does the Sun remain above the horizon once it first appears at the beginning of spring?

- A) less than 1 hour
- B) just a few minutes
- C) about 6 months
- D) exactly 12 hours

ans: C

206. If the horizon is considered to be split into northern and southern parts by the east-west line, can the Sun ever rise in the southern part of the sky when viewed from a mid-latitude site in the northern hemisphere?

- A) yes, for exactly half a year
- B) no, since the site is in the northern hemisphere
- C) yes, but only for a few days around midsummer
- D) yes, for most of the year, because the observing site is in the northern hemisphere

ans: A

207. If the horizon is considered to be split into northern and southern parts by the east-west line, can the Sun ever rise in the northern part of the sky when viewed from a mid-latitude site in the southern hemisphere?

- A) yes, for exactly half a year

- B) no, because the site is in the southern hemisphere
- C) yes, but only for a few days around midsummer
- D) yes, for most of the year, since the observing site is in the southern hemisphere

ans: A

208. The Arctic Circle, above which the Sun can be seen for a full 24 hours on at least one day of the year, is a line around Earth at what latitude?

- A) 90° N
- B) variable, averaging 66.5°
- C) 23.5° N
- D) 66.5° N

ans: D

209. Above 66.5° N, the Sun

- A) always shines, winter or summer.
- B) can be seen for 24 hours on at least one day of the year.
- C) is always 23.5° or more above or below the horizon.
- D) never shines at any time of the year.

ans: B

210. The “Land of the Midnight Sun” is so-named because

- A) the Sun is above the horizon for a full 24 hours at a certain time of the year.
- B) the Sun passes overhead at least once during the year within this region.
- C) twilight is bright and lasts all night through the summer months because the Sun never gets far below the horizon from these locations.
- D) the full Moon is always up whenever the Sun sets, maintaining light skies throughout the summer months.

ans: A

211. The vernal equinox is one time of the year when the Sun

- A) is at its lowest point in the sky at midday.
- B) crosses the ecliptic plane.
- C) crosses the celestial equator.
- D) crosses the Moon’s orbital path in the sky.

ans: C

212. Which of these statements describing the situation at a mid-latitude site at the time of equinox is correct?

- A) Day and night are of equal length.
- B) The midday Sun is at its highest in the sky on this date.
- C) There is no real darkness at this site on this date, only extended twilight.

D) This is the longest day at this site.

ans: A

213. How often does the Sun cross the celestial equator in a given year?

- A) never because it is always on the celestial equator and follows it throughout the year
- B) only once
- C) twice
- D) 365 times; it does this every day

ans: C

214. Imagine an observer standing on the South Pole (with the south celestial pole at their zenith) at the time of the vernal equinox. Where would the observer see the Sun all day?

- A) on the horizon
- B) well below the horizon
- C) 23.5° above the horizon
- D) at their zenith

ans: A

215. The vernal equinox is the time of the year when the

- A) Earth is at the closest point to the Sun in its elliptical orbit.
- B) Sun crosses the equatorial plane, or celestial equator, moving northward.
- C) Sun crosses the equatorial plane, or celestial equator, moving southward.
- D) Sun crosses the ecliptic plane.

ans: B

216. When the Sun is at one of the equinoxes,

- A) the day is longer than the night in one hemisphere of Earth and shorter in the other hemisphere.
- B) day and night are of equal length only for people on the equator.
- C) people on the equator have perpetual daylight.
- D) day and night are of equal length everywhere on Earth.

ans: D

217. The equinoxes are located at the intersections of the

- A) horizon and the celestial equator.
- B) ecliptic and the Moon's orbit.
- C) ecliptic and the celestial equator.
- D) ecliptic and the horizon.

ans: C

218. Twice per year, when day and night are equal in length, the Sun is at one of two positions in the sky known as equinoxes. These points are the intersections of which two planes in the sky?

- A) celestial equator and ecliptic
- B) celestial meridian and celestial equator
- C) ecliptic and celestial meridian
- D) ecliptic and arctic circle

ans: A

219. The autumnal equinox is the time of the year when the

- A) Sun crosses the ecliptic plane, moving north.
- B) Sun crosses the equatorial plane, moving south.
- C) Earth is at the closest point to the Sun in its elliptical orbit.
- D) Sun passes through the galactic plane.

ans: B

220. On the day of the vernal equinox (approximately March 21 each year), which of these conditions holds?

- A) The length of daylight is greatest on this day.
- B) The Sun passes through an observer's zenith only on this day.
- C) The Sun rises at its most northerly point on the horizon on this day.
- D) Both day and night are almost exactly 12 hours long at all locations on Earth.

ans: D

221. A particular location in the southern hemisphere experiences the longest day on about

- A) September 22.
- B) June 21.
- C) March 21.
- D) December 21.

ans: D

222. In the southern hemisphere, day and night are of equal duration on about

- A) March 21.
- B) December 21.
- C) January 1
- D) June 21.

ans: A

223. The approximate date around March 21 represents the beginning of which season for people living in New Zealand?

- A) summer
- B) spring

- C) autumn
- D) winter

ans: C

224. At the summer solstice in the northern hemisphere, the Sun is

- A) at its highest angle in the sky for the whole year.
- B) at midday at its lowest angle above the southern horizon for the whole year.
- C) on the celestial equator.
- D) nearest Earth.

ans: A

225. If an observer were at the South Pole of Earth for a full year, what would be the highest angle reached by the Sun above their horizon?

- A) 90°
- B) It would never reach above the horizon—the South Pole is always in darkness.
- C) 0° ; it would only just reach the horizon.
- D) 23.5°

ans: D

226. If an observer were standing on the South Pole at the time of the autumnal equinox, where would the Sun be at midday?

- A) at zenith
- B) 23.5° above the horizon
- C) well below the horizon
- D) on the horizon

ans: D

227. Where should an observer expect to see the Sun in the sky if they were at the North Pole at the beginning of fall (about September 21)?

- A) on the horizon
- B) at their zenith
- C) at about 23.5° above the horizon all day
- D) below their horizon all day

ans: A

Section: 1-8

228. The difference in longitude between Boston and San Francisco is approximately 52° . They are three time zones apart, so standard clocks differ by 3 hours. Without the time zones, what would be the difference between traditional (or astronomical) noon (when the Sun is highest in the sky) at these two places?

- A) 2.5 hours
- B) 3 hours
- C) 3.5 hours
- D) 4 hours

ans: C

229. A time zone on Earth, defined for convenience as the region over which civil time is the same at all locations, extends over what range of longitude, on average?

- A) 90°
- B) 15°
- C) 1°
- D) 30°

ans: B

230. In general, a sundial is NOT a good timekeeper because the

- A) Earth's orbital speed around the ecliptic is variable.
- B) Earth's rotation rate changes throughout the year.
- C) Sun's large angular diameter produces a fuzzy shadow.
- D) sky is often cloudy.

ans: A

231. In winter, clocks in New York (maintaining civil time, or mean solar time) compared to those in California will be

- A) 2 hours ahead.
- B) 3 hours behind.
- C) the same.
- D) 3 hours ahead.

ans: D

232. The city of Bristol, England, is located to the west of and in the same time zone as London. Astronomical noon in Bristol, when the Sun is highest in the sky, compared to astronomical noon in London occurs

- A) at exactly the same time by definition because both cities are in the same time zone.
- B) later in time in winter but earlier in time in summer.
- C) earlier in time.
- D) later in time.

ans: D

Section: 1-9

233. The time that elapses while the Sun moves from one vernal equinox to the next is known as
1

- A) Gregorian year.
- B) solar day.
- C) sidereal year.
- D) tropical year.

ans: D

234. The length of Earth's year at the present time

- A) is exactly 365 days.
- B) varies between 365 and 366 days over a period of about 400 years.
- C) is slightly smaller than 365 days.
- D) is slightly larger than 365 days.

ans: D

235. What is a tropical year?

- A) It is the time between seeing the Sun directly overhead in the tropics (between latitudes N 23.5 and S 23.5) and next seeing it directly overhead again.
- B) It is twice the period of time defined in answer A.
- C) It is the time from one vernal equinox to the next.
- D) It is the time between having Polaris as the North Star and having Polaris again as the North Star, divided by 26,000.

ans: C

236. The idea of one "leap day" every four years was introduced into the calendar by

- A) the ancient Babylonians.
- B) the Greeks.
- C) Julius Caesar.
- D) Pope Gregory XIII.

ans: C

237. Which of these years will be a leap year?

- A) 2200 A.D.
- B) 2300 A.D.
- C) 2100 A.D.
- D) 2400 A.D.

ans: D

238. Which of these years were leap years according to the calendar then in use: 1000, 1492,

- 1600, 1776?
A) just 1600
B) 1492 and 1776
C) all except 1600
D) all

ans: D

239. Which of these years was NOT a leap year?
A) 2000 A.D.
B) 1600 A.D.
C) 1988 A.D.
D) 1800 A.D.

ans: D

240. Leap years— years that contain an extra day—are necessary because
A) Earth's speed of revolution along its elliptical orbit varies throughout the year.
B) 365 days is not exactly divisible by four.
C) the rotation rate of Earth varies, leading to days of different length during the year.
D) the length of a year is not an exact number of days.

ans: D

241. Leap-year corrections in the calendar are necessary to account for the
A) fact that the actual rotation time of Earth with respect to the stars is not exactly 24 hours.
B) wobble of Earth's axis.
C) slow drift in the direction of Earth's spin axis.
D) fact that 1 year is not exactly 365 days.

ans: D

242. The reason leap years have an extra day is to account for the fact that the
A) Earth's rotation period is slowly increasing because of tidal effects.
B) year is not exactly equal to an integral number of days.
C) day is not exactly 24 hours because of Earth's periodically varying rotation period.
D) length of the year varies with a period of four years because of precession.

ans: B

243. The person who introduced the leap year into our calendar was
A) Sir Isaac Newton.
B) Pope Gregory XIII.
C) Julius Caesar.
D) Ptolemy.

ans: C

244. The most recent correction to the calendar to keep the yearly date in tune with the seasons (resulting in the present calendar) was instituted by

- A) Galileo.
- B) Pope Gregory XIII.
- C) Julius Caesar.
- D) Sir Isaac Newton.

ans: B

245. The present-day calendar, which includes leap years and century year exclusion, was introduced by

- A) Karl Marx in 1917.
- B) Julius Caesar in 50 B.C.
- C) Ptolemy in the second century B.C.
- D) Pope Gregory XIII in 1582.

ans: D

Section: 1-10

246. A science fiction writer, writing a story about inhabitants on Earth in 14,000 A.D. who have survived a disaster that included the loss of modern navigational aids, describes them traveling due north across barren wastes by walking toward Polaris, the pole star. What is wrong with this situation?

- A) Polaris will have moved away from due north since it is moving rapidly with respect to surrounding stars.
- B) Polaris will no longer be due north because of Earth's precession.
- C) By that time, Polaris will be due south, not due north, because of the reversal of Earth's spin axis.
- D) Polaris will no longer be visible since its lifetime is only a few thousand years.

ans: B

247. The position in Earth's orbit around the Sun that at present corresponds to winter solstice will instead correspond to summer solstice in about _____ years.

- A) 6500
- B) 13,000
- C) 19,500
- D) 26,000

ans: B

248. Because of precession, how long will it be before the spin axis of Earth points toward the present pole star again?

- A) at least 1 million years
- B) 13,000 years
- C) 26,000 years
- D) 9 years

ans: C

249. Precession makes the spin axis of Earth move in a slow coning pattern. The end of the axis covers a complete circle in a period of

- A) 2600 years.
- B) 26 million years.
- C) 26,000 years.
- D) 1 year.

ans: C

250. Precession is the

- A) occasional reversal in geological time of the direction of the spin axis of Earth.
- B) motion of Earth along its orbital path.
- C) daily rotational motion of Earth.

D) very slow coning motion of Earth's axis of rotation.

ans: D

251. Precession is the

- A) slow coning motion of the spin axis of Earth, similar to that of a spinning top.
- B) gradual reversal of Earth's magnetic field.
- C) motion of Earth along its orbital path during a year.
- D) daily spinning motion of Earth, producing the apparent motion of the Sun and the stars.

ans: A

252. Precession of Earth's spin axis results in

- A) changes of the positions of the constellations that are visible at night from Earth over the period of 1 year.
- B) a gradual shift of the vernal equinox along the ecliptic.
- C) a daily shift in the position of the overhead direction (the zenith) of an observer relative to the celestial equator (for an observer at a fixed location on Earth).
- D) a gradual change in the angle between the ecliptic and the celestial equator.

ans: B

253. The reason for the slow drift of the position of the vernal equinox through the sky against the background stars over long periods of time is the

- A) motion of Earth in its orbit.
- B) overall movement of local stars in the sky.
- C) movement of the Sun in the Milky Way Galaxy.
- D) precession of the spin axis of Earth.

ans: D

254. Precession of Earth's axis of rotation is caused by

- A) changes in the shape of Earth's orbit due to the gravitational pull of the Moon.
- B) the gravitational pull of the Moon and the Sun on the equatorial bulge of Earth.
- C) changes in the rate of rotation (length of the day) of Earth caused primarily by the gravitational pull of the Moon.
- D) changes in the shape of Earth's orbit due to the gravitational pull of the Sun.

ans: B

255. The phenomenon of precession of Earth's spin axis is caused by the

- A) variation of the spin rate of Earth.
- B) tidal ebb and flow of ocean waters on Earth.
- C) varying intensity and hence pressure of sunlight on Earth throughout the year.
- D) gravitational pull of Moon and Sun on Earth's equatorial bulge.

ans: D

256. How long will it take for precession to move Earth's spin axis to a position perpendicular to the ecliptic plane?

- A) no time at all because the axis is in this position now
- B) a very long or even infinite time because it is very unlikely to happen
- C) 13,000 years
- D) 26,000 years

ans: B

257. The phenomenon of the precession of the equinoxes was first reported by

- A) Hipparchus, 2nd century B.C.
- B) Ptolemy, 2nd century A.D.
- C) Newton, 17th century.
- D) Herschel, 18th century.

ans: A

258. After Aquarius, the vernal equinox will move into the constellation

- A) Capricorn.
- B) Sagittarius.
- C) Ophiuchus.
- D) Pisces.

ans: A

259. Polaris, the "pole star," is at present

- A) within 1° of the north celestial pole.
- B) precisely at the north celestial pole, by definition.
- C) above Earth's magnetic pole.
- D) exactly perpendicular to the ecliptic plane (ecliptic pole).

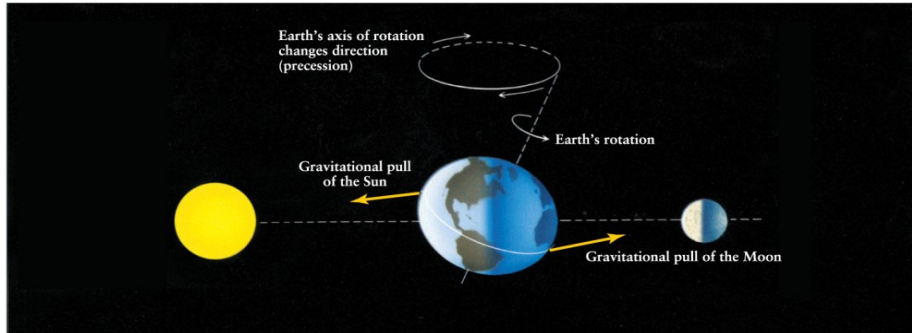
ans: A

260. As Earth rotates, the apparent motion of the pole star, Polaris, in a period of a day is

- A) a circle with a radius of 23.5° .
- B) a small circle with a radius of less than 1° .
- C) zero; there is no motion of the pole star, by definition.
- D) a slow but noticeable drift across the sky.

ans: B

261. If the polar axis of Earth moves through a full circle in 26,000 years as a result of precession (see Figure 1-22a), how long will it take for the line between the center of the circle and the spin axis to move through 180° (i.e., to the other side of the circle)?



a

- A) 26,000 years
- B) 1 year
- C) about 100 years
- D) 13,000 years

ans: D

262. The tropical year is different from the sidereal year because

- A) Earth precesses on its axis.
- B) the Sun moves through the Galaxy.
- C) Earth moves in its orbit.
- D) Earth's orbit is elliptical.

ans: A

263. To which constellation will the north celestial pole be closest in the year 14,000 A.D. (see Figure 1-22c)?



c

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- A) Lyra
- B) Draco
- C) Ursa Minor, because the north celestial pole never moves, by definition
- D) Cepheus

ans: A

264. The precessional motion of the north celestial pole of Earth is a circle of 47° diameter across the northern sky over a period of 26,000 years. The equivalent motion of the south celestial pole is a

- A) circle of 47° diameter, covered in a much shorter time, about 1000 years.
- B) circle of 47° diameter, covered in 26,000 years.
- C) much smaller circle, covered in 26,000 years.
- D) The south celestial pole does not move at all during precession.

ans: B

265. The present position of the vernal equinox in the sky is in the constellation

- A) Pisces.
- B) Ursa Minor.
- C) Aquarius.
- D) Aries.

ans: A

266. Why do the precise astronomical coordinates of right ascension and declination of a star change systematically night by night?

- A) precession of Earth's spin axis
- B) bending of light by Earth's atmosphere
- C) They do not change because they are fixed positions on a star chart.
- D) motion of Earth in its orbit around the Sun

ans: A

267. The axis around which Earth

- A) rotates always points toward Polaris, the North Star.
- B) precesses (wobbles) takes about a century to go around once.
- C) precesses takes many thousands of years to go around once.
- D) rotates always tilts slightly toward the direction of the Sun.

ans: C

Section: 1-11

268. On a particular day, the Sun is at the summer solstice and the Moon is at the vernal equinox. The lunar phase on that day is

- A) quarter.
- B) not predictable from this information.
- C) full.
- D) new.

ans: A

269. On a particular day, the Sun is at the vernal equinox and the Moon is at the autumnal equinox. The lunar phase on this particular day is

- A) full.
- B) new.
- C) quarter.
- D) not predictable from this information.

ans: A

270. Why does the Moon have phases as observed from Earth?

- A) The illuminated half of the Moon becomes more or less visible from Earth as the Moon orbits Earth.
- B) The Moon's distance from Earth changes as it moves in its elliptical orbit, thereby changing its apparent brightness.
- C) Earth's shadow gradually moves over the Moon's surface as the Moon orbits Earth.
- D) The Moon's rotation brings more or less of the illuminated hemisphere into view from Earth.

ans: A

271. Which of these is the correct sequence of appearances of Moon phases in the sky?

- A) waxing crescent, first quarter, waxing gibbous, full Moon
- B) new Moon, full Moon, waxing crescent, waning crescent
- C) full Moon, waxing gibbous, third quarter, waning crescent
- D) new Moon, waning crescent, first quarter, full Moon

ans: A

272. One major difference between the Sun and the Moon in the sky is that

- A) their motions across the sky in the course of a day are very different.
- B) the spectrums of their light are very different.
- C) their diameters subtend very different angles.
- D) the Sun emits light while the Moon merely scatters and reflects it.

ans: D

273. Which way will the “horns,” or the sharp ends of the crescent Moon, point in the sky when the Moon is on the western horizon at sunset 3 days later than new Moon?

- A) toward the Sun, westward
- B) The Moon is not crescent-shaped 3 days after new.
- C) at right angles to the Sun direction, northward
- D) away from the Sun, eastward

ans: D

274. From the northern hemisphere, where in the sky would an observer expect to see true astronomical new Moon?

- A) in a direction opposite to that of the Sun
- B) always in the south
- C) in a direction at right angles to that of the Sun
- D) The Moon is not visible at new Moon.

ans: D

275. The phase of the Moon when the Sun and Moon have the same right ascension is

- A) new Moon.
- B) first quarter.
- C) gibbous.
- D) full Moon.

ans: A

276. If the Moon is between the Sun and Earth and almost in line with the Sun, its phase is called

- A) new Moon.
- B) gibbous.
- C) The Moon never goes between the Sun and Earth.
- D) full Moon.

ans: A

277. About how much time passes between a new Moon and the first quarter?

- A) 1 day
- B) 1 week
- C) 1 sidereal month
- D) 1 synodic month

ans: B

278. When an observer looks at the Moon in the sky, the terminator line (the division between the illuminated and the unilluminated regions) moves

- A) right to left.
- B) left to right.

- C) right to left from new to full and then left to right to new again.
- D) left to right from new to full and then right to left to new again.

ans: A

279. At approximately what time does the new Moon rise?

- A) sunset
- B) sunrise
- C) midday
- D) midnight

ans: B

280. On a given evening, an observer notices that the sunlit portion of the Moon has a crescent shape. This simple observation implies

- A) that the Moon is farther from the Sun than Earth is at that time.
- B) nothing at all about the position of the Moon in space compared to that of Earth and the Sun.
- C) that the line from Earth to the Moon is exactly at right angles to the Sun–Earth line.
- D) that the Moon is closer to the Sun than Earth is on that evening.

ans: D

281. For the Moon to appear as a crescent shape to an observer, the

- A) observer must be closer to the Sun than to the Moon.
- B) observer must be on the opposite side of the Sun from the Moon.
- C) Moon must be closer to the Sun than the observer is and somewhere between the Sun and the observer.
- D) observer and the Moon must be at equal distances from the Sun.

ans: C

282. At approximately what time does the crescent Moon that occurs soon after the new Moon rise?

- A) midday
- B) midnight
- C) sunrise
- D) sunset

ans: C

283. Which of the Moon's phases is MOST easily seen during the daytime?

- A) quarter
- B) The Moon is never visible in daylight.
- C) new
- D) full

ans: A

284. Approximately what time will the first-quarter Moon rise?

- A) 6 A.M.
- B) midnight
- C) 6 P.M.
- D) noon

ans: D

285. The phase of the Moon when Sun and Moon are separated by 6 hours of right ascension is always

- A) full Moon.
- B) new Moon.
- C) crescent.
- D) either first or third quarter.

ans: D

286. What is the difference in right ascension between the Moon and the Sun when the Moon is at quarter phase?

- A) 6 hours
- B) 3 hours
- C) 12 hours
- D) 0 hours; they are in the same region of the sky.

ans: A

287. How much of the total surface of the Moon is illuminated by the Sun when it is at quarter phase?

- A) all
- B) one-half
- C) very little
- D) one-quarter

ans: B

288. How much of the Moon's surface is illuminated by the Sun at quarter-moon phase?

- A) about one-quarter
- B) about one-half
- C) only about one-tenth
- D) about three-quarter.

ans: B

289. When the Moon is at new Moon phase, what percentage of the area of the Moon illuminated

by the Sun can an observer see from Earth?

- A) 100%
- B) about 10%
- C) 0%
- D) 50%

ans: C

290. When the Moon is in its gibbous phase, the positions of the Moon, Earth, and the Sun are such that the

- A) Moon is closer to the Sun than Earth is.
- B) relative distances of Earth and the Moon from the Sun are irrelevant because this phase can occur at any time.
- C) Earth and the Moon are at almost the same distance from the Sun.
- D) Moon is farther from the Sun than Earth is.

ans: D

291. Approximately when does a full Moon rise?

- A) noon
- B) midnight
- C) sunrise
- D) sunset

ans: D

292. The full Moon always occurs

- A) on the first of the month.
- B) when the Moon is at right angles to the direction of the Sun.
- C) when the Moon is closer to the Sun than Earth is.
- D) when the Moon is farther from the Sun than Earth is.

ans: D

293. When the Sun and Moon are separated by 12 hours of right ascension, the phase of the Moon is always

- A) first quarter.
- B) third quarter.
- C) full.
- D) either first or third quarter.

ans: C

294. When does the third-quarter Moon rise?

- A) about 6 A.M.
- B) about 6 P.M.

- C) close to noon
- D) close to midnight

ans: D

295. If the Moon is located at the vernal equinox on the first day of spring, what is the phase of the Moon?

- A) first quarter
- B) third quarter
- C) full
- D) new

ans: D

296. When the Moon is in its gibbous phase, the right ascensions of the Sun and the Moon differ by

- A) more than 6 hours.
- B) 6 hours.
- C) 0 hours.
- D) less than 6 hours.

ans: A

297. The waxing gibbous phase of the Moon occurs between the two positions of

- A) third quarter and new Moon.
- B) full Moon and third quarter.
- C) first quarter and full Moon.
- D) new Moon and first quarter.

ans: C

298. A full Moon will always be at its highest in the sky at about

- A) sunrise.
- B) midnight.
- C) midday.
- D) sunset.

ans: B

299. The full Moon can be on the horizon

- A) only at sunrise or sunset.
- B) only at midnight.
- C) at any time, day or night.
- D) only at midday.

ans: A

300. The Moon is visible in the sky in the daytime from most places on Earth

- A) only at full Moon phase, when it is very bright.
- B) almost never—only during solar eclipses when the sky is dark.
- C) about half the time, or for 2 weeks in every month.
- D) at some time every day, but it is difficult to see because of the blue sky.

ans: C

301. In a mystery story, the culprit made these statements when describing the murder scene. Which of them was the only true statement?

- A) “It was just after midnight, as the new Moon was setting over the western horizon.”
- B) “The time must have been about midnight because the full Moon was just setting in the west.”
- C) “It was about 6 P.M., as the first-quarter Moon was just setting.”
- D) “The full Moon was just rising as the Sun set.”

ans: D

302. In writing a mystery story, the writer has the fictitious villain planning a robbery and needs to use a statement about the timing of the robbery. Which of these statements could accurately describe the Moon’s location at the time of the robbery?

- A) “Because it is new Moon this evening, we can plan the job for 3 weeks from today, when the night will be moonless.”
- B) “It is now full Moon, so we need to wait for 2 weeks before we get a moonless night.”
- C) “We will do the job about a month from now, when the sky will be moonless, because it is full Moon tonight.”
- D) “It is a first-quarter Moon now, so we have to wait only about a week for a dark, moonless night.”

ans: B

303. The Moon is seen to keep one face toward Earth at all times. If viewed from a point directly above the plane of the planetary system, how does it have to rotate to maintain this alignment?

- A) The moon must rotate once per day to maintain its direction toward Earth.
- B) The moon must not rotate at all because we always see the same face from Earth.
- C) The moon must rotate once per year as Earth and the Moon orbit the Sun together.
- D) The moon must rotate once per month, or once per orbit around Earth.

ans: D

304. Which of these phrases is the only one that truly and meaningfully describes the side of the Moon away from the Earth?

- A) anti-Sun side of the Moon
- B) region of the Moon’s equator not illuminated by the Sun
- C) dark side of the Moon
- D) far side of the Moon

ans: D

305. One synodic month is longer than one sidereal month by about

- A) 1 hour.
- B) 2.2 days.
- C) 4 minutes.
- D) 1 week.

ans: B

306. Why is the period between two successive full Moons NOT equal to the Moon's orbital period, or sidereal month?

- A) The Earth–Moon system is also orbiting the Sun.
- B) These two time intervals are not related because full-Moon time depends on the Moon's rotation period about its own axis.
- C) The Moon's orbit is inclined at about 5° to Earth's orbital plane.
- D) The Moon's orbit is elliptical, and the Moon therefore moves irregularly around Earth.

ans: A

307. The fact that the Earth–Moon system orbits the Sun (covering 30° per month) while the Moon orbits Earth means that, compared to one lunar orbital (sidereal) period, the time between successive full Moons (the synodic month) is

- A) about 2 days longer.
- B) about 2 days shorter.
- C) about twice as long.
- D) zero because these periods are always the same, by definition.

ans: A

308. The length of time for the Moon to move from new Moon to new Moon is known as 1 synodic month. Compared to one full orbital period with respect to the star background, or 1 sidereal month, the synodic month is

- A) about 2 days shorter.
- B) about twice as long.
- C) exactly the same length.
- D) about 2 days longer.

ans: D

309. The Moon will appear to an observer at mid-latitudes on Earth to rise in the east, in solar time, about (might attempt to verify this by observation!)

- A) 4 minutes later each evening.
- B) the same time each evening.
- C) 4 minutes earlier each evening.

D) 1 hour later each evening.

ans: D

310. The motion of the Moon across the sky, against the background of stars, is approximately

A) 13° per day.

B) 1° per day.

C) 15° per hour.

D) its own diameter per day.

ans: A

311. The motion of the Moon across the sky in 1 hour, as seen against the background of stars, is approximately

A) its own diameter ($1/2^\circ$).

B) $1/10^\circ$.

C) 4° .

D) 13° .

ans: A

312. The direction of motion of the Moon in the sky, against the background of stars is

A) always eastward.

B) mostly eastward, but occasionally (at full Moon) westward.

C) always westward, in concert with the stars.

D) sometimes eastward but mostly westward.

ans: A

313. In which way does the Moon move day by day in the sky, against the background of stars, when viewed from Earth?

A) toward the west

B) in no particular direction and with no particular pattern

C) toward the north in summer and the south in winter

D) toward the east

ans: D

314. How much of the total surface of the Moon is illuminated by the Sun when the Moon is at crescent phase?

A) none

B) less than half

C) half

D) more than half

ans: C

315. An observer faces the Moon from a position in the northern hemisphere and observes that the right half is illuminated and the left half is dark. What phase does the observer see?

- A) waxing crescent
- B) first quarter
- C) third quarter
- D) waning gibbous

ans: B

316. Why are different phases of the Moon observable from Earth?

- A) The motion of the Moon in its orbit around Earth causes observers to see different amounts of Earth's shadow falling on the Moon.
- B) The motion of the Moon in its orbit around Earth causes observers to see different amounts of the sunlit side of the Moon.
- C) The distance of the Moon from Earth changes because of the elliptical orbit of the Moon, causing the sunlit side of the Moon to move relative to Earth.
- D) The rotation of the Moon around its own axis causes observers to see different amounts of the sunlit side of the Moon.

ans: B

317. What is the phase of the Moon when it rises at midnight? (Hint: Sketch a diagram to work this out). Earth rotates toward the east, and the Moon's motion around Earth is also eastward.

- A) new
- B) first quarter
- C) Full
- D) third quarter

ans: D

318. Which of these planets will be seen as crescent-shaped from Earth at certain times in its orbit?

- A) Mars
- B) Uranus
- C) Jupiter
- D) Venus

ans: D

319. Which of these bodies will never be seen from Earth as a crescent?

- A) Mercury
- B) Mars
- C) Venus
- D) the Moon

ans: B

320. If an observer were on Mars, which of these bodies would never be seen as a crescent?

- A) Jupiter
- B) Earth's Moon
- C) Venus
- D) Earth

ans: A

321. According to an observer on the Moon, which of these bodies could occasionally appear as crescent shaped?

- A) Earth
- B) asteroid Ceres
- C) Mars
- D) Jupiter

ans: A

Section: 1-12

322. Which of these statements about eclipses in the Sun–Earth–Moon system is correct?

- A) A total eclipse of the Sun occurs only at first-quarter Moon.
- B) A total eclipse of the Sun occurs only at new Moon.
- C) A total eclipse of the Moon occurs only at new Moon.
- D) A total eclipse of the Sun occurs only at full Moon.

ans: B

323. Which of these statements about eclipses in the Sun–Earth–Moon system is NOT correct?

- A) A total eclipse of the Sun occurs only at full Moon.
- B) A total eclipse of the Moon occurs only at full Moon.
- C) Eclipses of the Moon and the Sun do not occur at quarter-Moon phases.
- D) A total eclipse of the Sun occurs only at new Moon.

ans: A

324. The total number of eclipses is limited to seven or fewer per year because one condition that must be met for a lunar or solar eclipse is that the

- A) Sun be on the celestial equator.
- B) Moon be close to or crossing the ecliptic plane.
- C) Earth be on the ecliptic plane.
- D) Sun be on the ecliptic plane.

ans: B

325. There is about a 5° angle between the orbit of the Moon and the

- A) plane of the Sun's equator.
- B) spin axis of Earth.
- C) plane of Earth's equator.
- D) plane of the ecliptic, or Earth's orbit.

ans: D

326. What is the approximate inclination of the Moon's orbit to the ecliptic plane?

- A) 23.5°
- B) 17°
- C) 0°
- D) 5°

ans: D

327. The Moon's path across the sky

- A) is confined to regions north of the celestial equator.
- B) is always along the ecliptic plane, by definition.

- C) can be anywhere in the sky.
- D) is confined to the zodiac, which is a band of sky extending on both sides of the ecliptic.

ans: D

328. The line of nodes of the Moon's orbit is the line of intersection of the orbit with the

- A) celestial equator.
- B) ecliptic plane.
- C) observer's celestial meridian.
- D) celestial meridian through Greenwich, England.

ans: B

329. The line of nodes of the Moon's orbit is the

- A) line of intersection between the Moon's orbit and Earth's orbit (the ecliptic plane).
- B) major axis (longest diameter) of the Moon's elliptical orbit.
- C) line between Earth and Moon when the Moon is farthest from the ecliptic plane.
- D) line joining the points of the Moon's nearest (perigee) and farthest (apogee) distances from Earth.

ans: A

330. A solar eclipse occurs on Earth when the

- A) Moon casts a shadow on Earth.
- B) Earth casts a shadow on the Moon.
- C) Sun passes in front of the Moon.
- D) Moon passes behind the Sun.

ans: A

331. A solar eclipse can occur only when the

- A) Earth comes between the Moon and the Sun.
- B) Moon comes between Earth and the Sun.
- C) Sun, the Moon, and Earth form a precise right-angled triangle.
- D) Sun comes between the Moon and Earth.

ans: B

332. Which of these conditions holds for relative distances during a solar eclipse?

- A) The Moon is closer to the Sun than Earth is.
- B) Earth is closer to the Sun than the Moon is.
- C) The Moon and Earth are at the same distance from the Sun.
- D) Because the condition for a solar eclipse is independent of relative distances of Earth and the Moon from the Sun, either the Moon or Earth can be closest to the Sun.

ans: A

333. What is the phase of the Moon during a total solar eclipse?

- A) crescent
- B) first quarter
- C) full
- D) new

ans: D

334. The phase of the Moon at the time of a solar eclipse

- A) is full.
- B) can be any phase: new, quarter, or full.
- C) is new.
- D) is third quarter.

ans: C

335. A lunar eclipse does not occur at every full Moon because the

- A) eclipse cannot occur after sunset.
- B) plane of the Moon's orbit is at an angle to the plane of Earth's orbit.
- C) path of the Sun is inclined at an angle of 5° to the ecliptic plane.
- D) orbit of the Moon is not a perfect circle.

ans: B

336. Eclipses of the Moon can occur

- A) twice per month.
- B) only once per year.
- C) once every month.
- D) at least twice in any year.

ans: D

337. If the plane of the Moon's orbit were the same as the ecliptic plane, there would be a lunar eclipse

- A) twice per month.
- B) twice per year.
- C) every day.
- D) once per month.

ans: D

338. If the Moon in its orbit around Earth moves alternately between Earth and the Sun and behind Earth from the Sun, why do observers not see solar and lunar eclipses every month?

- A) The Moon's motion in its orbit is so slow that it reaches eclipse position only once every 6 months.

- B) The Moon's orbital plane is slightly inclined to the ecliptic.
- C) The Moon's orbital plane is at right angles to the ecliptic.
- D) The Moon's orbital plane is inclined slightly to the celestial equator, which is the path of the Sun across the sky.

ans: B

339. What is the phase of the Moon during a total lunar eclipse?

- A) new
- B) full
- C) gibbous
- D) first quarter

ans: B

340. The maximum number of eclipses (including both solar and lunar) that can occur in one calendar year is

- A) 5.
- B) 1.
- C) 7.
- D) 2.

ans: C

341. A lunar eclipse is caused by the

- A) Sun passing behind the Moon.
- B) Moon passing into the shadow of Earth.
- C) Moon passing behind the Sun.
- D) Earth moving into the Moon's shadow.

ans: B

342. A lunar eclipse can occur ONLY when the

- A) Earth comes between the Moon and the Sun.
- B) Moon comes between Earth and the Sun.
- C) Sun, Moon, and Earth form a right-angle triangle.
- D) Sun comes between the Moon and Earth.

ans: A

343. Eclipses of the Moon can occur ONLY

- A) in the spring and fall, when the Sun is on the ecliptic plane.
- B) at new Moon.
- C) in June and December, when the Sun is near the solstices.
- D) at full Moon.

ans: D

344. At the time of lunar eclipse, the phase of the Moon is

- A) full.
- B) any phase.
- C) new.
- D) first quarter.

ans: A

345. Which of these statements describes a necessary condition for lunar or solar eclipses?

- A) Earth must be on the celestial equator.
- B) The Sun must be on the celestial equator.
- C) The Sun must be close to or crossing the ecliptic plane.
- D) The Moon must be close to or crossing the ecliptic plane.

ans: D

346. Suppose the Moon moved westward rather than eastward in its orbit. How would eclipses be affected?

- A) We would not be able to see eclipses of either type.
- B) Solar eclipses would occur but lunar eclipses would not.
- C) Lunar eclipses would occur but solar eclipses would not.
- D) We would still see both types of eclipses, much as we do now.

ans: D

Section: 1-13

347. During which type of lunar eclipse does the Moon remain longest in Earth's shadow?
- A) penumbral
 - B) partial
 - C) total
 - D) For all three types of eclipse, the Moon remains in Earth's shadow the same length of time.

ans: C

348. During a partial lunar eclipse, the illuminated portion of the Moon's surface receives light from
- A) the entire surface of the Sun.
 - B) part of the surface of the Sun.
 - C) refraction through Earth's atmosphere.
 - D) reflection from Earth's surface.

ans: B

349. In a penumbral lunar eclipse,
- A) no points on the Moon are shaded from the Sun, either totally or partially.
 - B) all parts of the Moon are partially (not totally) shaded from the Sun.
 - C) the entire Moon is shaded from the Sun.
 - D) some points on the Moon are totally shaded from the Sun while others are only partially shaded.

ans: B

350. A total lunar eclipse is visible in principle (assuming clear skies everywhere) to
- A) everyone in one hemisphere of Earth.
 - B) everyone on Earth.
 - C) only people in a circular area on Earth having a diameter equal to that of the Moon.
 - D) only people in a long, narrow, and very specific path, much smaller than a hemisphere.

ans: A

351. To someone on Earth who is watching a total lunar eclipse, the
- A) Sun is hidden behind the Moon.
 - B) Sun is hidden below the horizon.
 - C) Sun is relatively high in the sky because the Earth-Moon line is at right angles to the Earth-Sun line.
 - D) Moon is hidden behind the Sun.

ans: B

352. Earth's shadow at a distance of the Moon's orbit from Earth is

- A) considerably wider than the Moon.
- B) slightly less wide than the size of the Moon.
- C) almost exactly as wide as the Moon.
- D) extremely small, leaving only a narrow shadow band on the Moon during eclipse.

ans: A

353. What is the maximum length of totality for a lunar eclipse?

- A) 1 hour 47 minutes
- B) about 2 minutes
- C) several hours
- D) 7 minutes

ans: A

354. When in total lunar eclipse, the Moon shows a reddish color because

- A) the Moon is illuminated only by the residual glow from the dark side of Earth, which is predominantly red.
- B) only the red part of the solar spectrum is deflected onto it by Earth's atmosphere.
- C) the red light is the residual thermal glow from a still-warm Moon, after the abrupt removal of the heat of the Sun.
- D) light from the northern and southern lights (the aurora) on Earth, which are predominantly red, illuminates the Moon.

ans: B

355. The Moon does not look completely dark when it is in Earth's shadow during a total solar eclipse because

- A) of light reflected from the clouds on Earth, Earthshine.
- B) atmospheric refraction bends red solar light onto the Moon.
- C) there are faint emissions from the tenuous lunar atmosphere, excited by solar wind bombardment.
- D) there is a remnant glow from the hot lunar surface.

ans: B

356. During a total lunar eclipse, the Moon is

- A) totally invisible since Earth blocks all light from reaching it.
- B) barely visible because of "zodiacal light," that is, sunlight reflected off dust grains in space.
- C) barely visible because it glows slightly by its own light.
- D) barely visible because of light passing through Earth's atmosphere.

ans: D

357. The difference between an umbral eclipse and a penumbral eclipse is

- A) entirely dependent on viewing position on Earth.

- B) whether the Moon is farther from the Sun than Earth is or whether it is closer to the Sun than Earth is.
- C) dependent on the distance of the Moon above or below the ecliptic.
- D) whether Earth's rotation axis is tilted toward or away from the Moon during the eclipse.

ans: C

Section: 1-14

358. A person standing in the Moon's penumbra will see a

- A) total lunar eclipse.
- B) partial lunar eclipse.
- C) total solar eclipse.
- D) partial solar eclipse.

ans: D

359. It is unsafe to view which type of eclipse without special eye protection?

- A) penumbral lunar eclipse
- B) partial lunar eclipse
- C) total lunar eclipse
- D) solar eclipse

ans: D

360. We can occasionally see a total eclipse of the Sun on Earth because the

- A) Moon is cooler than the Sun.
- B) angular sizes of Sun and Moon, when viewed from Earth, are almost the same.
- C) Moon and the Sun both move precisely along the ecliptic plane.
- D) physical sizes of the Sun and the Moon are almost the same.

ans: B

361. Which of these factors makes it far more likely that a person will have seen a total lunar eclipse than a total solar eclipse?

- A) A total lunar eclipse can be seen by people on most of the nighttime side of Earth, whereas a specific total solar eclipse can be seen only by people within a narrow strip of Earth's surface.
- B) Total solar eclipses occur much less frequently than total lunar eclipses.
- C) The Moon appears brighter during a total lunar eclipse than does the Sun during a total solar eclipse.
- D) A total lunar eclipse occurs at full Moon when the Moon is bright and high in the sky, whereas a total solar eclipse occurs at new Moon when the Moon is dark and low in the sky.

ans: A

362. During any given solar eclipse, an observer will experience total shadow

- A) anywhere on the surface of Earth.
- B) from anywhere on the sunlit hemisphere of Earth.
- C) only over a region of Earth within $\pm 23.5^\circ$ of Earth's equator, or in the tropics.
- D) only within a specific narrow strip across Earth's surface.

ans: D

363. Where on Earth would an observer have to be to observe a particular total solar eclipse?

- A) always within 23.5° of the equator (i.e., in the tropics)
- B) within a narrow and specific strip of Earth's surface
- C) on the dark side of Earth
- D) within 250 km of Earth's equator

ans: B

364. A total solar eclipse is visible (assuming clear skies everywhere) to

- A) only people in a circular area on Earth having a diameter equal to that of the Moon.
- B) only people in a long narrow path, much smaller than a hemisphere.
- C) everyone on Earth.
- D) people anywhere in the sunlit hemisphere of Earth.

ans: B

365. Which of these parameters is the major factor in determining whether a particular solar eclipse appears as a total or as an annular eclipse to an observer on the center line of the Moon's shadow?

- A) phase of the Moon, whether it is new, quarter, or full
- B) time of day or night
- C) distance of the Moon from Earth
- D) distance of Earth from the Sun

ans: C

366. Solar eclipses (when the Moon and Sun are precisely in line) can be either total (Sun completely covered) or annular (Sun not quite covered) when viewed from the eclipse centerline. This is because

- A) the Moon has deep valleys on its surface.
- B) the Moon's orbit is inclined at several degrees to that of Earth.
- C) the Moon's distance from Earth varies from eclipse to eclipse.
- D) of the time of day at the viewing site; annular eclipses always occur in early mornings and early evenings.

ans: C

367. What is the major factor that governs whether a solar eclipse is total rather than annular when viewed from the center of the eclipse path on Earth?

- A) altitude of the observing site, because observers on a mountaintop are closer to the Moon and this affects the eclipse geometry
- B) Earth–Moon distance
- C) Earth–Sun distance
- D) phase of the Moon; total eclipses occur at new Moon, whereas annular eclipses occur at quarter Moon.

ans: B

368. A total lunar eclipse can last more than an hour and a half, but a total solar eclipse never lasts more than 7 1/2 minutes. What is the principal cause of the difference?

- A) A total solar eclipse always occurs when the Moon is at perigee; it is moving fastest at that time.
- B) A total solar eclipse always occurs when Earth is at perihelion; it is moving fastest at that time.
- C) Both Earth and the Moon move clockwise in their orbits, as seen from the north. Thus, during a solar eclipse, Earth and Moon are moving in opposite directions, and during a lunar eclipse, they are moving in the same direction.
- D) Earth's shadow at the Moon's distance is much larger than the Moon's shadow at Earth's distance. As Earth rotates, this narrow lunar shadow sweeps quickly over any given spot.

ans: D

369. What kind of eclipse occurs when the Moon's shadow does NOT extend all the way from the Moon to Earth?

- A) a total lunar eclipse
- B) a total solar eclipse
- C) a penumbral lunar eclipse
- D) an annular solar eclipse

ans: D

370. In view of the elliptical orbits of Earth and the Moon, which of these conditions will result in the longest period of totality during a total solar eclipse?

- A) Earth is closest to the Sun when the Moon is farthest from Earth.
- B) Earth is closest to the Sun when the Moon is closest to Earth.
- C) Earth is farthest from the Sun when the Moon is farthest from Earth.
- D) Earth is farthest from the Sun when the Moon is closest to Earth.

ans: D

371. What is the maximum time of totality for any total solar eclipse observed from Earth's surface?

- A) about 7.5 minutes
- B) a full 12-hour period
- C) about 2 hours
- D) only a few seconds

ans: A

372. The accurate prediction of the time and position of a total solar eclipse is

- A) difficult because of the varying distances of Earth from the Sun and the Moon from Earth in their elliptical orbits.

- B) not easy because of inaccurate knowledge of the rotation of Earth on its axis and of the revolution of Earth in its orbit.
- C) difficult because the Moon's motion is unpredictable, since it is affected in a major way by the tidal ebb and flow of water on Earth.
- D) relatively easy since the motions of Earth and Moon in space are predictable and accurately known.

ans: D

373. An observer can see a total solar eclipse from within a narrow band along Earth's surface. This band

- A) is always along the equator.
- B) is always parallel to the equator.
- C) always crosses the equator at a right angle.
- D) can begin almost anywhere on Earth's surface.

ans: D

374. What is the cause of an annular eclipse?

- A) Earth's position in its orbit is near aphelion, its farthest point from the Sun.
- B) Earth's position in its orbit is near perihelion, its nearest point to the Sun.
- C) The Moon's position in its orbit is near apogee, its farthest point from Earth.
- D) The Moon's position in its orbit is near perigee, its nearest point to Earth.

ans: C