The Cosmic Perspective, 8e **(Bennett)**
Chapter 2 Discovering the Universe for Yourself

2.1 Multiple-Choice Questions

1) How many stars can you see with your naked eye on a clear, moonless night from a dark location?
A) fewer than a thousand
B) a few thousand
C) about ten thousand
D) about a hundred thousand
E) more than you could count in your lifetime
Answer: B

2) Which of the following best describes the modern definition of a *constellation*?
A) a region of the celestial sphere
B) a pattern of bright stars in the sky
C) a Greek mythological figure
D) a collection of stars that are near one another in space
E) a group of stars that all lie at about the same distance from Earth
Answer: A

3) Which of the following statements about the celestial sphere is *not* true?
A) When we look in the sky, the stars all appear to be located on the celestial sphere.
B) Earth is placed at the center of the celestial sphere.
C) The celestial sphere does not exist physically.
D) The "celestial sphere" is just another name for our universe.
E) From any location on Earth, we can see only half the celestial sphere at any one time.
Answer: D

4) Which of the following statements about the celestial equator is true at *all* latitudes?
A) It lies along the band of light we call the Milky Way.
B) It represents an extension of Earth's equator onto the celestial sphere.
C) It cuts the dome of your sky exactly in half.
D) It extends from your horizon due east, through your zenith, to your horizon due west.
E) It extends from your horizon due north, through your zenith, to your horizon due south.
Answer: B

5) What is the *ecliptic*?
A) when the Moon passes in front of the Sun
B) the Moon's apparent path along the celestial sphere
C) the constellations commonly used in astrology to predict the future
D) the Sun's daily path across the sky
E) the Sun's apparent path along the celestial sphere
Answer: E

6) When we look into the band of light in our sky that we call the Milky Way, can we see distant galaxies? Why or why not?
A) Yes, they appear as small, fuzzy patches on the other side of our galaxy.
B) Yes, there are many other galaxies that we see inside the Milky Way.
C) No, because the stars, gas, and dust of the Milky Way block us from seeing them, however we can see close galaxies.
D) No, because there are only galaxies above and below the plane of the Milky Way.
E) No, we cannot see any other galaxies from Earth.
Answer: C

7) Which of the following correctly describes the *meridian* in your sky?
A) a half-circle extending from your horizon due east, through your zenith, to your horizon due west
B) a half-circle extending from your horizon due north, through your zenith, to your horizon due south
C) a half-circle extending from your horizon due east, through the north celestial pole, to your horizon due west
D) the point directly over your head
E) the boundary between the portion of the celestial sphere you can see at any moment and the portion that you cannot see
Answer: B

8) If it is midnight in New York, it is
A) daytime in Sydney, Australia.
B) midnight in Sydney, Australia.
C) midnight in Los Angeles.
D) midday in Rio de Janeiro, Brazil.
E) midnight everywhere.
Answer: A

9) How many arcseconds are in 1°?
A) 60
B) 360
C) 3,600
D) 100
E) 10,000
Answer: C

10) Which of the following statements does *not* use the term *angular size* or *angular distance* correctly?
A) The angular size of the Moon is about 1/2 degree.
B) The angular distance between those two houses in the distance is 30°.
C) The angular distance between those two bright stars in the sky is about 2 meters.
D) The angular size of the Sun is about the same as that of the Moon.
E) You can use your outstretched hand to estimate angular sizes and angular distances.
Answer: C

11) What is a *circumpolar* star?
A) a star that is close to the north celestial pole
B) a star that is close to the south celestial pole
C) a star that always remains above your horizon and appears to rotate around the celestial pole
D) a star that makes a daily circle around the celestial sphere
E) a star that is visible from the Arctic or Antarctic circles
Answer: C

12) Which of the following statements about circumpolar stars is true at *all* latitudes?
A) They are the stars close to the north celestial pole.
B) They always remain above your horizon.
C) They make relatively small circles, traveling clockwise around the north celestial pole.
D) Like all other stars, they rise in the east and set in the west.
E) You cannot see them from the Southern Hemisphere.
Answer: B

13) We can describe a position on Earth's surface by stating its
A) altitude and azimuth.
B) altitude and direction.
C) latitude and direction.
D) latitude and longitude.
E) meridian and longitude.
Answer: D

14) What makes the North Star, Polaris, special?
A) It is the brightest star in the sky.
B) It is the star straight overhead.
C) It appears very near the north celestial pole.
D) It is the star directly on your northern horizon.
E) It can be used to determine your longitude on Earth.
Answer: C

15) You are standing on Earth's equator. Which way is Polaris, the North star?
A) 30 degrees up, due West
B) on the northern horizon
C) directly overhead
D) The answer depends on whether it's winter or summer.
E) The answer depends on what time of day (or night) it is.
Answer: B

16) By locating the north celestial pole (NCP) in the sky, how can you determine your latitude?
A) The altitude of the NCP is the same as your latitude.
B) The altitude of the NCP is your angular distance from the North Pole.
C) The azimuth of the NCP is the same as your latitude.
D) The azimuth of the NCP is the angular distance from the North Pole.
E) The altitude of the NCP is the same as your distance from the North Pole.
Answer: A

17) Orion is visible on winter evenings in the northern hemisphere but not summer evenings because of
A) interference from the full Moon.
B) the tilt of Earth's axis.
C) the location of Earth in its orbit.
D) the precession of Earth's axis.
E) baseball on television.
Answer: C

18) Why do we have seasons on Earth?
A) As Earth goes around the Sun and Earth's axis remains pointed toward Polaris, the Northern and Southern hemispheres alternately receive more and less direct sunlight.
B) The tilt of Earth's axis constantly changes between 0 and 23 1/2°, giving us summer when Earth is tilted more and winter when it is straight up.
C) Earth's distance from the Sun varies, so that it is summer when we are closer to the Sun and winter when we are farther from the Sun.
D) Seasons are caused by the influence of the planet Jupiter on our orbit.
Answer: A

19) Why is it summer in the Northern Hemisphere when it is winter in the Southern Hemisphere?
A) The Northern Hemisphere is closer to the Sun than the Southern Hemisphere.
B) The Northern Hemisphere is "on top" of Earth and therefore receives more sunlight.
C) The Northern Hemisphere is tilted toward the Sun and receives more direct sunlight.
D) The Northern Hemisphere is tilted away from the Sun and receives more indirect sunlight.
E) It isn't: both hemispheres have the same seasons at the same time.
Answer: C

20) Which of the following statements is *true*?
A) Both the Northern and Southern hemispheres receive the same amount of sunlight on the equinoxes.
B) Both the Northern and Southern hemispheres receive the same amount of sunlight on the solstices.
C) The Northern Hemisphere receives the most direct sunlight on the summer solstice.
D) The Southern Hemisphere receives the most direct sunlight on the summer solstice.
E) Both A and C are true.
Answer: E

21) Which of the following statements about constellations is *false*?
A) There are only 88 official constellations.
B) Some constellations can be seen from both the Northern and Southern hemispheres.
C) Some constellations can be seen in both the winter and summer.
D) It is possible to see all the constellations from Earth's equator.
E) Most constellations will be unrecognizable hundreds of years from now.
Answer: E

22) Which of the following statements about lunar phases is *true*?
A) The time between new Moons is two weeks.
B) The time from one new Moon to the next new Moon is the same as the time from first-quarter Moon to third-quarter Moon.
C) The full Moon sometimes rises around midnight.
D) It is possible to have two full Moons during January, but not usually during February.
E) It is possible to have two full Moons during November, but not during December.
Answer: D

23) Which of the following is *not* a phase of the Moon?
A) first-quarter Moon
B) third-quarter Moon
C) half Moon
D) new Moon
E) full Moon
Answer: C

24) When someone on Earth observes the Moon in the first-quarter phase, someone on the Moon facing Earth observes Earth in the
A) new Earth phase.
B) first-quarter Earth phase.
C) crescent Earth phase.
D) third-quarter Earth phase.
E) full Earth phase.
Answer: D

25) If the Moon is setting at 6 A.M., the phase of the Moon must be
A) first quarter.
B) third quarter.
C) full.
D) new.
E) waning crescent.
Answer: C

26) If the Moon is setting at noon, the phase of the Moon must be
A) full.
B) first quarter.
C) third quarter.
D) waning crescent.
E) waxing crescent.
Answer: C

27) If the Moon is rising at midnight, the phase of the Moon must be
A) full.
B) first quarter.
C) third quarter.
D) waning crescent.
E) waxing crescent.
Answer: C

28) At approximately what time would a full Moon be on your meridian?
A) 6 A.M.
B) 9 A.M.
C) noon
D) 6 P.M.
E) midnight
Answer: E

29) At approximately what time would a first quarter Moon rise?
A) 6 A.M.
B) 9 A.M.
C) noon
D) 6 P.M.
E) midnight
Answer: C

30) If the Moon rises around 3 A.M., its phase must be
A) full.
B) first quarter.
C) third quarter.
D) waning crescent.
E) waxing crescent.
Answer: D

31) In which direction does a quarter Moon rise?
A) north
B) south
C) east
D) west
E) The Moon becomes a quarter Moon only after it has risen and changed phase.
Answer: C

32) Why do we see essentially the same face of the Moon at all times?
A) because the other face points toward us only at new Moon, when we can't see the Moon
B) because the Moon does not rotate
C) because the Moon's rotational and orbital periods are equal
D) because the Sun illuminates only one half at a time
E) because the Moon has a nearly circular orbit around Earth
Answer: C

33) Which of the following statements about the Moon is true?
A) The Moon goes through a cycle of phases because it always has the same side facing Earth.
B) If you see a full Moon from North America, someone in South America would see a new Moon.
C) The Moon's distance from Earth varies during its orbit.
D) The Moon is visible only at night.
E) The side of the Moon facing away from Earth is in perpetual darkness.
Answer: C

34) Suppose you live on the Moon. How long is a day (i.e., from sunrise to sunrise)?
A) 23 hours 56 minutes
B) 24 hours
C) a lunar month
D) a year
E) about 18 years
Answer: C

35) Ashen light (or earthshine) is
A) sunlight reflected by Earth that illuminates the "dark" portion of the Moon.
B) the sunlight that shines on the face of the Moon that we never see.
C) the light from the Moon that illuminates Earth's surface at night.
D) the light we see at dawn just before the Sun rises.
E) the light we see at dusk just after the Sun sets.
Answer: A

36) All of the following statements are true. Which one explains the reason why there is *not* a solar eclipse at every new Moon?
A) The nodes of the Moon's orbit precess with an 18-year period.
B) The orbital plane of the Moon is tilted by about 5° to the ecliptic plane.
C) The Moon rotates synchronously with its revolution about Earth.
D) The sidereal month is shorter than the lunar month.
E) The Moon is the primary cause of tides on Earth.
Answer: B

37) What effect or effects would be most significant if the Moon's orbital plane were exactly the same as the ecliptic plane?
A) Solar eclipses would be much rarer.
B) Solar eclipses would be much more frequent.
C) Solar eclipses would last much longer.
D) both A and C
E) both B and C
Answer: B

38) What conditions are required for a solar eclipse?
A) The phase of the Moon must be new, and the nodes of the Moon's orbit must be nearly aligned with Earth and the Sun.
B) The phase of the Moon must be full, and the nodes of the Moon's orbit must be nearly aligned with Earth and the Sun.
C) The phase of the Moon can be new or full, and the nodes of the Moon's orbit must be nearly aligned with Earth and the Sun.
D) The phase of the Moon must be new, and the Moon's orbital plane must lie in the ecliptic.
E) The phase of the Moon must be full, and the Moon's orbital plane must lie in the ecliptic.
Answer: A

39) What conditions are required for a lunar eclipse?
A) The phase of the Moon must be new, and the nodes of the Moon's orbit must be nearly aligned with Earth and the Sun.
B) The phase of the Moon must be full, and the nodes of the Moon's orbit must be nearly aligned with Earth and the Sun.
C) The phase of the Moon can be new or full, and the nodes of the Moon's orbit must be nearly aligned with Earth and the Sun.
D) The phase of the Moon must be new, and the Moon's orbital plane must lie in the ecliptic.
E) The phase of the Moon must be full, and the Moon's orbital plane must lie in the ecliptic.
Answer: B

40) In addition to the conditions required for any solar eclipse, what must also be true in order for you to observe a *total* solar eclipse?
A) Earth must lie completely within the Moon's umbra.
B) Earth must lie completely within the Moon's penumbra.
C) Earth must be near aphelion in its orbit of the Sun.
D) The Moon's umbra must touch the area where you are located.
E) The Moon's penumbra must touch the area where you are located.
Answer: D

41) If part of the full Moon passes through Earth's umbra, we will see a(n)
A) total lunar eclipse.
B) penumbral lunar eclipse.
C) partial lunar eclipse.
D) partial solar eclipse.
E) annular eclipse.
Answer: C

42) If the Moon is relatively far from Earth, so that the umbra does not reach Earth, someone directly behind the umbra will see
A) a penumbral lunar eclipse.
B) a partial lunar eclipse.
C) a partial solar eclipse.
D) an annular eclipse.
E) no eclipse.
Answer: D

43) When are eclipse seasons?
A) in the spring and fall
B) in the summer and winter
C) when the nodes of the Moon's orbit are nearly aligned with the Sun
D) when Earth and the Sun are aligned with one another
E) during an eclipse
Answer: C

44) What effect does the precession of the Moon's nodes have on eclipses?
A) there is a lunar eclipse every 6 months
B) there is a solar eclipse every 6 months
C) the eclipse seasons occur less than 6 months apart
D) the vernal equinox will be in Aquarius in a few hundred years
E) there are never two solar eclipses in the same year
Answer: C

45) What is the Saros cycle?
A) the roughly 6-month period between eclipse seasons
B) the 18-year cycle over which the pattern of eclipses repeats
C) the period between total solar eclipses
D) the period between a total solar eclipse and a total lunar eclipse
E) the period between eclipses
Answer: B

46) Ancient people who knew the Saros cycle could
A) completely predict every lunar eclipse.
B) completely predict every solar eclipse.
C) predict what type of eclipse would occur.
D) predict when they'd see the next total solar eclipse in their area.
E) predict when an eclipse would happen, but not necessarily what type and where it would be visible.
Answer: E

47) What happens during the apparent retrograde motion of a planet?
A) The planet rises in the west and sets in the east.
B) The planet appears to move westward with respect to the stars over a period of many nights.
C) The planet moves backward through the sky over the course of a night.
D) The planet moves backward in its orbit around the Sun.
E) The planet moves through constellations that are not part of the zodiac.
Answer: B

48) Why are lunar eclipses more commonly seen than solar eclipses?
A) Lunar eclipses occur at night and are easier to see.
B) The Moon goes around the Earth faster than the Earth goes around the Sun.
C) The Earth casts a bigger shadow than the Moon.
D) The tilt of the Moon's axis is smaller than the Earth's.
E) The Moon is much closer to the Earth than the Sun.
Answer: C

49) What causes the apparent retrograde motion of the planets?
A) As Earth passes another planet, its gravitational pull slows down the other planet so that it appears to be traveling backward.
B) When planets are farther from the Sun, they move slower than when they are nearer the Sun; it is during this slower period that they appear to move backwards.
C) The other planets never really appear to move backward; the background stars shift due to Earth's revolution around the Sun.
D) As Earth passes another planet, the other planet appears to move backward with respect to the background stars, but the planet's motion does not actually change.
E) Apparent retrograde motion is an illusion created by turbulence in Earth's atmosphere.
Answer: D

50) Which of the following never appears to exhibit retrograde motion?
A) the Sun
B) Venus
C) Mars
D) Jupiter
E) Saturn
Answer: A

51) Which of the following statements about parallax is *not* true?
A) You can demonstrate parallax simply by holding up a finger and looking at it alternately from your left and right eyes.
B) The existence of stellar parallax is direct proof that Earth orbits the Sun.
C) Measurement of stellar parallax allows us to determine distances to nearby stars.
D) The technique of stellar parallax was used by Hubble to determine that the Andromeda Galaxy (M 31) is about 2 million light-years away.
E) Ancient astronomers were unable to measure parallax and used the absence of observed parallax as an argument in favor of an Earth-centered universe.
Answer: D

52) Which of the following statements about stellar parallax is *true*?
A) We observe all stars to exhibit at least a slight amount of parallax.
B) Stellar parallax was first observed by ancient Greek astronomers.
C) The amount of parallax we see depends on how fast a star is moving relative to us.
D) It takes at least 10 years of observation to measure a star's parallax.
E) The closer a star is to us, the more parallax it exhibits.
Answer: E

53) We can't detect stellar parallax with naked-eye observations. Which of the following would make parallax easier to observe?
A) increasing the size of Earth's orbit
B) speeding up Earth's rotational motion
C) slowing down Earth's rotational motion
D) speeding up the precession of Earth's axis
E) getting away from streetlights
Answer: A

54) Why were ancient peoples unable to detect stellar parallax?
A) They did not look for it.
B) They could not see distant stars.
C) They did not have the ability to measure very small angles.
D) They did not observe for long enough periods of time.
E) They did detect it, but they rejected the observations.
Answer: C

2.2 True/False Questions

1) In South Africa, it's usually quite warm around the time of the Northern Hemisphere winter solstice and quite cool around the time of the summer solstice.
Answer: TRUE

2) Columbus was the first person to discover that Earth is round.
Answer: FALSE

3) You can find the tilt of Earth's axis by measuring the angle between your horizon and the North Star.
Answer: FALSE

4) The Milky Way can be seen only from the Northern Hemisphere.
Answer: FALSE

5) The seasons on Earth are caused by its elliptical orbit around the Sun.
Answer: FALSE

6) At midnight it is sometimes possible to observe the crescent Moon on the meridian.
Answer: FALSE

7) It is possible to see the third-quarter Moon near the western horizon at sunrise.
Answer: FALSE

8) It is possible to see the full Moon rising just before sunrise.
Answer: FALSE

9) If you lived on the Moon, you'd see full Earth when we see new Moon.
Answer: TRUE

10) It is possible to view the Moon in first-quarter phase the day after a total lunar eclipse.
Answer: FALSE

11) The Moon and the Sun are approximately the same angular size.
Answer: TRUE

12) A solar eclipse occurs only when the Moon is new.
Answer: TRUE

13) A lunar eclipse occurs only when the Moon is new.
Answer: FALSE

14) Lunar eclipses are more commonly seen than solar eclipses.
Answer: TRUE

15) Process of Science: Because we do not see stellar parallaxes with our eyes, we conclude that the Earth is at the center of the Solar System.
Answer: FALSE

2.3 Short Answer Questions

Choose the letter for the real motion of space from the list below that is responsible for the apparent motion of space as seen from Earth.

A. Earth rotates once each day.
B. Earth revolves around the Sun once each year.
C. The direction of Earth's axis in space precesses with a period of 26,000 years.
D. Stars appear to move randomly in the local solar neighborhood.
E. The universe is expanding.

1) Polaris will no longer be the North Star 1,000 years from now.
Answer: C

2) In the year A.D. 15,000, Vega will be a better north star than Polaris.
Answer: C

3) The Big Dipper will look different 100,000 years from now than it does today.
Answer: D

4) The Moon rises in the east and sets in the west.
Answer: A

5) The stars of Orion's belt rise in the east and set in the west.
Answer: A

6) A million years from now, Alpha Centauri will no longer be the nearest star system to our own.
Answer: D

7) If Earth's axis had no tilt, would we still have seasons? Why or why not?
Answer: We would no longer have seasons, because the Sun's light would hit at the same angle all throughout the year, depending only on where you lived. The slight change in distance between Earth and the Sun during the year would not produce much of an effect.

8) Consider the following statement, and explain whether or not it is sensible: If you had a very fast spaceship, you could travel to the celestial sphere in about 100 years.
Answer: This statement does not make sense because the celestial sphere is a concept and not a physical object.

9) Consider the following statement, and explain whether or not it is sensible: When I looked into the dark fissure of the Milky Way with my binoculars, I saw what must have been a cluster of distant galaxies.
Answer: This statement does not make sense because we cannot see through the band of light we call the Milky Way to external galaxies; the dark fissure is gas and dust blocking our view.

10) Why does the Milky Way appear as a *band* of light in the sky?
Answer: The solar system lies in the outer parts of the thin disk of a spiral galaxy. Thus when we look along the plane of the disk, we see large numbers of stars that, to the naked eye, merge into a band of light. When we look out of the plane of the disk, there are very few stars and the night sky is much darker.

11) Consider the following statement, and explain whether or not it is sensible: Although all the known stars appear to rise in the east and set in the west, we might someday discover a star that will appear to rise in the west and set in the east.
Answer: This statement does not make sense. The stars aren't really rising and setting, they only appear to rise in the east and set in the west because the Earth rotates.

12) At what altitude and in what direction in your sky does the north or south celestial pole appear?
Answer: Answers will vary with your latitude; latitude = altitude of NCP (or SCP in Southern Hemisphere).

13) Consider the following statement, and explain whether or not it is sensible: My sign is Ursa Major because the Sun was in Ursa Major when I was born.
Answer: Not sensible: The Sun appears only in the constellations of the zodiac—and Ursa Major is not one of these.

14) Consider the following statement, and explain whether or not it is sensible: Last night I saw Jupiter in the constellation Ursa Major.
Answer: This statement does not make sense because Jupiter, like all the planets, is always found very close to the ecliptic in the sky. The ecliptic passes through the constellations of the zodiac, so Jupiter can appear to be only in one of the 12 zodiac constellations—and Ursa Major is not one of these.

15) Answer each of the following questions for our local sky.

A. Where is the north celestial pole in our sky?
B. Is Polaris a circumpolar star in our sky? Explain.
C. Describe the meridian in our sky.
D. Describe the celestial equator in our sky.
Answer: A. Answers will vary with latitude; here is a sample for 40°N: The north celestial pole appears at an altitude of 40°, in the direction due north.
B. Yes, for any location in the Northern Hemisphere; no, for any location in the Southern Hemisphere. Polaris is circumpolar because it never rises or sets in our sky. It makes a daily circle, less than 1° in radius, around the north celestial pole.
C. The meridian is a half-circle that stretches from the due south point on the horizon, through the zenith, to the due north point on the horizon.
D. Answers will vary with latitude; here is a sample answer for 40°N: The celestial equator is a half-circle that stretches from the due east point on the horizon, through an altitude of 50° due south, to the due west point on the horizon.

16) Consider the following statement, and explain whether or not it is sensible: If you lived on the Moon, you'd see full Earth when we see new Moon.
Answer: This is true, because at full Moon, Earth lies between the Sun and the Moon. Thus, an observer on the Moon would be looking at the night side of Earth.

17) Suppose you lived on the Moon near the center of the face that we see from Earth. During the phase of full Moon, what phase would you see for Earth? Would it be day or night at your home?
Answer: During the full Moon, it would be daytime and you would see the phase of new Earth.

18) Suppose you lived on the Moon near the center of the face that we see from Earth. During the phase of new Moon, what phase would you see for Earth? Would it be day or night at your home?
Answer: During the new Moon, it would be nighttime and you would see the phase of full Earth.

19) Suppose you lived on the Moon near the center of the face that we see from Earth. At what phase of the Moon would you see sunset? What phase of Earth would you see at this time?
Answer: Sunset would occur at the Moon's first-quarter phase. You would see Earth in third-quarter phase at this time.

20) Suppose you lived on the Moon near the center of the face that we see from Earth. At what phase of the Moon would you see sunrise? What phase of Earth would you see at this time?
Answer: Sunrise would occur at the Moon's third-quarter phase. You would see Earth in first-quarter phase at this time.

21) What would you see if you were on the Moon during a lunar eclipse?
Answer: During a lunar eclipse, you would see Earth pass in front of the Sun. It would be completely dark where you were.

22) Why is the Moon not completely invisible (it appears as a very deep red color) to the naked eye during a total lunar eclipse?
Answer: The Moon shines through reflected light from the Sun and thus it becomes very dark during a lunar eclipse since the Moon lies within Earth's shadow at this time. However, some sunlight still gets through because it is bent (similar to the way a lens works) by Earth's atmosphere. We see the reflection of this faint light and thus the Moon is not completely invisible. (The bending of light is called *refraction* and the effect is strongest at long wavelengths. Thus it is most pronounced for red light and the eclipsed Moon appears dark red.)

23) What would you see if you were on the Moon during a solar eclipse?
Answer: During a solar eclipse, you would see a small circular shadow traveling across a portion of Earth's surface.

24) Suppose the distance to the Moon were twice its actual value. Could we still have solar eclipses? If so, what type(s)?
Answer: If the Moon were twice its actual distance from us, we would no longer be able to see total solar eclipses because the Moon would not be able to completely cover the surface of the Sun; however, we would still see partial and annular eclipses, although the Moon would not block as much of the Sun during these times.

25) Consider the following statement, and explain whether or not it is sensible: Last night I saw Mars move westward through the sky in its apparent retrograde motion.
Answer: This statement does not makes sense because the apparent retrograde motion is noticeable only over many nights, not during a single night. (Of course, like all celestial objects, Mars moves from east to west over the course of every night.)

26) If, from the point of view of Earth-bound observers, the Moon is in new Moon phase on a particular day, what phase is Earth as seen from the Moon?
Answer: full Earth

27) *Process of Science:* Your friend hypothesizes that the phases of the Moon are produced by Earth's shadow being cast on the Moon's surface. Devise an experiment to prove your friend wrong. Describe an observation you will make (time of day/night, location in sky) and describe what you will see that will clearly demonstrate that your friend's idea cannot be correct.
Answer: If you observe any time when the Moon and Sun are both in the sky (*e.g.*, in the daytime during a crescent Moon), you can clearly see that Earth's shadow cannot be cast on the Moon, as it is on the other side of Earth, where the Moon is not. Similarly, an observation of the full Moon shows the opposite: no Earth shadow at all, though the alignment would favor one. If the full Moon occurred when Earth's shadow could not hit it, it should be seen in the daytime, not at night—and then it would have no light source.

28) *Process of Science*: How could you show that the seasons depend on the tilt of the Earth rather than the distance the Earth is from the Sun?
Answer: You could fly across the equator to see that there can be winter in one hemisphere at the same time there is summer in the other.

2.4 Mastering Astronomy Reading Quiz

1) About how many stars are visible to the naked eye on a clear, dark night away from city lights?
A) a few dozen
B) a couple thousand
C) several million
D) a few hundred billion
Answer: B

2) What do astronomers mean by a *constellation*?
A) A constellation is a region in the sky as seen from Earth.
B) A constellation is a group of stars related through an ancient story.
C) A constellation is any random grouping of stars in the sky.
D) A constellation is a group of stars that are all located in about the same place in space.
Answer: A

3) What is the *ecliptic*?
A) the path the Sun appears to trace around the celestial sphere each year
B) the Sun's daily path from east to west in our sky
C) the path traced by the Moon's shadow on Earth during a solar eclipse
D) a half-circle extending from your horizon due north, through your zenith, to your horizon due south
Answer: A

4) What is the *celestial sphere*?
A) The celestial sphere is a representation of how the entire sky looks as seen from Earth.
B) The celestial sphere is a model that shows the true locations in space of the Sun and a few thousand of the nearest stars.
C) The celestial sphere is a model of how the stars are arranged in the sky relative to our Sun, which is in the middle of the sphere.
D) It represents a belief in an Earth-centered universe, and hence is no longer considered to have any use.
Answer: A

5) What do we mean when we talk about the *Milky Way* in our sky?
A) the patchy band of light that outlines the *plane* of the Milky Way Galaxy as seen from Earth
B) the whitish patch of light we see when we look toward the *center* of the Milky Way Galaxy
C) the spiral-shaped galaxy in which we live
D) the bright stars of the constellations that lie along the ecliptic in our sky
Answer: A

6) Which of the following statements does *not* use the term *angular size* or *angular distance* correctly?
A) The angular distance between those two houses in the distance is 30 degrees.
B) The angular distance between those two bright stars in the sky is about 2 meters.
C) The angular size of the Sun is about the same as that of the Moon.
D) You can use your outstretched hand against the sky to estimate angular sizes and angular distances.
Answer: B

7) Which of the following correctly describes the *meridian* in your local sky?
A) a half-circle extending from your horizon due east, through your zenith, to your horizon due west
B) a half-circle extending from your horizon due east, through the north celestial pole, to your horizon due west
C) a half-circle extending from your horizon due north, through your zenith, to your horizon due south
D) the point directly over your head
Answer: C

8) The point directly over your head is called
A) the meridian.
B) the zenith.
C) the north celestial pole.
D) the North Star.
Answer: B

9) Stars that are visible in the local sky on any clear night of the year, at any time of the night, are called
A) bright.
B) seasonal.
C) circumpolar.
D) celestial.
Answer: C

10) We can describe a location on *Earth's surface* by stating its
A) altitude and direction (or azimuth).
B) meridian and longitude.
C) latitude and direction.
D) latitude and longitude.
Answer: D

11) If you are located in the Northern Hemisphere, which of the following correctly describes a relationship between the sky and your location?
A) The altitude of the north celestial pole equals your latitude.
B) The altitude of the celestial equator equals your latitude.
C) The altitude of the north celestial pole equals your longitude.
D) The longitude of the north celestial pole is circumpolar, and therefore crosses your zenith at the meridian.
Answer: A

12) Which of the following best describes why we have seasons on Earth?
A) The tilt of Earth's axis causes different portions of the Earth to receive more or less direct sunlight at different times of year.
B) Earth's elliptical orbit means we are closer to the Sun and therefore receive more intense sunlight at some times of year than at others.
C) The tilt of Earth's axis causes the northern hemisphere to be closer to the Sun than the southern hemisphere in summer, and visa versa in winter.
D) The varying speed of Earth in its orbit around the Sun gives us summer when we are moving fastest and winter when we are moving slowest.
Answer: A

13) Each choice below describes how a few astronomical phenomena are related to time periods. Which list is entirely correct? (Careful: some lists are partially correct.)
A) Earth's rotation defines a day.
The cycle of the Moon's phases takes about a month.
Earth's orbit defines a year.
Earth's cycle of axis precession takes 26,000 years.
B) Earth's rotation defines a day.
The cycle of the Moon's phases takes about a week.
Earth's orbit defines a year.
Earth's cycle of axis precession defines a month.
C) Earth's rotation defines a day.
The Sun's rotation defines a week.
The Moon's rotation defines a month.
Earth's orbit defines a year.
D) Earth's rotation defines a day.
The saros cycle of eclipses defines a month.
Earth's orbit defines a year.
Earth's cycle of axis precession takes 26,000 years.
Answer: A

14) If we have a new Moon today, when we will have the next full Moon?
A) in about 2 weeks
B) in about 1 week
C) in about a month
D) in about 6 months
Answer: A

15) We cannot see a new moon in our sky because
A) it is obscured by Earth's shadow.
B) no sunlight is illuminating the Moon.
C) a new moon is quite near the Sun in the sky.
D) it is above the horizon during the daytime.
Answer: C

16) The Moon always shows nearly the same face to Earth because
A) the Moon does not rotate.
B) sunlight always hits the same face of the Moon.
C) the Moon rotates once in the same amount of time that it takes Earth to orbit the Sun once.
D) the Moon rotates once in the same amount of time that it takes the Moon to orbit Earth once.
Answer: D

17) Lunar eclipses can occur only during a
A) new Moon.
B) first quarter Moon.
C) full Moon.
D) third quarter Moon.
Answer: C

18) What is the *saros cycle*?
A) the 26,000-year cycle of the Earth's precession
B) the roughly 18-year cycle over which the pattern of eclipses repeats
C) the roughly one-month cycle of lunar phases in the sky
D) the annual cycle of the seasons
Answer: B

19) During the time that a planet is in its period of *apparent retrograde motion*,
A) the planet moves backwards (clockwise as viewed from above Earth's north pole) in its orbit of the Sun.
B) the planet appears to rise in the west and set in the east, rather than the usual rising in the east and setting in the west.
C) over many days or weeks, the planet moves westward relative to the stars, rather than the usual eastward relative to the stars.
D) the planet is getting closer to the Sun in its orbit.
Answer: C

20) What is *stellar parallax*?
A) It is the daily rise and set of the stars.
B) It describes the fact that stars are actually moving relative to one another, even though to our eyes the stars appear fixed in the constellations.
C) It is the slight back-and-forth shifting of star positions that occurs as we view the stars from different positions in Earth's orbit of the Sun.
D) It is the change in the set of constellations that we see at different times of year in the evening sky.
Answer: C

2.5 Mastering Astronomy Concept Quiz

1) Which of the following statements about the celestial sphere is *not* true?
A) The Earth is placed at the center of the celestial sphere.
B) When we look in the sky, the stars all appear to be located on the celestial sphere.
C) The "celestial sphere" is another name for our universe.
D) The celestial sphere does not exist physically.
Answer: C

2) The Andromeda Galaxy is faintly visible to the naked eye in the constellation Andromeda. Suppose instead it were located in the same direction in space as the center of the Milky Way Galaxy (but still at its current distance). How would it appear to the eye in that case?
A) We could not see it at all.
B) It would look about the same, but would be in the constellation Sagittarius instead of Andromeda.
C) It would be much brighter, because it would be illuminated by the many stars in the center of our galaxy.
D) It would look about the same, but it would be harder to pick out because its cloud-like appearance would make it blend in with the cloud-like appearance of the Milky Way in our sky.
Answer: A

3) An angle of 1 arcsecond is
A) about the width of your fist held at arm's length.
B) about the width of a finger held at arm's length.
C) less than the thickness of a human hair held at arm's length.
D) slightly more than the width of a basketball held at arm's length.
Answer: C

4) When traveling north from the United States into Canada, you'll see the North Star (Polaris) getting
A) brighter.
B) dimmer.
C) higher in the sky.
D) lower in the sky.
Answer: C

5) Suppose you use the Southern Cross to determine that the south celestial pole appears 40 degrees above your horizon. Then you must be located at
A) latitude 40 degrees north.
B) latitude 50 degrees south.
C) latitude 40 degrees south.
D) longitude 40 degrees.
Answer: C

6) Suppose you are facing north and you see the Big Dipper close to your northern horizon, with Polaris (and the Little Dipper) above it. Where will you see the Big Dipper in six hours?
A) to the right of Polaris; that is, 90 degrees counterclockwise from its current position
B) to the left of Polaris; that is, 90 degrees clockwise from its current position
C) directly above Polaris
D) still in the same place, below Polaris
Answer: A

7) In any particular place on Earth, certain constellations are visible in the evening only at certain times of the year because
A) our evening view of space depends on where Earth is located in its orbit around the Sun.
B) during some times of year, some constellations drop below the southern horizon.
C) some constellations are circumpolar.
D) on any particular night, we can only see stars that are directly opposite (180 degrees away from) the Sun in the sky.
Answer: A

8) The Sun's path, as viewed from the equator, is highest in the sky on
A) the winter solstice.
B) the spring and fall equinoxes.
C) the summer solstice.
D) the day when Earth is closest to the Sun.
Answer: B

9) Suppose Earth's axis tilt was significantly greater than its current 23.5 degrees, but Earth's rotation period and orbital period were unchanged. Which statement below would *not* be true?
A) Summers and winters would be more severe (for example, hotter and colder, respectively) than they are now.
B) The region of Earth where the Sun does not rise on the winter solstice would be larger (extending farther south) than it is now.
C) The length of each season (for example, the number of days from the summer solstice to the fall equinox) would be significantly longer than it is now.
D) Polaris would not be our North star.
Answer: C

10) If our year were twice as long (that is, if Earth took twice as many days to complete each orbit around the Sun), but Earth's rotation period and axis tilt were unchanged, then
A) stars would take twice as long to rise and set.
B) the cycle of precession would take 13,000 years instead of 26,000 years.
C) the four seasons would each be twice as long as they are now.
D) the Earth would not have seasons.
Answer: C

11) How does Earth's varying distance from the Sun affect our seasons?
A) It doesn't—Earth's orbital distance plays no significant role in the seasons.
B) It makes summer warmer in the Northern Hemisphere than in the Southern Hemisphere.
C) It is responsible for the fact that the seasons are opposite in the Northern and Southern hemispheres.
D) It causes the seasons to be more extreme than they would be if the Earth's distance from the Sun were always the same.
Answer: A

12) Suppose you live in the United States and you see a crescent Moon in your evening sky tonight. What will a friend in South America see tonight?
A) Your friend will see a gibbous Moon.
B) Your friend will also see a crescent Moon.
C) Your friend will see a first quarter Moon.
D) Your friend won't see the Moon tonight, because it is up only in the morning.
Answer: B

13) Suppose it is full Moon. What phase of Earth would someone on the Moon see at this time?
A) Full Earth
B) New Earth
C) First quarter Earth
D) Earth does not go through phases as seen from the Moon.
Answer: B

14) It's 6 A.M. and the Moon is at its highest point in your sky (crossing the meridian). What is the Moon's phase?
A) new
B) first quarter
C) full
D) third quarter
Answer: D

15) You observe a full Moon rising at sunset. What will you see at midnight?
A) a full Moon high in the sky
B) a first quarter Moon
C) a waning gibbous Moon
D) a third quarter Moon
Answer: A

16) All the following statements are true. Which one explains the reason that there is *not* a solar eclipse at every new Moon?
A) The nodes of the Moon's orbit precess with an 18-year period.
B) The orbital plane of the Moon is tilted slightly (by about 5 degrees) to the ecliptic plane.
C) The Moon is only about 1/4 as large as Earth in diameter.
D) The Moon goes through a complete cycle of phases about every 29 1/2 days.
Answer: B

17) For most of history, the lack of observable stellar parallax was interpreted to mean that
A) stars must all lie at the same distance from Earth, on the celestial sphere.
B) stars were too far away for parallax to be measured with available technology.
C) Earth is stationary at the center of the universe.
D) Galileo's theories of the universe were essentially correct.
Answer: C

18) During the period each year when we see Mars undergoing apparent retrograde motion in our sky, what is really going on in space?
A) Mars is moving around the Sun in the opposite direction from which Earth is moving around the Sun.
B) Earth and Mars are getting closer together.
C) Earth is catching up with and passing by Mars in their respective orbits.
D) Earth and Mars are on opposite sides of the Sun.
Answer: C

19) Suppose you see a photo showing Jupiter half in sunlight and half in shadow (that is, a *first quarter* Jupiter). This photo might have been taken by
A) the *Galileo* spacecraft that orbited Jupiter in the 1990s.
B) the Hubble Space Telescope (which orbits Earth).
C) the Keck Telescope on Mauna Kea, Hawaii.
D) the Arecibo Radio Telescope in Puerto Rico.
Answer: A