CHAPTER 02: A Universe Made, A Universe Discovered

MULTIPLE CHOICE

1. On any given day, the primary factor determining the Sun's path on the sky for an observer on Earth is:
   a. the phase of the Moon.
   b. his or her altitude.
   c. his or her longitude.
   d. his or her latitude.

   ANS: D DIF: Easy REF: 2.2
   OBJ: Relate your position on Earth to the apparent locations of celestial objects.
   MSC: Remembering

2. Each night, most stars:
   a. remain stationary.
   b. rise in the east and set in the west.
   c. vary in brightness.
   d. pass through the zenith.

   ANS: B DIF: Easy REF: 2.2
   OBJ: Illustrate the motions of the Sun and stars on the celestial sphere.
   MSC: Remembering

3. Each night, an observer in the northern hemisphere sees the stars circle around a point called the:
   a. north celestial pole.
   b. zenith.
   c. declination.
   d. solstice.

   ANS: A DIF: Easy REF: 2.2
   OBJ: Illustrate the motions of the Sun and stars on the celestial sphere.
   MSC: Remembering

4. An observer at the equator sees the south celestial pole at what altitude?
   a. 90 degrees
   b. 45 degrees
   c. 0 degrees
   d. -90 degrees

   ANS: C DIF: Easy REF: 2.2
   OBJ: Relate your position on Earth to the apparent locations of celestial objects.
   MSC: Applying

5. Suppose two of your friends, Alice and Bob, hold identical signs. Alice stands 100 m from you, while Bob stands 400 m from you. Alice's sign occupies an angle ________ as large as Bob's sign.
   a. one-quarter
   b. half
   c. twice
   d. four times

   ANS: D DIF: Easy REF: 2.2 OBJ: Use the small-angle formula.
   MSC: Applying

6. A resident of the Northern Hemisphere measures the length of daylight every day for a year. The longest day occurs on:
   a. March 21.
   b. June 21.
   c. September 21.
   d. December 21.

   ANS: B DIF: Easy REF: 2.2
   OBJ: Relate Earth's tilted rotation axis to the yearly motions of the Sun on the celestial sphere, the seasons, and the length of days. MSC: Applying

7. Which of the following phenomena is primarily due to the elliptical shape of Earth's orbit?
   a. the seasons
   b. the changing lengths of days
   c. the Sun's changing position in the sky
   d. none of the above

   ANS: D DIF: Easy REF: 2.2
   OBJ: Relate Earth's tilted rotation axis to the yearly motions of the Sun on the celestial sphere, the seasons, and the length of days. MSC: Remembering

8. The constellation Libra is high in the sky at noon during the month of October (though it cannot be seen next to the bright Sun). At what time of year is it high in the sky at midnight?
   a. April
   b. July
   c. October
   d. January

   ANS: A DIF: Easy REF: 2.2
   OBJ: Explain how Earth's orbit causes the yearly cycle of visible constellations.
   MSC: Applying

9. The Sun's path across the celestial sphere over the course of a year is the:
   a. zenith.
   b. zodiac.
   c. ecliptic.
   d. analemma.

   ANS: C DIF: Easy REF: 2.2
   OBJ: Illustrate the motions of the Sun and stars on the celestial sphere.
   MSC: Remembering

10. Suppose that you observe the sky at midnight and see the star Betelgeuse just rising above the eastern horizon. Where will it be at 6 A.M.?
    a. at its highest point
    b. halfway between the horizon and at its highest point
    c. the horizon
    d. the opposite side of Earth

    ANS: A DIF: Moderate REF: 2.2
    OBJ: Relate your position on Earth to the apparent locations of celestial objects.
    MSC: Applying

11. A resident of the Southern Hemisphere observes the Sun's position at noon every day over the course of a year. The Sun will be highest in the sky on:
    a. March 21.
    b. June 21.
    c. September 21.
    d. December 21.

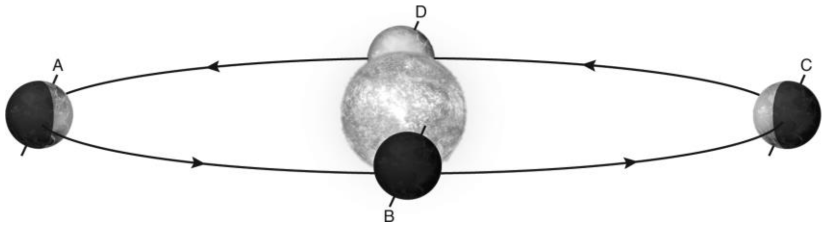
    ANS: D DIF: Moderate REF: 2.2
    OBJ: Relate Earth's tilted rotation axis to the yearly motions of the Sun on the celestial sphere, the seasons, and the length of days. MSC: Applying

12. Suppose you take a snapshot of the night sky at midnight tonight. At what time would you have to observe the sky six months from now in order to find the stars in exactly the same position on the sky? You may assume that you can observe the stars at any time, day or night.
    a. sunrise
    b. noon
    c. sunset
    d. midnight

    ANS: B DIF: Moderate REF: 2.2
    OBJ: Explain how Earth's orbit causes the yearly cycle of visible constellations.

MSC: Understanding

13. The following figure shows Earth's orbit around the Sun. Which position corresponds to summer in the Northern Hemisphere?



a. A	c. C
b. B	d. D

ANS: A DIF: Moderate REF: 2.2
OBJ: Relate Earth's tilted rotation axis to the yearly motions of the Sun on the celestial sphere, the seasons, and the length of days. MSC: Analyzing

14. An observer on the dwarf planet Pluto sees the Sun pass through a different set of constellations than an observer on Earth over the course of one orbit. Which of the following best explains this?
    a. Pluto is farther from the Sun.
    b. Pluto has a longer orbital period than Earth.
    c. Pluto's orbit is tilted with respect to Earth's orbit.
    d. Pluto has a longer rotation period than Earth.

ANS: C DIF: Difficult REF: 2.2
OBJ: Explain how Earth's orbit causes the yearly cycle of visible constellations.
MSC: Understanding

15. Two people, one in the Brazilian city of Manaus (near the equator) and one in New York City (near 40 degrees north latitude), observe the Sun at noon on June 21. How will their views of the Sun compare?
    a. The Sun will appear at the zenith for both observers.
    b. The Sun will appear higher in the sky to the observer in Manaus.
    c. The Sun will appear higher in the sky to the observer in New York City.
    d. The Sun will appear brighter to the observer in Manaus.

ANS: B DIF: Difficult REF: 2.2
OBJ: Relate your position on Earth to the apparent locations of celestial objects.
MSC: Understanding

16. For an observer in the Northern Hemisphere, on which of the following dates does the Sun pass through the lowest altitude point on its analemma?

a. March 21	c. September 21
b. June 21	d. December 21

ANS: D DIF: Moderate REF: 2.2
OBJ: Relate Earth's tilted rotation axis to the yearly motions of the Sun on the celestial sphere, the seasons, and the length of days. MSC: Applying

17. You see two balls in the distance. The blue ball is half a degree across and rests half of a football field away. The red ball is one-quarter of a degree across and rests two football fields away. The red ball is ________ as large as the blue ball.

a. one-quarter	c. two times
b. one-half	d. four times

ANS: C DIF: Difficult REF: 2.2 OBJ: Use the small-angle formula.
MSC: Applying

18. The constellation Ursa Minor includes Polaris, the North Star, as a member. An observer just north of the equator might:
    a. see Ursa Minor rise and set on some nights throughout the year.
    b. see Ursa Minor rise and set every night.
    c. see Ursa Minor throughout the night, every night of the year.
    d. never see Ursa Minor.

    ANS: A DIF: Difficult REF: 2.2
    OBJ: Relate your position on Earth to the apparent locations of celestial objects.
    MSC: Understanding

19. A scientific model provides a ________ of a natural phenomenon.
    a. simplified description
    b. testable explanation
    c. mathematical treatment
    d. physical representation

    ANS: B DIF: Easy REF: 2.3 OBJ: Define a scientific model.
    MSC: Remembering

20. If you observe the Moon to be in the waning gibbous phase tonight, in three days it could be in the ________ phase.
    a. new
    b. first quarter
    c. full
    d. third quarter

    ANS: D DIF: Easy REF: 2.3
    OBJ: Identify the phases of the Moon. MSC: Remembering

21. Which of the following phases of the Moon occurs when Earth is between the Sun and the Moon?
    a. new
    b. third quarter
    c. full
    d. first quarter

    ANS: C DIF: Easy REF: 2.3
    OBJ: Illustrate the origin of the Moon’s phases. MSC: Remembering

22. What kind of eclipse is shown in the image below?

a. total lunar
b. partial lunar
c. annular
d. total solar

ANS: C DIF: Easy REF: 2.3
OBJ: Distinguish the types of eclipses. MSC: Remembering

23. You observe a lunar eclipse. In what phase must the Moon be?
a. first quarter
b. full
c. third quarter
d. new

ANS: B DIF: Easy REF: 2.3
OBJ: Illustrate the Earth-Moon-Sun geometry necessary for eclipses.
MSC: Understanding

24. At what time of day does the Moon rise above the horizon when it is in the first quarter phase?
a. 6 P.M.
b. midnight
c. 6 A.M.
d. noon

ANS: D DIF: Moderate REF: 2.3
OBJ: Illustrate the origin of the Moon's phases. MSC: Applying

25. If an observer on Earth views the Moon to be in a full phase, in what phase would an observer on the Moon view Earth to have?
a. new
b. waxing crescent
c. waning gibbous
d. full

ANS: A DIF: Moderate REF: 2.3
OBJ: Illustrate the origin of the Moon's phases. MSC: Applying

26. A synodic month is about two days longer than a sidereal month. Why?
a. The Earth-Moon system is revolving around the Sun.
b. The Moon's orbit around Earth is tilted with respect to Earth's orbit around the Sun.
c. The Moon must follow the ecliptic.
d. The Moon's distance from Earth varies across its orbit.

ANS: A DIF: Moderate REF: 2.3
OBJ: Illustrate the origin of the Moon's phases. MSC: Remembering

27. Solar eclipses are rare because the:
a. Moon and the Sun are different sizes on the sky.
b. Moon's orbit around Earth is tilted with respect to Earth's equator.
c. Moon's orbit around Earth is tilted with respect to Earth's orbit around the Sun.
d. Moon is not in the correct phase.

ANS: C DIF: Moderate REF: 2.3
OBJ: Illustrate the Earth-Moon-Sun geometry necessary for eclipses.
MSC: Understanding

28. If you fall under the Moon's penumbra during a solar eclipse, what kind of eclipse will you see?
a. total
b. annular
c. partial
d. nodal

ANS: C DIF: Moderate REF: 2.3
OBJ: Distinguish the types of eclipses. MSC: Remembering

29. Imagine that the Moon's orbit was tilted with respect to the plane of Earth's orbit around the Sun by LESS than the actual value of 5 degrees. What is the most likely consequence?
   a. The phases of the Moon would change more frequently.
   b. The new Moon would be easier to see during the day.
   c. Solar eclipses would be more frequent.
   d. Tides would be weaker.

   ANS: C DIF: Moderate REF: 2.3
   OBJ: Illustrate the Earth-Moon-Sun geometry necessary for eclipses.
   MSC: Understanding

30. While driving at sunrise, you see the Moon high in the sky, with the eastern face bright. What phase must it be?
   a. new
   b. first quarter
   c. full
   d. third quarter

   ANS: D DIF: Difficult REF: 2.3
   OBJ: Identify the phases of the Moon. MSC: Applying

31. At what time of day might the Moon rise when it is in the waning crescent phase?
   a. midnight
   b. 3 A.M.
   c. noon
   d. 3 P.M.

   ANS: B DIF: Difficult REF: 2.3
   OBJ: Illustrate the origin of the Moon's phases. MSC: Applying

32. While a planet is undergoing retrograde motion, what direction does it move relative to the stars?
   a. east to west
   b. west to east
   c. north to south
   d. south to north

   ANS: A DIF: Easy REF: 2.4
   OBJ: Characterize the motions of planets across the night sky. MSC: Remembering

33. Which of the following astronomical sources always appears near the ecliptic?
   a. galaxies
   b. stars
   c. planets
   d. the Milky Way

   ANS: C DIF: Easy REF: 2.4
   OBJ: Describe how planets may be identified in the night sky. MSC: Remembering

34. Which of the following does NOT correctly characterize a planet's motion on the sky?
   a. Planets vary in brightness over the course of a year.
   b. Planets remain near the ecliptic.
   c. Planets occasionally move west to east across the sky during a single night.
   d. Planets change their locations relative to the background stars from night to night.

   ANS: C DIF: Moderate REF: 2.4
   OBJ: Describe how planets may be identified in the night sky. MSC: Understanding

35. If you know that Mercury is going to be visible, at what time and where in the sky would you look for it?
   a. near sunrise, on the eastern horizon
   b. near sunset, on the eastern horizon
   c. at midnight, high in the sky
   d. at midnight, on the western horizon

ANS: A DIF: Moderate REF: 2.4
OBJ: Describe how planets may be identified in the night sky. MSC: Applying

36. From night to night, planets typically move:
 a. east to west relative to the background stars.
 b. east to west at the same rate as the background stars.
 c. west to east relative to the background stars.
 d. away from the ecliptic.

ANS: C DIF: Moderate REF: 2.4
OBJ: Characterize the motions of planets across the night sky. MSC: Remembering

37. The earliest ancient civilization known to have observed and recorded the positions of the planets over long periods was the:
 a. Greeks.
 b. Egyptians.
 c. Romans.
 d. Babylonians.

ANS: D DIF: Easy REF: 2.5
OBJ: Describe how ancient societies approached astronomical phenomena.
MSC: Remembering

38. Megaliths like Stonehenge provided astronomical information to ancient societies, including predictions of:
 a. retrograde motion.
 b. eclipses.
 c. seasonal changes.
 d. Moon phases.

ANS: C DIF: Easy REF: 2.5
OBJ: Describe how ancient societies approached astronomical phenomena.
MSC: Remembering

39. The Babylonians were important to the history of astronomy for all of the following EXCEPT:
 a. recognizing the periodicity of astronomical phenomena.
 b. measuring the diameter of Earth.
 c. offering mathematical predictions of the lengths of days.
 d. keeping detailed records of astronomical observations.

ANS: B DIF: Moderate REF: 2.5
OBJ: Describe how ancient societies approached astronomical phenomena.
MSC: Remembering

40. The Greek figure most responsible for introducing mathematical explanations of natural phenomena was:
 a. Plato.
 b. Thales.
 c. Ptolemy.
 d. Pythagoras.

ANS: D DIF: Easy REF: 2.6
OBJ: Describe the development of mathematical astronomy. MSC: Remembering

41. The earliest ancient civilization known to have developed the geocentric model to explain the motions of the heavens was the:
 a. Egyptians.
 b. Greeks.
 c. Romans.
 d. Babylonians.

ANS: B DIF: Easy REF: 2.6
OBJ: Describe the development of mathematical astronomy. MSC: Remembering

42. The principle of Occam's Razor would favor which of the following hypotheses?
    a. a simple explanation for many experimental results
    b. a rigorous mathematical explanation of an experimental result
    c. an intuitive explanation of an experimental result
    d. a predictive theory

    ANS: A DIF: Easy REF: 2.6
    OBJ: Describe the development of mathematical astronomy. MSC: Applying

43. The astronomer responsible for developing the stellar magnitude system still in use today was:
    a. Herschel.
    b. Ptolemy.
    c. Hipparchus.
    d. Tycho Brahe.

    ANS: C DIF: Easy REF: 2.6
    OBJ: Describe the development of mathematical astronomy. MSC: Remembering

44. The astronomer who used the geocentric model to make accurate predictions of planetary positions was:
    a. Herschel.
    b. Ptolemy.
    c. Hipparchus.
    d. Tycho Brahe.

    ANS: B DIF: Easy REF: 2.6
    OBJ: Describe the development of mathematical astronomy. MSC: Remembering

45. Ptolemy's formulation provided the first successful set of accurate predictions for the:
    a. retrograde motion of the planets.
    b. annual motion of the Sun across the constellations.
    c. precession of Earth's rotation axis.
    d. phases of the Moon.

    ANS: A DIF: Easy REF: 2.6
    OBJ: Explain the ancient Greek model for astronomical motions.
    MSC: Remembering

46. In order to explain the varying speed of the planets across the night sky, Ptolemy's model introduced:
    a. elliptical orbits.
    b. the equant.
    c. the celestial sphere.
    d. synodic months.

    ANS: B DIF: Moderate REF: 2.6
    OBJ: Explain the ancient Greek model for astronomical motions.
    MSC: Understanding

47. According to Ptolemy's model, a planet undergoing retrograde motion on the sky would be moving on its epicycle:
    a. in the opposite direction to the orbit of the epicycle's center.
    b. in the same direction to the orbit of the epicycle's center.
    c. away from Earth.
    d. toward Earth.

    ANS: A DIF: Moderate REF: 2.6
    OBJ: Explain the ancient Greek model for astronomical motions.
    MSC: Understanding

48. The lack of periodic movement of any stars over the course of a year was taken by Greek astronomers to be good evidence for:

a. Platonic ideals.
b. the heliocentric model.
c. Aristotelian physics.
d. the geocentric model.

ANS: D DIF: Moderate REF: 2.6
OBJ: Describe why most Greek astronomers rejected the heliocentric model.
MSC: Applying

49. Place the following ancient astronomers in chronological order, from earliest to most recent:
a. Pythagoras, Hipparchus, Ptolemy, Aristotle.
b. Pythagoras, Aristotle, Hipparchus, Ptolemy.
c. Aristotle, Pythagoras, Ptolemy, Hipparchus.
d. Aristotle, Ptolemy, Hipparchus, Aristotle.

ANS: B DIF: Moderate REF: 2.6
OBJ: Describe the development of mathematical astronomy. MSC: Remembering

50. Which of the following objects will have the largest parallax?
a. a 1-m wide cold object that is 10 km away
b. a 10-m wide hot object that is 8 km away
c. a 5-m wide hot object that is 1 km away
d. a 100-m wide cold object that is 100 km away

ANS: C DIF: Difficult REF: 2.6
OBJ: Describe why most Greek astronomers rejected the heliocentric model.
MSC: Applying

51. What aspect of Ptolemy's model would account for the changes in a planet's brightness as it undergoes retrograde motion?
a. the equant
b. motion along multiple epicycles
c. the velocity of an epicycle
d. the radius of an epicycle

ANS: D DIF: Difficult REF: 2.6
OBJ: Explain the ancient Greek model for astronomical motions.
MSC: Applying

SHORT ANSWER

1. What is a solar day? Why is it longer than a sidereal day?

ANS:
A solar day is the time between consecutive crossings of the same celestial meridian by the Sun. It is longer than a sidereal day because Earth moves around its orbit each day.

DIF: Easy REF: 2.2
OBJ: Illustrate the motions of the Sun and stars on the celestial sphere.
MSC: Remembering

2. Describe the nightly motion of a circumpolar star.

ANS:
A circumpolar star rotates around the celestial pole without rising or setting; it is visible throughout the night.

DIF: Easy REF: 2.2

OBJ: Illustrate the motions of the Sun and stars on the celestial sphere.
MSC: Understanding

3. How does the location at which the Sun rises change across the year, for an observer in the Northern Hemisphere?

ANS:
The Sun rises due east on the equinoxes. On the winter solstice, it rises the farthest south of east, while on the summer solstice it rises the farthest north of east.

DIF: Easy REF: 2.2
OBJ: Relate Earth's tilted rotation axis to the yearly motions of the Sun on the celestial sphere, the seasons, and the length of days. MSC: Remembering

4. The angular size of the Moon is about 30 arcminutes, while its true diameter is 3,500 km. How far from Earth is the Moon?

ANS:
The Earth-Moon distance is about 384,400 km (or 400,000 km using the values given in the problem).

DIF: Moderate REF: 2.2 OBJ: Use the small-angle formula.
MSC: Applying

5. Suppose Earth were tilted 40° relative to the plane of its orbit (rather than 23.5°). How would the seasons change?

ANS:
If Earth's axis had a larger tilt, the temperature variations from summer to winter would be more extreme, because both the angle at which the Sun's rays hit Earth and the length of days and nights would vary more.

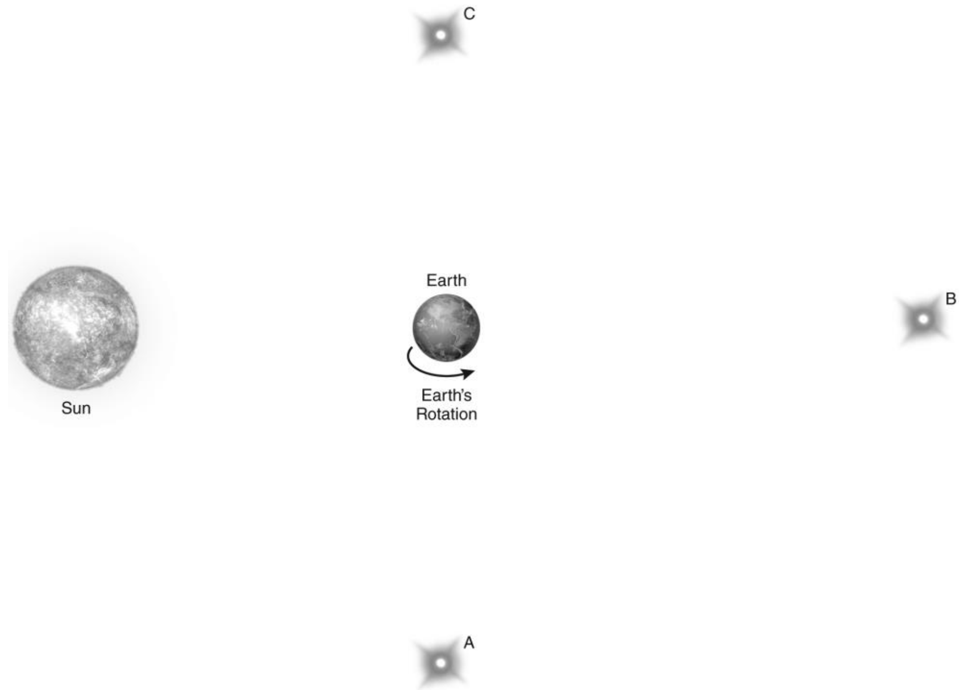
DIF: Moderate REF: 2.2
OBJ: Relate Earth's tilted rotation axis to the yearly motions of the Sun on the celestial sphere, the seasons, and the length of days. MSC: Understanding

6. Suppose you stand on an asteroid that rotates in the opposite sense to Earth (in other words, if viewed from above the solar system they rotate in opposite directions from each other) but otherwise has the same orbital properties as Earth. To an observer on this asteroid, what would the path of the stars look like over the course of one "night"?

ANS:
The stars would rise in the west and set in the east.

DIF: Moderate REF: 2.2
OBJ: Illustrate the motions of the Sun and stars on the celestial sphere.
MSC: Applying

7. The following figure shows Earth, the Sun, and three stars, A, B, and C. Where will these stars appear for an observer on the equator at sunset and at midnight?



ANS:
At sunset, stars A, B, and C appear on the zenith, eastern horizon, and below the eastern horizon, respectively. At midnight, stars A, B, and C appear on the western horizon, zenith, and eastern horizon, respectively.

DIF: Difficult REF: 2.2
OBJ: Relate your position on Earth to the apparent locations of celestial objects.
MSC: Applying

8. Describe the changing appearance of the Moon during a total lunar eclipse.

ANS:
The Moon darkens as it passes into Earth's penumbra, becoming progressively darker until it reaches totality. When it is entirely inside Earth's umbra, the Moon appears reddish thanks to light refracted through Earth's atmosphere. As the Moon passes back into the penumbra, it brightens.

DIF: Easy REF: 2.3 OBJ: Distinguish the types of eclipses.
MSC: Remembering

9. Label the phases of the Moon shown in the following diagram. Assume that the phases occur chronologically from left to right in the figure.

ANS:
From left to right: full, waning gibbous, third quarter, waning crescent, new.

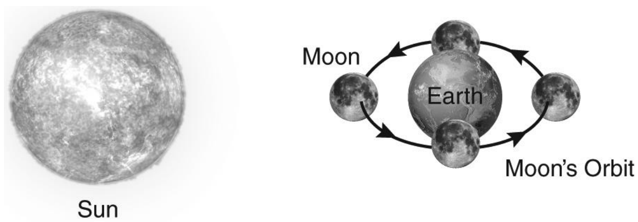
DIF: Moderate REF: 2.3 OBJ: Identify the phases of the Moon.
MSC: Remembering

10. Why are solar eclipses sometimes annular?

ANS:
Both the Earth-Moon distance and the Earth-Sun distance vary. When the Moon is relatively far from Earth, or the Sun relatively close, the angular size of the Moon is somewhat smaller than that of the Sun, so the Moon does not always block the entirety of the Sun's surface.

DIF: Moderate REF: 2.3
OBJ: Illustrate the Earth-Moon-Sun geometry necessary for eclipses.
MSC: Understanding

11. The figure below shows the Earth, Moon, and Sun system at four different points during the month. Label the phase of the Moon that occurs at each point. At what time of day will an observer on Earth see each of these phases reach its highest point in the sky?



ANS:
Clockwise from the top: third quarter, full, first quarter, new. In the same order, an observer on Earth would see these phases highest in the sky at sunrise, midnight, sunset, and noon.

DIF: Difficult REF: 2.3 OBJ: Illustrate the origin of the Moon's phases.
MSC: Analyzing

12. Describe the phenomenon of retrograde motion. What astronomical sources undergo it?

ANS:
Retrograde motion occurs when a planet's night-to-night motion relative to the background stars reverses course; planets usually move west to east relative to those stars, but during retrograde motion they reverse and move east to west. Planets undergo retrograde motion.

DIF: Easy REF: 2.4
OBJ: Characterize the motions of planets across the night sky. MSC: Understanding

13. To the naked eye, planets and stars both appear as points of light on the night sky. Describe two methods to determine whether a particular source is a planet.

ANS:
The two ways to distinguish stars and planets are as follows: (1) stars appear to twinkle, while planets do not; and (2) from night to night, planets move relative to the other stars (usually west to east, but sometimes east to west).

DIF: Moderate REF: 2.4
OBJ: Describe how planets may be identified in the night sky. MSC: Remembering

14. You observe a bright object one night near the North Star at midnight. It does not twinkle. Can this object be a planet? Why or why not?

ANS:
No. The North Star is near the north celestial pole, far from the ecliptic. All the planets appear on or near the ecliptic.

DIF: Moderate REF: 2.4
OBJ: Describe how planets may be identified in the night sky. MSC: Applying

15. Why was the development of cities important to the development of astronomy?

ANS:
Cities allowed specialized groups devoted to astronomical measurements to appear, and their longevity allowed detailed records of observations over long time scales.

DIF: Easy REF: 2.5
OBJ: Describe how ancient societies approached astronomical phenomena.
MSC: Understanding

16. Most Greek astronomers took the lack of a stellar parallax as evidence against the heliocentric model. What is the true explanation for the lack of an apparent parallax?

ANS:
The stars are so distant from us that the parallax cannot be perceived with the naked eye.

DIF: Easy REF: 2.6
OBJ: Describe why most Greek astronomers rejected the heliocentric model.
MSC: Remembering

17. Describe Eratosthenes' most important astronomical achievement.

ANS:
Eratosthenes used the length of midday shadows observed at two different cities to measure the diameter of Earth.

DIF: Easy REF: 2.6
OBJ: Describe the development of mathematical astronomy. MSC: Remembering

18. Compare and contrast the methodology Aristotle used to arrive at his model of the Universe with the scientific method.

ANS:
Aristotle began with a set of beliefs he took to be self-evident and used reason, supported by select observations, to follow its consequences. He did not test his hypotheses with experiments, so did not follow the scientific method.

DIF: Moderate REF: 2.6
OBJ: Describe the development of mathematical astronomy. MSC: Remembering

19. Describe how Ptolemy's geocentric model accounted for the retrograde motions of the planets.

ANS:

The planets in the geocentric model have two components to their motion. The overall rotation around Earth is described by the deferent, which is a circle. But the planet moves on one or more epicycles, which are smaller circles whose centers move along the deferent. The planet moves along the epicycle in the opposite sense from which the epicycle moves along the deferent. The combinations of these two motions can sometimes make the planet move opposite to its normal direction on the sky.

DIF: Difficult REF: 2.6
OBJ: Explain the ancient Greek model for astronomical motions.
MSC: Understanding

20. Suppose you traveled back in time and explained to ancient Greek astronomers the true distance to the nearest star. Why might this single fact have convinced them that the heliocentric model was correct?

ANS:
For the Greeks, the principal empirical objection to the heliocentric model was the lack of a stellar parallax, which must exist if Earth moves in its orbit. However, if they knew the true distance to the stars, they would have realized that the parallax was much too small to observe with the naked eye, so this objection would have been meaningless.

DIF: Difficult REF: 2.6
OBJ: Describe why most Greek astronomers rejected the heliocentric model.
MSC: Understanding