

Astronomy Today, 7e (Chaisson/McMillan)

Chapter 1 Charting the Heavens: The Foundations of Astronomy

1.1 True/False

1) The distances to bodies in the solar system are a few light minutes to light hours.

Answer: TRUE

Diff: 2

Section Ref: 1.1

2) It was Aristotle who used the scientific method to show the Earth was a sphere.

Answer: TRUE

Diff: 2

Section Ref: 1.2

3) Constellations are close clusters of stars, all at about the same distance from the Sun.

Answer: FALSE

Diff: 1

Section Ref: 1.3

4) From the South Pole, Polaris would appear directly overhead.

Answer: FALSE

Diff: 1

Section Ref: 1.3

5) Only at the equator are all the stars visible over the course of the year.

Answer: TRUE

Diff: 1

Section Ref: 1.3

6) Over the course of a night, Polaris moves less than any other visible star in the sky.

Answer: TRUE

Diff: 2

Section Ref: 1.3

7) There are 3,600 arc seconds in a degree.

Answer: TRUE

Diff: 2

Section Ref: More Prec. 1-1

8) A star with a right ascension of 2.6 hrs will rise 2.6 hours after the vernal equinox.

Answer: TRUE

Diff: 3

Section Ref: More Prec. 1-1

9) In general, the brightest star in a given constellation is designated as alpha.

Answer: TRUE

Diff: 1

Section Ref: More Prec. 1-2

10) Latitude and right ascension are coordinate systems used to find objects on the Celestial Sphere.

Answer: FALSE

Diff: 1

Section Ref: More Prec. 1-2

11) If your latitude is 40 degrees north, then stars that pass through your zenith have a declination of +40 degrees.

Answer: TRUE

Diff: 1

Section Ref: More Prec. 1-2

12) The south celestial pole is located at a declination of -90 degrees.

Answer: TRUE

Diff: 1

Section Ref: More Prec. 1-2

13) At apogee the moon is at its farthest from earth and thus appears smaller than normal. Because of this it can produce only annular solar eclipses, but not total solar eclipses.

Answer: TRUE

Diff: 2

Section Ref: More Prec. 1-2

14) If a star rises about 9 PM tonight, and with the sidereal day being four minutes less than the solar one, then in a month it will rise about 7 PM.

Answer: TRUE

Diff: 3

Section Ref: 1.4

15) From Earth, the Sun and Moon have about the same angular diameter.

Answer: TRUE

Diff: 1

Section Ref: 1.6

16) The Full Moon rises at sunrise, and sets at sunset.

Answer: FALSE

Diff: 1

Section Ref: 1.6

17) From full moon to third quarter moon takes about a week.

Answer: TRUE

Diff: 2

Section Ref: 1.6

18) The first quarter moon will rise about noon, and set about midnight.

Answer: TRUE

Diff: 2

Section Ref: 1.6

19) As it orbits the Earth, the Moon appears to move eastward about its own diameter every hour.

Answer: TRUE

Diff: 3

Section Ref: 1.6

20) The parallax shift of a star would be greater if viewed from Mars than from Earth.

Answer: TRUE

Diff: 2

Section Ref: 1.7

1.2 Multiple-Choice

1) Which of the choices below correctly lists things in order from largest to smallest?

A) Local Group, Solar System, Milky Way, Universe

B) Universe, Milky Way, Local Group, Solar System

C) Solar System, Local Group, Universe, Milky Way

D) Universe, Local Group, Milky Way, Solar System

E) Milky Way, Universe, Solar System, Local Group

Answer: D

Diff: 2

Section Ref: 1.1

2) Modern scientific theories are NOT:

A) testable.

B) continuously tested.

C) simple.

D) perfect.

E) elegant.

Answer: D

Diff: 1

Section Ref: 1.2

3) Aristotle's hypothesis was that:

A) lunar eclipses were created by our shadow.

B) only a spherical Earth would always cast a circular shadow on the Moon.

C) lunar eclipses would have to happen every full moon.

D) the Sun lay at the center of the planet orbits.

E) the Moon orbited the Earth.

Answer: B

Diff: 2

Section Ref: 1.2

4) About how many stars are visible on a clear, dark night with the naked eye alone?

A) a few dozen

- B) a few hundred
- C) a few thousand
- D) tens of thousands
- E) millions and millions

Answer: C

Diff: 1

Section Ref: 1.3

5) Into how many constellations is the celestial sphere divided?

- A) 12
- B) 44
- C) 57
- D) 88
- E) 110

Answer: D

Diff: 1

Section Ref: 1.3

6) What are constellations?

- A) Groups of galaxies gravitationally bound and close together in the sky
- B) Groups of stars making an apparent pattern in the celestial sphere
- C) Groups of stars gravitationally bound and appearing close together in the sky
- D) Ancient story boards, useless to modern astronomers
- E) Apparent groupings of stars and planets visible on a given evening

Answer: B

Diff: 2

Section Ref: 1.3

7) Where on Earth would you be if Polaris was at your zenith?

- A) North Pole
- B) Arctic Circle
- C) Tropic of Cancer
- D) Equator
- E) It lies overhead everywhere on Earth.

Answer: A

Diff: 2

Section Ref: 1.3

8) Where on Earth can you observe all the stars in the sky over an entire year?

- A) North Pole
- B) Arctic Circle
- C) Tropic of Cancer
- D) Equator
- E) Everyone on Earth can see the whole sky.

Answer: D

Diff: 2

Section Ref: 1.3

9) In general, what is true of the alpha star in a constellation?

- A) It is the brightest star in the constellation.
- B) It is the easternmost star in the constellation.
- C) It is the westernmost star in the constellation.
- D) It is the reddest star in the constellation.
- E) It is the star that is closest to Earth.

Answer: A

Diff: 1

Section Ref: More Prec. 1-2

10) What is the range of values for declination?

- A) +90 to -90 degrees
- B) +180 to -180 degrees
- C) +23.5 to -23.5 degrees
- D) 0 to 23 hours
- E) Correct answer is not given.

Answer: A

Diff: 1

Section Ref: More Prec. 1-2

11) What is the range of values for Right Ascension?

- A) 90 degrees to 0 degrees
- B) 0 to 360 degrees
- C) +23.5 to -23.5 degrees
- D) 0 to 12 hours
- E) 0 to 23 hours

Answer: E

Diff: 1

Section Ref: More Prec. 1-2

12) While watching a star, you see it moves 15 degrees across the sky. How long have you been watching it?

- A) 1 hour
- B) 3 hours
- C) 15 minutes
- D) 15 seconds
- E) 1 minute

Answer: A

Diff: 2

Section Ref: More Prec. 1-2

13) Which statement about declination is FALSE?

- A) Polaris is almost at +90 degrees.
- B) Stars passing your zenith have a declination equal to your local latitude.
- C) Its origin is the celestial equator.
- D) It is measured eastward in units of time.
- E) It is much like latitude on the earth's globe.

Answer: D

Diff: 2

Section Ref: More Prec. 1-2

14) A star with a right ascension of 1.0 hours will rise

- A) 1.0 hours before the vernal equinox.
- B) 13.0 hours before the vernal equinox.
- C) 1.0 hour after the vernal equinox.
- D) 11.0 hours after the vernal equinox.
- E) at the same time as the vernal equinox.

Answer: C

Diff: 3

Section Ref: More Prec. 1-2

15) Which statement about Right Ascension is FALSE?

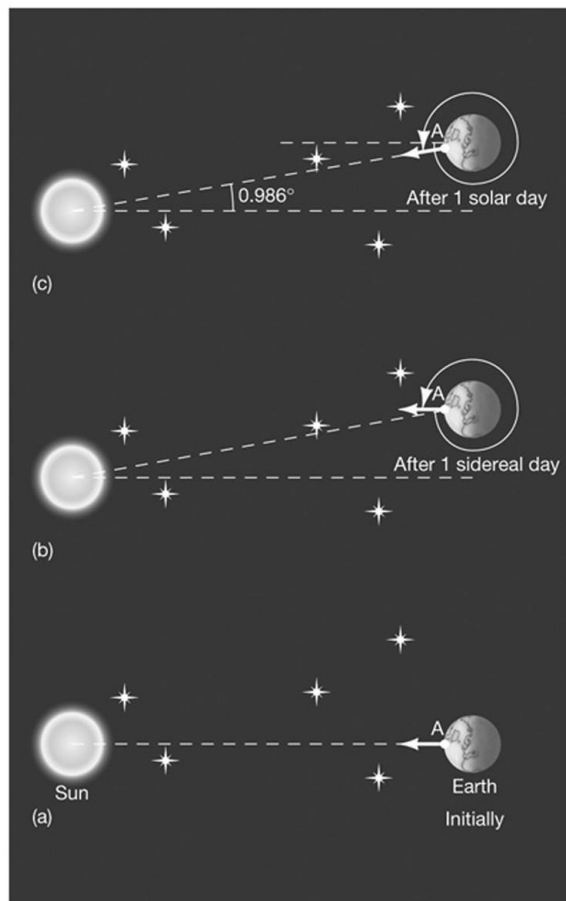
- A) Each hour is equal to 15 degrees of sky.
- B) Its origin is the Vernal Equinox.
- C) It is very similar to latitude on the Earth.
- D) It turns the sky into a vast 24 hour clock face.
- E) It is measured eastward in units of time.

Answer: C

Diff: 3

Section Ref: More Prec. 1-2

16) This diagram explains



- A) the difference between solar time and sidereal time.
- B) precession.
- C) the solar day's relation to the Moon.
- D) the sidereal day's relation to the seasons.
- E) the reason for the solstices.

Answer: A

Diff: 1

Section Ref: 1.4, Fig. 1.13

17) How long is the precession cycle?

- A) 1 day
- B) 29.5 days
- C) 365.24 days
- D) 18 years, 11.3 days
- E) 26,000 years

Answer: E

Diff: 1

Section Ref: 1.4

18) The place the Sun stops its northward motion along the ecliptic is the:

- A) equator.
- B) prime meridian.

- C) summer solstice.
- D) vernal equinox.
- E) node of the ecliptic.

Answer: C

Diff: 1

Section Ref: 1.4

19) The places where the Sun crosses the equator are called the:

- A) annalemmas.
- B) prime meridians.
- C) zeniths.
- D) equinoxes.
- E) solstices.

Answer: D

Diff: 1

Section Ref: 1.4

20) A year is defined as

- A) the time it takes for Earth to complete a rotation on its axis.
- B) the time it takes for the moon to complete an orbit of Earth.
- C) the time it takes for the moon to complete a phase cycle.
- D) the time it takes for Earth to complete an orbit around the Sun.
- E) the time it takes for the Sun to complete an orbit around Earth.

Answer: D

Diff: 2

Section Ref: 1.4

21) From a location in the United States of America, a star is observed to be rising due East. Where will this star be located 6 hours later?

- A) Directly overhead.
- B) High in the Northern sky.
- C) High in the southern sky.
- D) Setting due West.
- E) The location of the star cannot be determined from the information given.

Answer: C

Diff: 2

Section Ref: 1.4

22) Which statement about the ecliptic is FALSE?

- A) The Sun appears to move about a degree per day eastward long it.
- B) It is tilted 23.5 degrees with respect to the equator.
- C) The year is marked by the Sun's return to the same place along it.
- D) The Moon can never leave it, but moves twelve times faster than the Sun.
- E) The major planets stay close to it, but not always on it.

Answer: D

Diff: 2

Section Ref: 1.4

23) You note that a particular star is directly overhead. It will be directly overhead again in

- A) 1 hour.
- B) 12 hours.
- C) 23 hours 56 minutes.
- D) 24 hours.
- E) 24 hours 4 minutes.

Answer: C

Diff: 2

Section Ref: 1.4

24) That Polaris will not always be the pole star is due to

- A) the sidereal day being shorter than the solar day.
- B) precession shifting the celestial pole.
- C) the Moon following the ecliptic, instead of the equator.
- D) the earth's revolution being slightly less than exactly 365.25 days.
- E) the Solar winds blowing the earth farther away from the Sun.

Answer: B

Diff: 2

Section Ref: 1.4

25) What celestial line is a product of the Earth's orbit around the Sun?

- A) Ecliptic
- B) Prime Meridian
- C) Equator
- D) Galactic Plane
- E) Analemma

Answer: A

Diff: 2

Section Ref: 1.4

26) If your astrological sign is Aries, the Sun should be in the constellation Aries on your birthday. The dates, according to astrological tradition, during which the Sun is in the constellation Aries are March 21 to April 20th. In which constellation is the Sun actually in, during this time period?

- A) Aquarius
- B) Pisces
- C) Aries
- D) Taurus
- E) Gemini

Answer: B

Diff: 2

Section Ref: 1.4

27) Where would you be if the Sun sets for six continuous months, beginning on September 23rd?

- A) North Pole
- B) Arctic Circle
- C) Equator
- D) Antarctic Circle
- E) South Pole

Answer: A

Diff: 2

Section Ref: 1.4

28) When is the Sun located at 6 hours RA, -23.5 degrees declination?

- A) Vernal Equinox
- B) Summer Solstice
- C) Autumnal Equinox
- D) Winter Solstice
- E) Sun is never found at this position.

Answer: E

Diff: 3

Section Ref: 1.4

29) Where would you be if the Sun passes through your zenith on December 21st?

- A) Equator
- B) Tropic of Cancer
- C) Tropic of Capricorn
- D) Antarctic Circle
- E) South Pole

Answer: C

Diff: 3

Section Ref: 1.4

30) When the sun rises it is located in the constellation Gemini. When the sun sets later that same day it will be

- A) in the constellation Aries.
- B) in the constellation Taurus.
- C) in the constellation Gemini.
- D) in the constellation Cancer.
- E) in the constellation Leo.

Answer: C

Diff: 3

Section Ref: 1.4

31) Which statement about the length of a day is FALSE?

- A) At the North Pole, the day lasts six months, then six months of night.
- B) At the equator, every day is twelve hours long, then twelve hours of night.
- C) For the United States, June 21st will be the longest day.
- D) The solar day is four minutes longer than the sidereal one.
- E) The sidereal day includes both the Earth's rotation and revolution around the Sun.

Answer: E

Diff: 3

Section Ref: 1.4

32) If Taurus is now rising at sunset, which constellation will rise at sunset next month?

- A) Scorpius
- B) Aquarius
- C) Gemini
- D) Aries
- E) Pisces

Answer: C

Diff: 3

Section Ref: 1.4

33) A solar eclipse can only happen during a:

- A) new moon.
- B) solstice.
- C) first quarter moon.
- D) full moon.
- E) perihelion passage of the Sun.

Answer: A

Diff: 1

Section Ref: 1.6

34) A lunar eclipse can only happen during a:

- A) new moon.
- B) equinox.
- C) full moon.
- D) perigee.
- E) aphelion.

Answer: C

Diff: 1

Section Ref: 1.6

35) If the Moon rose tonight at 6 PM, then tomorrow it will rise about:

- A) the same time.
- B) 7 PM.
- C) 5 PM.
- D) dawn.
- E) midnight.

Answer: B

Diff: 1

Section Ref: 1.6

36) If you are in the Moon's umbral shadow, then you will witness

- A) nighttime.
- B) a total solar eclipse.
- C) a total lunar eclipse.
- D) a partial solar eclipse.
- E) some kind of lunar eclipse.

Answer: B

Diff: 1

Section Ref: 1.6

37) Which statement about the first quarter moon is FALSE?

- A) It rises about noon.
- B) From the Earth, it appears 25% sunlit.
- C) It is the half moon of the evening sky.
- D) It is highest in the sky at sunset.
- E) It occurs about a week after new moon.

Answer: B

Diff: 2

Section Ref: 1.6

38) If new Moon fell on March 2nd, what is the Moon's phase on March 14th?

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

Answer: C

Diff: 2

Section Ref: 1.6

39) Why is there a two day difference in the sidereal and synodic months?

- A) The Moon speeds up at perigee, and slows down at apogee.
- B) The sidereal day is four minutes shorter than the solar day, and it adds up.
- C) The Earth is closer to the Sun during the sidereal month.
- D) The Earth is also revolving around the Sun, so the Moon must "catch up".
- E) The Moslem lunar year is only 354 days long, on average.

Answer: D

Diff: 2

Section Ref: 1.6

40) What conditions are necessary for an annular solar eclipse?

- A) new moon on equator at perigee
- B) full moon on ecliptic at perihelion
- C) new moon on ecliptic at perigee
- D) new moon on equator at apogee
- E) new moon on ecliptic at apogee

Answer: E

Diff: 2

Section Ref: 1.6

41) What conditions are necessary for a total solar eclipse?

- A) new moon on ecliptic near perigee
- B) full moon on ecliptic near aphelion
- C) new moon on equator at perigee
- D) full moon on equator at perigee
- E) new moon on ecliptic near aphelion

Answer: A

Diff: 2

Section Ref: 1.6

42) Driving eastward just before sunrise, if you observe the moon in the eastern sky, its phase must be

- A) Full Moon
- B) First Quarter
- C) Waxing Gibbous
- D) Waning Crescent
- E) New Moon

Answer: D

Diff: 2

Section Ref: 1.6

43) When the Moon is directly opposite the Sun in the sky, its phase is

- A) new.
- B) waxing or waning crescent
- C) first or third quarter.
- D) waxing or waning gibbous.
- E) full.

Answer: E

Diff: 2

Section Ref: 1.6

44) The Last Quarter phase of the moon

- A) rises at sunrise
- B) sets at sunrise
- C) crosses the meridian at sunrise
- D) rises at sunset
- E) sets at sunset

Answer: C

Diff: 2

Section Ref: 1.6

45) What conditions are necessary for a partial solar eclipse?

- A) new moon on ecliptic, with us in the penumbral shadow
- B) full moon on equator, with us in the umbral shadow
- C) new moon at perigee
- D) full moon at apogee
- E) first or third quarter moon at a node

Answer: A

Diff: 2

Section Ref: 1.6

46) Some type of solar eclipse will happen about:

- A) every month at new moon.
- B) every week at full moon.
- C) every month at full moon.
- D) about every six months at new moon.
- E) every year at new moon.

Answer: D

Diff: 3

Section Ref: 1.6

47) The star Wolf 1061 has a parallax of 2.34 arcseconds, while the star Ross 652 has a parallax of 1.70 arcseconds. What can you correctly conclude?

- A) Both stars are outside the Milky Way galaxy.
- B) Wolf 1061 must have a larger proper motion than Ross 652.
- C) Ross 652 must have a larger proper motion than Wolf 1061.
- D) Ross 652 is closer to Earth than Wolf 1061.
- E) Wolf 1061 is closer to Earth than Ross 652.

Answer: E

Diff: 2

Section Ref: 1.7

48) The Earth's circumference was first determined by:

- A) Aristotle using lunar eclipses.
- B) Pythagoras with geometry.
- C) Hipparchus with stellar parallaxes.
- D) Eratosthenes with solstice shadows.
- E) Aristarchus with first and third quarter moon timings.

Answer: D

Diff: 2

Section Ref: 1.7

49) Which of the following describes parallax?

- A) It is best measured over exactly one year intervals.
- B) It is inversely proportional to the distance to the star.
- C) It was first observed by Galileo with his new telescope.
- D) It is only applicable to objects within the solar system.
- E) It is more accurate as the distances to objects becomes greater.

Answer: B

Diff: 3

Section Ref: 1.7

- 50) A star with a large parallax
A) is at a great distance from Earth.
B) is moving at a great speed with respect to Earth.
C) is at a short distance from Earth.
D) is moving at a slow speed with respect to Earth.
E) is not moving with respect to Earth.

Answer: C

Diff: 3

Section Ref: 1.7

1.3 Fill-in-the-Blank

- 1) The distances to other stars is best measured in _____.

Answer: light years

Diff: 1

Section Ref: 1.1

- 2) The Milky Way galaxy contains about _____ stars.

Answer: 100 billion

Diff: 1

Section Ref: 1.1

- 3) A _____ is a framework of ideas and assumption used to explain some set of observations and make predictions about the real world.

Answer: theory

Diff: 1

Section Ref: 1.2

- 4) If a theory is testable, its underlying _____ and its _____ can be exposed to experimental verification.

Answer: assumptions; predictions

Diff: 2

Section Ref: 1.2

- 5) Astronomical objects are viewed against the background of the _____.

Answer: celestial sphere

Diff: 1

Section Ref: 1.3

- 6) The celestial sphere appears to move fastest above the _____.

Answer: equator

Diff: 1

Section Ref: 1.3

7) The prime meridian of the sky coordinates is the Sun's position at the _____.

Answer: Vernal Equinox

Diff: 2

Section Ref: More Prec. 1-2

8) The Sun's lowest position in the sky occurs at the _____.

Answer: winter solstice

Diff: 1

Section Ref: 1.4

9) The two days when the Sun rises due east and sets due west are the _____.

Answer: equinoxes.

Diff: 1

Section Ref: 1.4

10) The four extra minutes in the solar day are due to our _____ around the Sun.

Answer: revolution

Diff: 1

Section Ref: 1.4

1.4 Short Answer

1) Pensacola, Florida lies at a latitude of 30 degrees north. Where is Polaris in its sky?

Answer: 30 degrees high in the north

Diff: 3

Section Ref: 1.2

2) How far above or below the equator can the Sun appear to move? Why?

Answer: The earth's axial tilt means the Sun's declination can reach 23.5 degrees north or south of the equator at the solstices.

Diff: 1

Section Ref: 1.4

3) How far above or below the ecliptic can the Sun move?

Answer: The Sun follows the ecliptic eastward across the sky, never leaving it.

Diff: 1

Section Ref: 1.4

4) Which is longer, the sidereal or solar day? By how much?

Answer: The solar day is approximately four minutes longer than the sidereal day.

Diff: 1

Section Ref: 1.4

5) How far above and below the celestial equator can the Sun move?

Answer: The Sun never appears more than 23.5 degrees above or the below the celestial equator.

Diff: 2

Section Ref: 1.4

6) If intending to teach his students the constellations by season, why would an astronomy

instructor be advised to always assign the stars in the current western sky at the beginning of each term?

Answer: As the earth revolves around the Sun, the Sun appears to move one degree eastward per day. These stars are, therefore, soon lost in the Sun's glare.

Diff: 2

Section Ref: 1.4

7) If Sirius transits my local meridian tonight at 6:43 PM, when will it transit tomorrow?

Answer: At 6:39 PM tomorrow night, as the earth spins once in a sidereal day

Diff: 3

Section Ref: 1.4

8) If the Moon rises exactly at sunset, what will its phase be? Why?

Answer: The phase will be full because it is rising opposite the Sun. If the Moon is directly opposite the Sun in the sky, its phase will be full.

Diff: 2

Section Ref: 1.6

9) The first quarter Moon rises about noon today; what will its phase be, and when will it rise tomorrow?

Answer: It will be waxing gibbous, and rise about 1 PM by the next day.

Diff: 2

Section Ref: 1.6

10) Why are some solar eclipses total, and others annular?

Answer: The Moon's orbit is not a perfect circle. When the Moon is closer to Earth it is big enough to cover the Sun completely; when it is too far away it appears smaller, so a ring of sunlight is still seen.

Diff: 2

Section Ref: 1.6

1.5 Essay

1) In what sense is our unique Earth just "ordinary" from a cosmic perspective?

Answer: We are not in the center of our solar system, which is not in the center of the Milky Way, which is just one of billions of known galaxies in the universe. Our planet is made of common minerals that are abundant throughout the known universe, and are probably part of almost any planet forming around any other star now.

Diff: 2

Section Ref: 1.1

2) How did Aristotle apply the scientific method to lunar eclipses?

Answer: He noted that during all lunar eclipses, the Earth always casts a circular shadow considerably larger than the Moon's disk, so hypothesized the Earth was in fact a sphere and predicted that future eclipses would show the same curved shadow of Earth.

Diff: 2

Section Ref: 1.2

3) Of all visible objects in the celestial sphere, which appears to move the least? Why?

Answer: Polaris, because it lies very close to the north celestial pole, making everything else

seem to revolve around it as the Earth rotates on its axis daily.

Diff: 2

Section Ref: 1.3

4) What is the significance of the zodiacal signs, and why can all twelve not be seen on a given night?

Answer: They are twelve constellations along the ecliptic, the apparent path of the Sun. Thus the Sun's glare will typically hide at least two of them at any given time.

Diff: 2

Section Ref: 1.4

5) Why are summers hotter than winters? Relate this to the Sun's position in the celestial sphere and the length of the days.

Answer: The Sun is 47 degrees higher in the noon sky for northern hemisphere observers in June than in December, and also gives several extra hours of daylight as well.

Diff: 2

Section Ref: 1.4

6) Compare hours of Right ascension to time zones on the Earth.

Answer: Like time zones, hours of RA are 15 degrees wide, and they run eastward across the sky from the Vernal Equinox, much like the time zones originate from the Prime Meridian.

Diff: 3

Section Ref: 1.4

7) What are some observable consequences of the Earth's revolution around the Sun in relation to the zodiacal constellations?

Answer: Month by month, our revolution causes the Sun to appear to move eastward by about a degree per day, or through a new sign of the zodiac every month.

Diff: 3

Section Ref: 1.4

8) Why can many more people witness a total lunar eclipse than a total solar eclipse?

Answer: For a total solar eclipse to be seen, the observer must be in the Moon's umbra, a shadow only about a hundred miles across, while everyone on the night side of the Earth can look up to witness the full moon moving through our shadow.

Diff: 2

Section Ref: 1.6

9) On April 8, 2005, observers off New Zealand observe an annular eclipse at sunrise, and those in Columbia see an annular eclipse at sunset. Yet in the middle of the path, off the Galapagos Islands, cruise ships are advertising that they will show their guests a total solar eclipse. How can this be possible?

Answer: The Earth's radius is about 6,000 km (4,000 miles), so this means that at noon, when the Sun is highest overhead, the cruise ship passengers will be just close enough to the Moon to see it big enough to cover the Sun, if only for a few seconds.

Diff: 3

Section Ref: 1.6

10) Describe how Erastotenes measured the circumference of our planet.

Answer: Using the fact that the noon solstice sun was directly overhead at Syene, on the Tropic of Cancer, yet was 7 degrees south of his zenith in Alexandria, Erastotenes realized this was due to the curvature of the earth, and that the 7 degrees was about 1/50th of the earth's total circumference, so the Earth must be about fifty times larger in circumference than the 800 kilometer separation between Alexandria and Syene, or about 40,000 kilometers around.

Diff: 3

Section Ref: 1.7