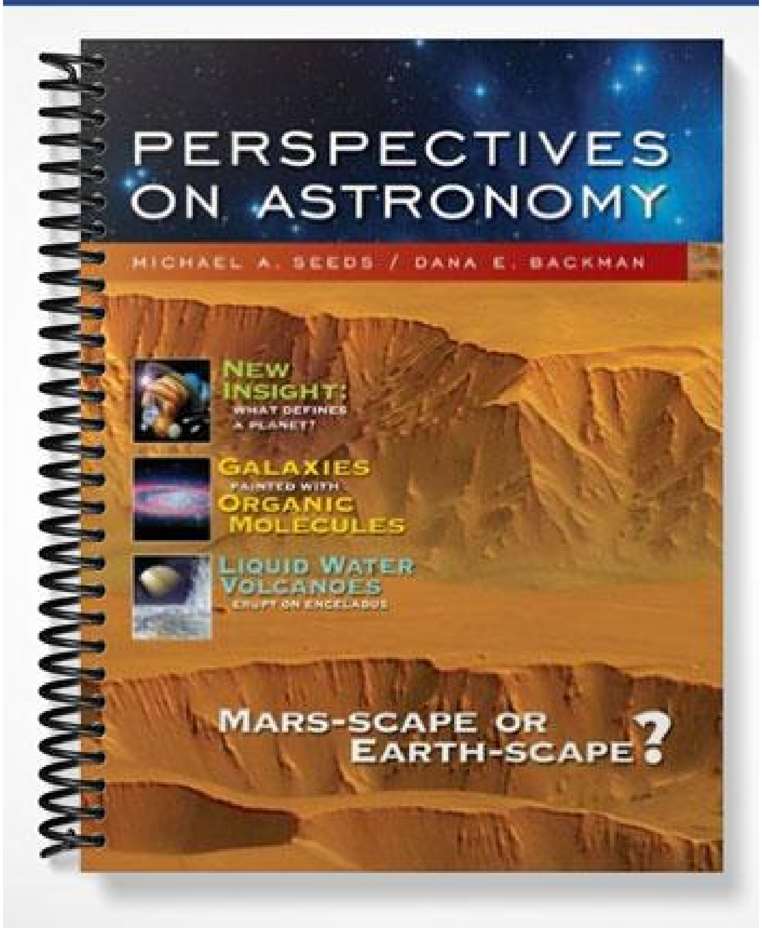
# TEST BANK


PERSPECTIVES
ON ASTRONOMY
MICHAEL A. SEEDS / DANA E. BACKMAN
NEW
INSIGHT:
WHAT DEFINES
A PLANET?
GALAXIES
PAINTED WITH
ORGANIC
MOLECULES
LIQUID WATER
VOLCANOES
ERUPT ON ENCELADUS
MARS-SCAPE OR
EARTH-SCAPE?

## CHAPTER 2

# USER'S GUIDE TO THE SKY: PATTERNS AND CYCLES

**CHAPTER OUTLINE**

2-1 The Stars
- Constellations
- The Names of the Stars
- The Brightness of Stars

2-2 The Sky and Its Motions
- The Celestial Sphere
- Precession
- *Window on Science 2-1*
  - *Frameworks for Thinking about Nature: Scientific Models*
- *The Sky Around Us*

2-3 The Cycle of the Sun
- The Annual Motion of the Sun
- The Seasons
- *The Cycle of the Seasons*
- *Window on Science 2-2*
  - *Astrology and Pseudoscience: Misusing the Rules of Science*

2-4 The Cycles of the Moon
- The Motion of the Moon
- The Cycle of Moon Phases
- *The Phases of the Moon*

2-5 Eclipses
- Solar Eclipses
- Lunar Eclipses

**KEY CONCEPTS**
This chapter describes the motions and cycles of naked-eye objects in the sky. In the times before people moved indoors using artificial lighting, people observed these cycles for themselves. If at all possible, convince your students to start observing the sky for themselves. Some instructors assign "sky journals" with either prescribed or open assignments for watching and recording the sky.

The chapter begins with constellations, naming conventions, and the magnitude system. The magnitude system is difficult even for science majors, so don't be surprised if it takes some repetition for students to get it straight. The concept of precession is also covered fairly thoroughly.

The celestial sphere is important not only for its usefulness in describing and predicting the sky's cycles, but as discussed in Window on Science 2-1, it is an example of a scientific model that does not have to be correct to be useful. After discussing this idea it is probably worth the time to discuss other useful-but-inaccurate scientific models such as the Bohr atom.

This chapter also covers two concepts that constitute perhaps the most widespread of all astronomical misconceptions: why the Earth experiences seasons, and why the moon shows phases. Most of your students will have pre-conceived answers to these questions, and many of those pre-conceived ideas will be wrong. Just telling them the correct answer is probably not enough; it may require making predictions using their own models, and then finding those predictions to be wrong. Luckily both of these concepts are inherently three-dimensional, and doing demonstrations as discussed below can help.

When asked "why is it warmer in the summer than in the winter," the most common misconception is that Earth is closer to the sun in the summer. Many of the students were (incorrectly) taught this in grade school, so it can be a very deep-seated belief. It is also true that this is a perfectly reasonable hypothesis that just doesn't happen to be true. The ellipticity of Mars' orbit does contribute to its seasonal variations. For those students who say correctly that the cause of seasons is the Earth's tilt, further questioning will often reveal that they believe that it is warmer in the summer because the hemisphere tilted towards the sun is *closer* to the sun. They also may have no idea as to "what" is tilted with respect to "what." It is important to address these common misconceptions directly.

Almost as common is the idea that the moon exhibits phases because part of the moon is blocked from our sight. Most students do not have a three-dimensional picture of solar illumination in their mental models. Again, three-dimensional demonstrations in the classroom are essential.

A positive aspect of seasons and moon phases is that it offers your students a chance to think critically and use the mental models they create. Unlike some parts of introductory astronomy where the test questions almost have to resort to pure recall; it is possible to ask questions that require real thinking. In addition to the useful review questions at the end of the chapter, it is possible to elaborate on the "what time does a given phase of the moon rise or set" as described briefly on page 25. As suggested on page 22, it is also very useful to consider "what if" questions, such as what would the seasons be like if Earth's equator were inclined more or less than the present 23.5º.

The final concept in this chapter is that of solar and lunar eclipses. The mechanics of eclipses are fairly easily understood by most students once their previous misconceptions are addressed, but the question of "why is there not an eclipse during every full and new moon" is more subtle. This question also requires a three-dimensional demonstration. It also points out the problems with having diagrams that are (sometimes necessarily) not to scale.

**Demonstration Ideas:**
(1) Try to have the class meet outside at night at least once. A flashlight with a fairly well focused beam makes a good pointer when working outside. Even with a large group you can use the flashlight to point out the locations of the north celestial pole, zenith, celestial equator, etc. Pointing out some of the bright constellations in addition to the celestial sphere can help students to begin to watch the sky.

(2) Use a planetarium program such as The Sky, Redshift, or Voyager to demonstrate the daily motions of the sky as seen from different latitudes. (Even better, use a real planetarium!)

(3) A planetarium program also allows you to do several very effective computer simulations to demonstrate the annual motion of the sun. Try watching the motion of the sun along the horizon at sunset or sunrise throughout the year, or using daytime mode to watch the position of the sun at noon over the course of a year.

(4) When discussing the reasons for seasons, demonstrate the motion of Earth around the sun using a globe and a light bulb on a ring stand. As you start, emphasize the fact that the rotation axis of the Earth always points at the same point in space, i.e. the North Celestial Pole (NCP). If you hand them the globe and tell them to move it around a light bulb, most students will keep the axis tipped towards the light bulb rather than towards a fixed point in space. It can be useful to pin something on the north wall of the classroom (an "N" works nicely) to represent the NCP. This comes in handy later when reviewing the subject; simply pointing at the "N" reminds the students of the three-dimensional demonstration. During the demonstration, be sure to demonstrate the counter-examples, i.e. what are the differences if Earth is not tilted, or if it is tilted by 90 degrees?

(5) One simple way of addressing students' pre-conceived scale of the Earth-Moon system is as follows. At the beginning of class you can draw a circle with a diameter of 4 cm on the board. This circle represents the Earth. Have prepared enough sticky notes such that there is one per student, each with a 1 cm diameter circle drawn on it. Each student should put their name on a sticky note, and then put the sticky note on the board in the spot that best represents the true scale of the Earth-Moon system. You can even offer a prize such as an astronomy poster for the person who comes the closest. The correct answer is that the moon is about ¼ the diameter of the Earth, but is about 30 Earth-diameters distant, or about 120 cm on this scale. After years of looking at moon-phase diagrams that show a completely different scale, most students will guess a distance much smaller than this.

(6) The phases of the moon really need to be demonstrated three-dimensionally. This requires a fairly bright light such as a clear 200-W bulb. For a small class, have each student hold a small Styrofoam ball at arm's length while rotating; the student is Earth, and the light bulb is the sun. For a large class, hold up a basketball in the light to show how half of it is always illuminated. Make it clear that *you* are Earth. Then demonstrate the lunar phases by holding the basketball at arm's length and slowly moving it around you in a circle parallel to the floor, pointing out which parts of the ball you can see as it goes around.

(7) One convincing demonstration that your students can do by themselves is the following assignment. Starting about three days after new moon, have them go out at sunset every night until the moon becomes full. Each night they should both sketch the moon, and measure the angular distance between the sun and moon in "fists" (the angle subtended by one of their own fists held at arm's length). Before they turn it in, have them make a scale drawing where they sketch the correct phase at the measured number of fists from the sun. Make sure you try this yourself once before you assign it so that you can appreciate the pitfalls!

(8) It is also possible to use a planetarium program to demonstrate the progression of the moon in its orbit. Try showing the position and phase of the moon at the same time every night for a month.

(9) A simple but effective demonstration of why we only see one side of the moon can be done with one volunteer in your classroom. First ask the students why we always see the same side of the moon. Many of them will venture that the moon doesn't rotate. Have the volunteer stand in front of the class; the volunteer is the Earth. As the moon, the instructor should circle around the volunteer. If you always point towards the same direction in space – i.e., if you keep facing the same wall – the volunteer will quickly see your back. If, however, you slowly circle the volunteer such that you are always facing her, you will discover that you have rotated exactly once for each revolution.

(10) The answer to "why is there not an eclipse every month" is also best demonstrated three-dimensionally. Use a light bulb (or anything, really) to represent the sun, and then two balls of different sizes for Earth and the moon. Have the "moon" orbit around "Earth", pointing out the five degree tilt in the lunar orbit with respect to the ecliptic. When exaggerated for the sake of the demonstration, it is fairly easy for students to see why there can only be an eclipse when the moon is passing through the ecliptic plane, or about every six months. All three bodies just need to be lined up!

**RESOURCE INTEGRATION**

| **Class Preparation/<br>Lecture Tools** | **Student Mastery:<br>Homework/Tutorials/Labs** |
|---|---|
| **Astronomical Society of the Pacific**<br>http://www.astrosociety.org/education.html<br>A long list of programs, activities, and resources, including *Web links for Teaching Introductory Astronomy to College Non-science Majors* and *Selected Bibliographies* for background reading.<br><br>**The Astronomy Center**<br>http://astronomycenter.org<br>A collection of digital resources for college-level introductory astronomy. The site is funded by the American Astronomical Society, the American Association of Physics Teachers, and the National Science Digital Library, and includes opportunities for discussion with other users.<br><br>**Multimedia Manager Instructor's Resource CD-ROM**<br>Customizable lecture tool with images, animations, and video.<br><br>**JoinIn™ on TurningPoint®**<br>Book-specific student response system.<br><br>**Great Ideas for Teaching Astronomy**<br>Chapter 2 Science and Pseudoscience<br>Chapter 3 Observational and Historical Astronomy<br>Chapter 4 The Moon and Eclipses<br><br>**Transparency Package**<br>Acetates 7–21<br><br>**WebTutor™ ToolBox on WebCT and Blackboard**<br>http://webtutor.thomsonlearning.com<br>Free online course management option.<br><br>**Book Companion Website**<br>http://astronomy.brookscole.com/sh9e<br>Online instructional resources and study tools | **AceAstronomy**<br>Chapter 2:<br>Active Figures<br>• Constellations from Different Latitudes<br>• The Celestial Sphere<br>• Rotation of the Sky<br>Chapter 3:<br>Active Figures<br>• Constellations in Different Seasons<br>Astronomy Exercises<br>• Sunrise Through the Seasons<br>• The Seasons<br>• Phases of the Moon<br>• Moon Calendar<br>Virtual Astronomy Lab<br>• Lab 6: Tides and Tidal Forces<br><br>**TheSky™ Student Edition CD-ROM/ Workbook**<br>Chapter 4 Naming Objects in *TheSky*<br>Chapter 5 Locating Objects in *TheSky*<br>Chapter 6 Motions in *TheSky*<br>Chapter 7 Keeping Time in *TheSky*<br>Chapter 8 Seasons in *TheSky*<br>Chapter 9 Phases and Eclipse in *TheSky*<br><br>**RedShift™ College Edition CD-ROM/ Workbook**<br>Chapter 3 Finding Your Way Around (in the Dark!)<br>Chapter 4 Address ~~Un~~Known!<br>Chapter 5 Timing is Everything<br>Chapter 6 Time Passages<br>Chapter 7 Eclipses<br><br>**Out of the Classroom: Observations and Investigations in Astronomy**<br>Exercise 1 Using a Planisphere<br>Exercise 3 Apparent Magnitudes of Stars<br>Exercise 4 The Number of Stars Visible to the Naked Eye<br>Exercise 7 Observing an Eclipse of the Moon<br>Exercise 8 Exploring the Winter Sky<br>Exercise 9 Exploring the Spring Sky<br>Exercise 10 Exploring the Summer Sky<br>Exercise 11 Exploring the Autumn Sky<br>Exercise 14 Measuring the Moon's Orbital Motion<br>Exercise 16 Observations of the Setting Sun<br>Exercise 17 The Moon's Phases<br>Exercise 18 Shadow-Stick Astronomy |

## OTHER EDUCATIONAL RESOURCES

### Videos and Films

*The Sky,* 1994, (28 minutes) Produced by Coast Telecourse. Part of the *Universe: The Infinite Frontier* video series. This program describes how the motions of Earth determine the length of the day and year and the cause of the seasons. Additionally, it describes how different cultures viewed the sky.

*Cycles of the Sky*, 1994 (28 minutes) Produced by Coast Telecourse. Part of *Universe: The Infinite Frontier.* This video describes the phases of the moon and eclipses.

*A Private Universe,* 1987 (20 minutes), ISBN: 1-57680-404-6. Every astronomy instructor should watch this short video produced at the Harvard-Smithsonian Center for Astrophysics., which discusses how even the brightest students can have problems learning new science concepts. The opening scene is worth showing to your students – graduating seniors at Harvard's commencement are asked why it is warmer in the summer than in the winter, and most get it wrong. Available from www.learner.org.

### Computer Software and CD-ROMs

There are several planetarium programs that simulate the night sky. These include *RedShift College Edition* and *TheSky Student Edition*. The internet has a few excellent sites for determining the phase of the moon at any time and information on eclipses.

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|---|---|
| http://aa.usno.navy.mil/data/docs/RS_OneDay.html | Lunar phases at any date & time |
| http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html | NASA's Eclipse page |
| http://aa.usno.navy.mil/data/docs/UpcomingEclipses.html | Naval Observatory's Eclipse page |

## ANSWERS TO BUILDING SCIENTIFIC ARGUMENTS

1. If Earth's equator were inclined with respect to its orbital plane by more or less than the present 23.5 degrees, the seasons would be very different. With no tilt at all, there would be no seasonal variation at all: the average temperature of a location on Earth would depend only on its latitude. Thus a tilt intermediate between 0 degrees and the present 23.5 degrees would produce smaller seasonal variations than we have. A larger tilt would produce stronger seasonal variations, as both the number of hours of daylight and the angle at which sunlight hits Earth would experience larger variations. (In the extreme case of a 90 degree tilt, Earth would actually experience two summers and two winters each year. Try drawing it!)

2. If Earth had no atmosphere, the moon would appear completely dark during a total lunar eclipse. The faint, red illumination on the face of the moon during a total lunar eclipse is supplied by light rays refracted through Earth's atmosphere. If Earth had no atmosphere, the shadow would be complete, and the moon would appear completely dark.

## ANSWERS TO REVIEW QUESTIONS

1. Astronomers have added constellations over the past few hundred years for two reasons. The first is that the stars in the southern hemisphere had not been observed by western civilization before sailors and explorers began to sail south of the tropics. New star patterns were observed and named in order to help with navigation. The second reason is that astronomers now consider constellations to be areas of the sky rather than particular groups of stars, and some new constellations were needed to fill in the gaps such that every part of the sky would be associated with some constellation.

2. People from different cultures all see the same stars, but the asterisms and constellations are different. According to the technical definition of constellation, we now all see the same constellations, because these have official definitions and borders. However, this designation might not be well accepted by people of various cultures. The asterisms are certainly dependent on the culture. The images we see in the sky depend on how we view different objects and the value we place on them. In the U.S. some asterisms have now taken on more modern nicknames. For example, Sagittarius is often referred to as the teapot, and some people refer to Hercules as the styrofoam cup!

3. The Greek letter designations indicate the relative brightness for stars in a particular constellation, because the stars are generally given letters running in alphabetical order from brightest to faintest within that constellation. However, the system does not allow us to compare the relative brightness of stars in different constellations with certainty, as not all constellations contain the same number of bright stars.

4. The word *apparent* in *apparent visual magnitude* means simply that it is the magnitude of the star as it *appears* to us when viewing the star from here on Earth. Apparent visual magnitude does not take into account the star's distance, and as such does not indicate the intrinsic luminosity of the star. It is simply the brightness as it appears to us in the night sky.

5. The celestial sphere is an excellent example of a scientific model that is useful even though it is not correct. It is an accurate representation of what we *observe* in the sky, and easily permits us to make accurate *predictions* of the motions of the sky, sun, moon, and stars as seen from various positions on Earth. In this respect the model is very useful, even though it is in fact the Earth that moves, and not the sky.

6. To see both the north and south celestial poles at the same time, an observer needs to be at Earth's equator.

7. If you travel to the north geographic pole at a latitude of 90° N, the north celestial pole will be at your zenith. If you travel to the south geographic pole at a latitude of 90° S, the south celestial pole will be at your zenith.

8. In the northern hemisphere, your latitude can be determined by measuring the angle between your northern horizon and the north celestial pole. Since Polaris, the North Star, is within 1° of the north celestial pole, Polaris can be used as a fairly accurate marker of the north celestial pole. Determining latitudes in the southern hemisphere is more difficult because there is no bright star within a few degrees of the south celestial pole.

9. Circumpolar constellations are those constellations close enough to the celestial pole such that they never pass below an observer's horizon, but at their lowest points in the sky instead pass between the celestial pole and horizon. At different latitudes the celestial pole will be at different distance above an observer's horizon, thus changing the number of constellations that are seen as circumpolar. For example, if the observer is at a latitude of 60° N, then all constellations within 60° of the north celestial pole will be circumpolar. However, if an observer is at a latitude of only 30° N, then only those constellations within 30° of the north celestial pole will be circumpolar.

10. In principle, one could detect the existence of precession by examining ancient Egyptian star charts and determining the location of the north celestial pole at that time. Depending on how the charts were presented, one way of determining the location of the north celestial pole might be to look at which stars were described as circumpolar. Since precession causes the location of the north celestial pole to move relative to the stars, the stars that appear within the circumpolar zone also changes.

11. The apparent daily motion of the sun is due to the rotation of Earth on its axis. This rotation causes the sun to appear to rise above the eastern horizon, reach its greatest altitude at local noon, and set below the western horizon in the evening. The apparent annual motion of the sun relative to the distant stars is caused by Earth's revolution around the sun. As Earth orbits the sun, the sun appears to move slowly eastward along the ecliptic from day to day. Note that the apparent daily motion is toward the west (towards the western horizon as seen in the sky), while the apparent slow annual motion is toward the east.

12. If Earth's rotation axis were tipped 35° relative to the pole of the ecliptic, the seasonal variations would be greater. During the summer months the sun would shine even more directly on the ground than it currently does, and the length of daylight would be even longer. With more solar energy per unit surface area, a longer period of heating per day, and a shorter night time for cooling off, the temperatures in the summer would be greater than are now the case. Conversely, in the winter, the sun would shine much more obliquely on the surface and for a shorter period of time. With less sun light hitting the ground per unit surface area for a shorter amount of time, winter would be colder than is now the case.

    If Earth's equator were parallel to its orbit, i.e. if it had no tilt, there would be virtually no seasonal variations. The average temperature of a location would depend primarily on its latitude, with areas at the equator much warmer because they received direct sunlight, and areas closer to the poles much colder because they received oblique sunlight. Every location on Earth would have 12 hours of daylight and 12 hours of night, all year long.

13. The seasons in the Southern Hemisphere (SH) are opposite to those of the Northern Hemisphere (NH) because during the solstices, one hemisphere is tilted towards the sun, receiving direct sunlight and experiencing longer days. The opposite hemisphere is tilted away from the sun, receiving indirect sunlight, and experiencing shorter days. Therefore the NH winter occurs at the same time as the SH summer, and vice versa. At the equinoxes both hemispheres are receiving sunlight at the same angle and experiencing days and nights that are approximately equal in length.

14. Earth is at perihelion (closest to the sun) about January 3 every year, and at that time is only about 2% closer than the average distance. This occurs during the Northern Hemisphere winter. Since the sun is a tiny bit closer, the NH winters should be a little warmer on average than the SH winters, resulting in a smaller contrast between summer and winter.

15. The phases of the moon appear the same to all people on Earth at a given time. The phases are caused by the reflection of sun light from the lunar surface. Since all of us on Earth view the moon from essentially the same spot with respect to the sun, the portion of the moon that is visible to us and has sun light incident on it will be the same for all observers.

16. If you were standing on the moon during full moon, Earth would appear to be in a "new" phase; that is, you would see only the night-side of the Earth. If you stand on the moon during first quarter moon, the Earth would appear to be in its third quarter phase. [To understand this, study the diagram in the chapter illustrating the phases of the moon.]

17. A total lunar eclipse occurs when the moon moves into Earth's shadow, and can be seen by anyone on the night side of Earth. A total solar eclipse occurs when the tip of the moon's shadow crosses the face of Earth, and can be seen only by people who are inside that shadow. The shadow is quite narrow, only a few miles across. Thus it is much less likely for the average person to have seen a total solar eclipse than a total lunar eclipse.

18. Eclipses occur only when the sun, Earth and moon are directly in line with each other. The moon's orbit is inclined about 5° with respect to the ecliptic so that when the moon is either new or full it may be as much as 5° north or south of the ecliptic. For an eclipse to occur then, the moon must be either full or new AND be very near the ecliptic. Usually when the moon is new or full it is north or south of the ecliptic and an eclipse does not occur.

19. The moon appears red during a total lunar eclipse because it is being illuminated only by light that has already been scattered through Earth's atmosphere. Small particles in Earth's atmosphere scatter more blue light than red light out of a beam of light. Therefore the remaining light is reddish, just as the light of sunset looks reddish after it has traveled through a lot of atmosphere. Thus the eclipsed moon looks red for the same reason that the sun looks red at sunset.

**POSSIBLE ANSWERS TO DISCUSSION QUESTIONS**

1. Early cultures used constellations as navigational aids. Most cultures have used constellations to illustrate myths. Even today learning constellations gives you a welcoming friend wherever you go.

2. You would need to watch Polaris very carefully to try to deduce how far from the real celestial pole it is.

3. Planets orbiting other stars have ecliptics by definition; the ecliptic is just the plane of the planet's orbit. However, planets orbiting other stars would not necessarily have seasons. In order to experience seasons they would need to be tilted with respect to the orbital plane, or have a fairly elliptical orbit.

4. As seen from the Earth, the moon and the sun have about the same angular diameter. Thus during a total solar eclipse, the sun's disk is just barely covered by the moon, and faint features in the solar atmosphere can be seen out to the sides. However, as seen from the moon, Earth has a much greater angular diameter than the sun (see Figure 2-12a). Thus only a small portion of the solar atmosphere would be seen around Earth as the moon slipped into its shadow.

**TEST QUESTIONS**

**Multiple Choice Questions**

1. Most individual star names, such as Aldebaran and Betelgeuse are derived from
   a. Latin.
   b. Greek.
*  c. Arabic.
   d. English.
   e. Italian.

2. The Big Dipper is
   a. a circumpolar constellation for southern hemisphere observers.
   b. always on an observer's zenith.
*  c. an asterism.
   d. only visible from the southern hemisphere.
   e. a constellation.

3. The apparent visual magnitude of a star is a measure of the star's
   a. size.
*  b. flux.
   c. distance.
   d. color.
   e. temperature.

4. The apparent visual magnitude of a star is 7.3. This tells us that the star is
   a. one of the brighter stars in the sky.
   b. bright enough that it would be visible even during the day.
*  c. not visible with the unaided eye.
   d. very far from Earth.
   e. very close to Earth.

5. Seen from the northern latitudes, the star Polaris
   a. is never above the horizon during the day.
   b. always sets directly in the west.
*  c. is always above the northern horizon.
   d. is never visible during the winter.
   e. is the brightest star in the sky.

6. An observer on Earth's equator would find
   a. Polaris directly overhead.
   b. Polaris 40° above the northern horizon.
   c. that the celestial equator coincides with the horizon.
*  d. that the celestial equator passed directly overhead.
   e. that the ecliptic coincided with the horizon.

7. The celestial equator is
   a. a line around the sky directly above Earth's equator.
   b. the dividing line between the north and south celestial hemispheres.
   c. the path that the sun appears to follow on the celestial sphere as Earth orbits the sun.
*  d. a and b
   e. a and c

8. The ________ is the point on the celestial sphere directly above any observer.
   a. north celestial pole
   b. south celestial pole
*  c. zenith
   d. celestial equator
   e. asterism

9. An observer's nadir is
*  a. the point directly opposite the observer's zenith.
   b. the north point on the observer's horizon.
   c. located at the center of Earth.
   d. always located near a circumpolar constellation.
   e. directly opposite the north celestial pole.

10. A(n) __________________ is one-3,600$^{th}$ of a degree.
   a. precession
*  b. second of arc
   c. minute of arc
   d. nadir
   e. angular diameter

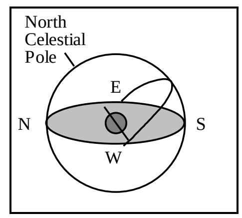
11. An observer in the Northern Hemisphere watches the sky for several hours. Due to the motion of Earth, this observer notices that the stars near the north celestial pole appear to move
*  a. counter clockwise around the celestial pole.
   b. clockwise around the celestial pole.
   c. from left to right.
   d. from right to left.
   e. nearly vertically upward.

12. You live at a latitude of 73° N. What is the angle between the northern horizon and the north celestial pole?
*  a. 73°
   b. 27°
   c. 17°
   d. 23½°
   e. 5°

13. You live at a latitude of 39° S. What is the angle between the southern horizon and the south celestial pole?
    a. 45°
    b. 23.5°
*   c. 39°
    d. 51°
    e) The answer depends on the day of the year.

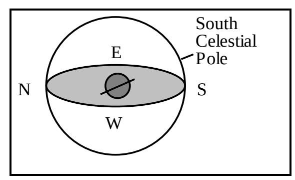
14. If the north celestial pole appears on your horizon, what is your latitude?
    a. 90° N
    b. 90° S
*   c. 0°
    d. 45° N
    e. The latitude of the observer can not be determined from the information given.

15. What is the approximate latitude of the observer in the diagram to the right?



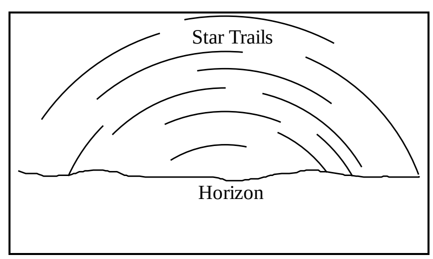

    a. 90° N
    b. 90° S
*   c. 50° N
    d. 50° S
    e. 0°

16. What is the approximate latitude of the observer in the diagram to the right?



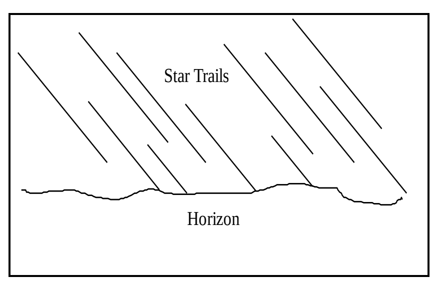

    a. 20° N
*   b. 20° S
    c. 70° N
    d. 70° S
    e. 0°

17. An observer in the Northern Hemisphere takes a time exposure photograph of the night sky. If the illustration to the right depicts the photograph taken by the observer, which direction was the camera pointing?



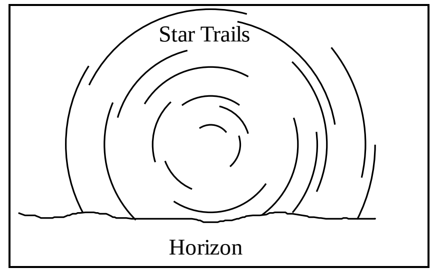

    a. straight north
    b. straight east
*   c. straight south
    d. straight west
    e. straight up, directly overhead

18. An observer in the Northern Hemisphere takes a time exposure photograph of the night sky. If the illustration to the right depicts the photograph taken by the observer, which direction was the camera pointing?

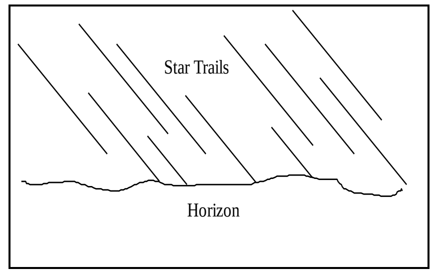



    a. straight north
    b. straight east
    c. straight south
*   d. straight west
    e. straight up, directly overhead

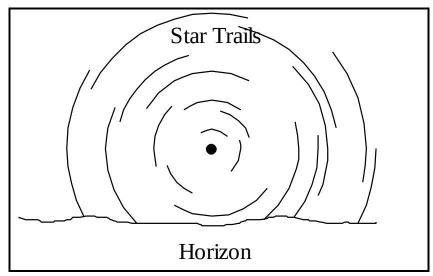
19. An observer in the Southern Hemisphere takes a time exposure photograph of the night sky. If the illustration to the right depicts the photograph taken by the observer, which direction was the camera pointing?
    a. straight north
    b. straight east
*   c. straight south
    d. straight west
    e. straight up, directly overhead



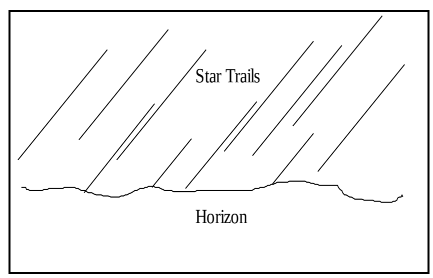

20. An observer in the Southern Hemisphere takes a time exposure photograph of the night sky. If the illustration to the right depicts the photograph taken by the observer, which direction was the camera pointing?
    a. straight north
*   b. straight east
    c. straight south
    d. straight west
    e. straight up, directly overhead




21. An observer in the Northern Hemisphere takes a time exposure photograph of the night sky. If the illustration to the right depicts the photograph taken by the observer, which direction was the camera pointing?
*   a. straight north
    b. straight east
    c. straight south
    d. straight west
    e. straight up, directly overhead




22. An observer in the Southern Hemisphere takes a time exposure photograph of the night sky. If the illustration to the right depicts the photograph taken by the observer, which direction was the camera pointing?
    a. straight north
    b. straight east
    c. straight south
*   d. straight west
    e. straight up, directly overhead



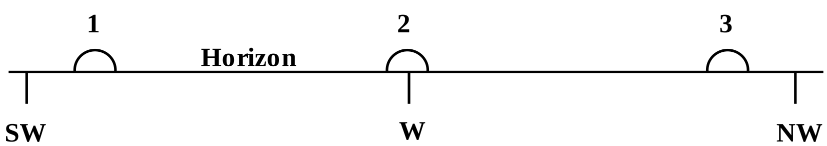

23. Which star in the table to the right would appear the brightest to an observer on Earth?
    a. α Cet
*   b. α CMa
    c. Nim
    d. ρ Per
    e. δ Dra

| **Star Name** | **Apparent Visual Magnitude** |
|---|---|
| δ Dra | 3.07 |
| α Cet | 2.53 |
| ρ Per | 3.98 |
| Nim | 8.07 |
| α Cma | -1.46 |

24. Which star in the table to the right would not be visible to the unaided eye of an observer on Earth?
    a. α Cet
    b. α Cma
*   c. Nim
    d. ρ Per
    e. δ Dra

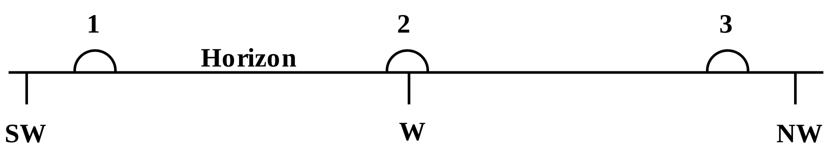
| Star Name | Apparent Visual Magnitude |
|---|---|
| δ Dra | 3.07 |
| α Cet | 2.53 |
| ρ Per | 3.98 |
| Nim | 8.07 |
| α Cma | -1.46 |

25. The diagram below shows three approximate locations of the sun along the western horizon. Which number indicates the location of the sun at sunset on December 21 for an observer at a latitude of 48° S?



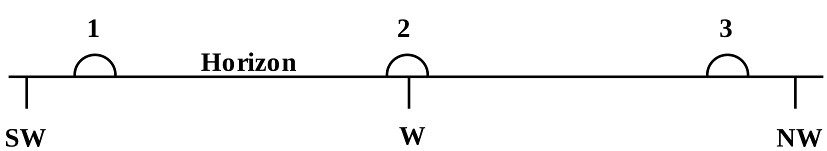

*   a. 1
    b. 2
    c. 3
    d. The sun will set in the east for an observer in the southern hemisphere.
    e. The sun will not set on December 21 at this latitude.

26. The diagram below shows three approximate locations of the sun along the western horizon. Which number indicates the location of the sun at sunset on the autumnal equinox for an observer at a latitude of 45° N?




    a. 1
*   b. 2
    c. 3
    d. The sun will set in the east for an observer in the northern hemisphere.
    e. The sun will not set on the autumnal equinox at this latitude.

27. The diagram below shows three approximate locations of the sun along the western horizon. Which number indicates the location of the sun at sunset on June 21 for an observer at a latitude of 48° N?




    a. 1
    b. 2

* c. 3
  d. The sun will set in the east for an observer in the northern hemisphere.
  e. The sun will not set on June 21 at this latitude.

28. Northern Hemisphere winters are colder than Northern Hemisphere summers because
    a. Earth is closer to the sun during the summer than it is during the winter.
    b. the snow that falls in the northern latitudes cools Earth during the winter.
    c. the light from the sun shines more directly on the Northern Hemisphere during the summer.
    d. the period of sunlight is longer during the summer than during the winter.
*   e. c and d

29. The sun is on the celestial equator at
    a. the vernal equinox and the summer solstice.
*   b. the autumnal equinox and the vernal equinox.
    c. the summer solstice and the winter solstice.
    d. the autumnal equinox and the winter solstice.
    e. no time. The sun is on the ecliptic and is never on the celestial equator.

30. The ecliptic is
    a. the centerline of the zodiac.
    b. the projection of Earth's orbit on the sky.
    c. the apparent path of the sun around the sky.
*   d. all of the above
    e. none of the above

31. When will the full moon be highest above the southern horizon for an observer in the Northern Hemisphere?
    a. at midnight near the summer solstice
    b. at midnight near the vernal equinox
*   c. at midnight near the winter solstice
    d. at midnight near the vernal equinox
    e. The angle between the southern horizon and the full moon at midnight does not change with the seasons.

32. What is the angle between the noon sun on the winter solstice and the southern horizon for an observer at a latitude of 38° N?
    a. 38°
    b. 52°
    c. 75.5°
*   d. 28.5°
    e. 14.5°

33. If Earth were to lose its tilt, you would expect that the seasons would
*   a. become less extreme than they are now.
    b. become more extreme than they are now.
    c. stay exactly the same as they are now.
    d. be reversed.
    e. none of the above

34. If Earth’s orbit were more elliptical than is currently the case, such that its perihelion was noticeably closer to the sun, what would be the effect on the climate of the Southern Hemisphere?
    a. Their winter season would be much colder than present.
    b. Their winter season would be much warmer than present.
    c. Their summer season would be much colder than present.
*   d. Their summer season would be much warmer than present.
    e. Their would be no change in any of their seasonal temperatures.

35. A(n) ___________ is a set of beliefs that appears to be based on scientific ideas, but which fails to obey the most basic rules of science.
a. theory
b. hypothesis
* c. pseudoscience
d. allegory
e. scientific model

36. The point in Earth's orbit where Earth is farthest from the sun is known as
* a. aphelion.
b. perihelion.
c. precession.
d. the winter solstice
e. a and d

37. On the autumnal equinox the sun is
a. 23½° north of the celestial equator.
b. 23½° south of the celestial equator.
c. on the celestial equator and moving north with respect to the equator.
* d. on the celestial equator and moving south with respect to the equator.
e. closest to the north celestial pole.

38. The __________ moon is visible above the western horizon a couple of hours before sunrise.
* a. waning gibbous
b. waxing gibbous
c. waxing crescent
d. waning crescent
e. new moon

39. The __________ moon is visible above the eastern horizon a couple of hours before sunrise.
a. waning gibbous
b. waxing gibbous
c. waxing crescent
* d. waning crescent
e. new moon

40. A waxing crescent moon is visible
a. near the eastern horizon just before sunrise.
b. near the eastern horizon just after sunset.
c. near the western horizon just before sunrise.
* d. near the western horizon just after sunset.
e. from sunset until sunrise.

41. A third quarter moon is visible
a. near the eastern horizon just before sunrise.
b. near the eastern horizon just after sunset.
* c. in the southern sky at sunrise.
d. in the southern sky at sunset.
e. from sunset until sunrise.

42. A full moon is visible
a. near the eastern horizon just before sunrise.
b. near the eastern horizon just after sunset.
c. in the southern sky at sunrise.
d. in the southern sky at sunset.
* e. from sunset until sunrise.

43. The first quarter moon rises
* a. at about noon.
  b. at sunset.
  c. at sunrise.
  d. at about midnight.
  e. during the second week of each calendar month.

44. During a total lunar eclipse,
  a. the moon must be new.
  b. the observer must be in the path of totality.
* c. the moon's color will be affected by Earth's atmosphere.
  d. the moon must be at about its greatest distance from Earth.
  e. it must be near the time of one of the equinoxes.

45. A totally eclipsed moon glows coppery red because
  a. the moon' surface is made of iron ore which is red in color.
  b. red light is cooler than blue light.
  c. during a lunar eclipse the sun is cooler than normal and its light is more red.
* d. only red light is able to pass completely through Earth's atmosphere and reach the moon.
  e. The moon appears red during a total solar eclipse, not a total lunar eclipse.

46. A total lunar eclipse is
  a. visible only from the path of totality.
  b. visible only during a new moon.
* c. visible to all observers on the side of Earth from which the moon would be visible at that time.
  d. an opportunity to study the corona of the sun.
  e. none of the above

47. Total lunar eclipses always occur
  a. at the time of new moon.
* b. at the time of full moon.
  c. during either equinox.
  d. during either solstice.
  e. at the time that the sun is directly overhead.

48. During a total lunar eclipse, which of the following are true?
  I. The disk of the sun is obscured by the moon.
  II. The moon is in Earth's umbra.
  III. The moon is new.
  IV. The moon is full.

  a. I, III
* b. II, IV
  c. I, II, III
  d. II, III
  e. I, II, III, IV

**Fill in the Blank Questions**

1. __________ is a measure of the light energy that hits one square meter in one second.

** Flux

2. __________ is the turning of a body on its axis. _____________ is the motion of a body around a point outside the body.

** rotation, revolution

3. The _________ is the apparent annual path of the sun through the sky.

** ecliptic

4. Which planets are never visible near the eastern horizon at sunset? ______________________

** Mercury and Venus

5. _________ is the point in Earth's orbit when Earth is closest to the sun.

** Perihelion

6. The ________ is the point on the celestial sphere directly above an observer, regardless of where the observer is located on Earth.

** Zenith

7. Earth's rotation axis _______________ slowly so that in a few thousand years Polaris will no longer be the North Star.

** precesses

8. The third quarter moon rises at ______________ .

** midnight

9. For a northern Hemisphere observer the __________ __________ moon is visible in the south-eastern sky just after sunset.

** waxing gibbous

**True-False Questions**

F 1. A star with a negative apparent magnitude is fainter than a star with a positive apparent magnitude.

T 2. A second magnitude star in Ursa Major is brighter than a fourth magnitude star in Orion.

T 3. The Greek letter designation conveys information about a star's location and brightness.

F 4. The celestial equator always passes directly overhead.

T 5. The celestial equator always crosses the horizon at the east point and west point.

T 6. Navigators can find their latitude in the northern hemisphere by measuring the angle from the northern horizon to the north celestial pole.

T 7. A scientific model is a mental conception that provides a framework that helps us think about some aspect of nature.

F 8. The constellation of Orion is currently visible in the evenings in January. Precession will not affect this and Orion will still be visible in January 13,000 years from now.

T 9. As Earth rotates, circumpolar stars appear to move counterclockwise around the north celestial pole.

T 10. The path of totality for a solar eclipse is swept out by the tip of the moon's umbra as the umbra moves across Earth.

F 11. A total lunar eclipse is visible only from the path of totality.

T 12. If you were on the moon during a total lunar eclipse, the sun would be hidden behind Earth.

T 13. The totally eclipsed moon glows coppery red because sunlight reaches the moon's surface after passing through Earth's atmosphere.

T 14. The moon and visible planets are always seen within a few degrees of the ecliptic.

T 15. The precession of Earth's axis causes a slow change in the date at which perihelion of Earth's orbit occurs.

F 16. Polaris has always been the star nearest the north celestial pole.

**Essay Questions**

1. Describe the path that a star on the celestial equator follows from the time it rises until it sets for a person at a latitude of 60° N and a person at the equator.

2. Describe the location of Polaris in the sky relative to the horizon as seen by observers in Alaska (lat. = 60° N), Texas (lat. = 33° N), Ecuador (lat. = 0°), and Australia (lat. = 30° S)

3. Discuss in what ways the celestial sphere is a scientific model.

4. How are the celestial poles and equator defined by Earth's rotation?

5. Describe the differences between a constellation and an asterism.

6. Explain the difference between rotation and revolution, and then give some astronomical examples.

7. Why does the moon glow coppery red during a total lunar eclipse?

8. Why have more people seen total lunar eclipses than total solar eclipses?

9. Why don't eclipses occur at every new moon and full moon?

10. What would you see if you were on the moon and facing Earth when people on Earth saw a total lunar eclipse, and why?

11. Why does one cycle of lunar phases take 29.53 days even though the moon orbits Earth in 27.32 days?

12. Describe how a small change in the relative distance of Earth from the sun at perihelion could affect the formation of glaciers on Earth.

13. Give two reasons why summer days are warmer than winter days.

14. Describe the effect of the shape of Earth's orbit on its seasons.

15. Why can neither Venus nor Mercury remain visible throughout the night as the full moon does?

16. What causes precession and why does it move the celestial equator?

17. Describe how the cycle of eclipses would change if, instead of being tipped 5º with respect to the ecliptic plane, the plane of the moon's orbit were identical to the ecliptic plane.