Horizons Exploring the Universe Enhanced 13th edition Seeds Solutions Manual

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C H A P T E R 2

A USER'S GUIDE TO THE SKY

CHAPTER OUTLINE

2-1 The Stars
- Constellations
- The Names of the Stars
- Favorite Stars
- The Brightness of Stars
- *Reasoning with Numbers 2-1*
  - *Magnitudes*

2-2 The Sky and Its Motion
- The Celestial Sphere
- *How Do We Know? 2-1*
  - *Scientific Models*
- *The Sky Around You*
- Precession

What Are We? Along for the Ride

KEY CONCEPTS

This chapter focuses on the appearance of the night sky. Many of the concepts presented were common knowledge before time became quantified on clocks and city lights blocked our nightly view of the sky. Most people today no longer have an understanding of the basic appearance or motions of the sky.

The discussion of the celestial sphere as a scientific model points out both the usefulness and limitations inherent in most scientific models. Other more familiar models might be briefly discussed as examples of scientific models (e.g., the Bohr model of the atom). The concepts of model, theory, and hypothesis are used consistently and coherently throughout the book.

One topic presented in this chapter that is confusing for many students is the magnitude of a star. It is important to cover this topic because magnitudes will be used in later chapters. Most Hertzsprung-Russell diagrams used in connection with stellar evolution employ absolute visual magnitude, so the magnitude system will be encountered again.

Finally, this chapter uses numerous diagrams and pictures to communicate critical information. Emphasize the importance of looking at the figures and reading the figure captions. Astronomy is a visual science and pictures greatly add to the understanding of a concept. Think of a picture as a miniature scientific model. One of the things that many of us who teach general education science courses believe we do is help students learn to critically observe pictures and learn to read graphs and charts. Yet, few of us test this skill. Several of the exam questions in the test bank make use of pictures, tables, and graphs. It will help the students greatly in the course, and their development of critical reading skills, if they know at the beginning that understanding the diagrams, pictures, charts, and graphs is important and something they will be tested on.

Demonstration Idea:

Have the class meet outside at night at least once during the first week or two of the term. A flashlight with a fairly well focused beam or a strong laser pointer makes a good pointer when working outside as long as the humidity is not too low. The location of the north celestial pole, zenith, celestial equator, and ecliptic can be adequately pointed out even to large groups. Some constellations, asterisms, and selected bright stars can also be presented. Working outside also helps students begin to notice the natural world above them. It makes astronomy personal and something beyond the books, pictures, and classroom.

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The Sky Idea:

You have the option of including *The Sky* software CD with your students' texts. The primary function of *The Sky* software is to serve as a planetarium on your computer. There are many demonstrations you can do or have your students do as lab experiments to illustrate concepts from this chapter.

Set the program up for your current location, date, and time. Make sure that you are in *Daytime Sky Mode* and facing the northern horizon. Set the Time Step to 5 minutes. Under the *View* Tab select *Filters* and set the magnitude limit to –30.0 to 5.0 and turn off the display of all objects except stars, planets, moon, and sun. For now turn off all reference lines, including the constellation reference lines. Now you're ready to begin the demonstration. Press Alt+> and the program will display the daily motion of the sky in 5-minute increments. At the 5-minute time step, a full 24 hours passes in about 35 seconds. Point out the circumpolar stars and the general counterclockwise motion of the stars about the north celestial pole. Now click on the icon in the tool bar to display the constellation lines. This will show where the constellations are during the daylight hours as well, while still showing the blue sky of day. Next click on the tool bar icon to view the eastern horizon. You can observe the general motion of objects as they rise at your location. Do this also looking at the south and west horizons.

You can also demonstrate the effects of latitude on the apparent motion of the night sky with *The Sky*. Perform The Sky Idea described above. Then alter your location to a new latitude. Go to the equator or North Pole and run the demonstration again. Point out the difference in the size of the circumpolar region and the angle at which objects climb above the eastern horizon and dive into the western horizon.

Downloading and Installing Stellarium on Your Computer

If you do not have The Sky as an option for your students, Stellarium is an open-source planetarium program available for download. The program can be downloaded at:
http://www.stellarium.org

Once you have gone to this site, click on the large button that corresponds to your platform (e.g., Mac OS X, Windows, or Linux). The *Stellarium* installation package will download to your computer. There is also a button to download a User's Manual (which is rather technical). Many other resources about Stellarium are available on this site.

For Windows installation: Double click on the stellarium-0.10.2.exe file to run the installer. Follow the on-screen instructions.

Starting Stellarium in Windows: The Stellarium installer creates an item in the Start Menu in the Programs section. Select this to run Stellarium. If you cannot find it, type "stellarium" in the "Search" box and hit return. You will then get the series of Setup boxes. Stellarium will then appear as an item in the Start Menu and as a desk-top icon. Use this icon to start the program in the future. Instructions are available in the site.

A "low tech" paper "Star and Planet Locator" can be ordered from Edmund Scientifics online. Express shipping is available. The Edmund Scientific's phone and web site address are: 1-800-728-6999and www.scientificsonline.com. Enter the item number 3009227or name in the site search box.

EDUCATIONAL RESOURCES

http://amazing-space.stsci.edu/tonights_sky/ A NASA video about constellations. This URL always lands on the current month11—brows the archive for other constellations during other months. Planet positions or moon phases are shown. Chapter 3 will cover that material.

http://domeofthesky.com/foyer.html Online sky constellation maps as seen from different latitudes and different times of the year. This is the subject matter of Chapter 2. There is some good background on why we see the stars in the sky that we do. No planet positions or moon phases are shown. Chapter 3 will cover that material.

Here are other sites with planet and moon positions as well as constellations.

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http://www.skyandtelescope.com/ Sky and Telescope magazine site. Sky maps which include planets and the moon.

http://aa.usno.navy.mil/data/docs/RS_OneDay.html Sun and moon location data; current observational events. This site is powerful but a bit technical. You have to know your location (latitude and longitude).

http://nightsky.jpl.nasa.gov/planner.cfm Excellent for planning observations.

Also look in the "Animations" list by chapter in the "Power Lecture" DVD. I advise browsing through all the Chapters to find useful subjects according to your own preferences for this particular chapter.

The text has a "Go Online" link given at the end of the chapter which presents useful material for the student, in this case measurement and unit conversion and scientific notation. You may want to assign this for some or all students.

Books and Periodicals

Aveni, Anthony "A Stairway to the Stars." *Astronomy 25* (Nov. 1997), p. 92.

Kunitzch, Paul "How We Got Our 'Arabic' Star Names." *Sky and Telescope 65* (Jan. 1983), p. 20.

Pasachoff, Jay M. and Wil Tirion *A Field Guide to the Stars and Planets*. Boston: Houghton Mifflin, 2000.

Monroe, Jean Guard, and Ray A. Williamson *They Dance in the Sky: Native American Sky Myths*. Boston: Houghton Mifflin, 1987.

Ridpath, Ian *Norton's Star Atlas and Reference Handbook* (20th Edition) Peasons 2004 This is an updated revision of a classic detailed atlas, the standard for amateur astronomers.

Schaefer, Bradley E. "The Origin of the Greek Constellations." *Scientific American 295* (Nov. 2006), p. 96.

Serviss, Garret P. *Astronomy with the Naked Eye - A New Geography of the Heavens.* Standard Publications, Incorporated, 2006.

Williamson, Ray A. *Living the Sky: The Cosmos of the American Indian*. Boston: Houghton Mifflin, 1984.

ANSWERS TO REVIEW QUESTIONS

1. Most of the constellations that were not handed down from ancient civilizations were added during the 15th to 17th centuries. Some of the added constellations were very small constellations composed of faint stars located in the Northern Hemisphere. These constellations filled in gaps between larger and brighter constellations. Also added were constellations in the Southern Hemisphere that had not been observed by western civilization. When sailors and explores began to sail south of the tropics, new star patterns were observed and named to help in remembering them for navigation.

2. An asterism is a group of stars that is not formally recognized as a constellation by the International Astronomical Union (IAU). Many asterisms are part of larger constellations. There are 88 constellations officially recognized by the IAU. Examples of asterisms include the Big Dipper (part of Ursa Major), the Great Square (part of Pegasus), the Water Jug (part of Aquarius), the Summer Triangle (composed of three bright stars in the constellations of Lyra, Cygnus, and Aquilla), and Medusa's Head (part of Perseus).

3. The stars in a constellation or an asterism are generally close to each other in the sky and have a shape that suggests a particular object, person, or animal to the people of a given culture.

4. People from different cultures all see the same stars, but the asterisms and constellations are different. Technically, we would 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

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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. Even within a culture we can have different asterisms. My son sees a small duck in the sky. I have had him point it out in the planetarium, and see only a loose collection of faint stars, but year after year he points out the same group of stars as a duck, so something definitely appears as a duck to him.

5. The Greek-letter designations generally indicate the brightness because the stars in a given constellation were given Greek-letter designations running in alphabetical order from brightest to faintest within that constellation. This system does not allow us to compare the relative brightness of stars in different constellations with certainty since the brightest star in each constellation is generally designated α, but not all constellations contain a really bright star.

6. Ancient astronomers devised a "class" system of stars. The brightest stars were placed in the first class, magnitude 1, the next brightest stars were placed in the second class, magnitude 2, and so on. Consequently, bright stars have small numerical magnitude values, while faint stars have very large numerical magnitude values. This seems backwards because a 5th magnitude star is fainter than a 1st magnitude star.

7. 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 any corrections for the star's distance, size, temperature, or the amount of dust between us and the star. It is simply the brightness as it appears to us in the night sky.

8. The celestial sphere is an excellent scientific model. It is an accurate representation of what we *observe* when we view the night sky. Note that as we look out at the night sky, all the stars appear to be an equal distance away as if they were dots painted on a giant ceiling. Consequently, the celestial sphere does represent what we see, and permits us to discuss what would happen if Earth is at the center and Earth rotated on its axis, and/or revolved around the sun. It provides us with a way to step back and picture in our minds what is going on as Earth rotates on its axis and revolves around the sun.

9. The use of the word *on* instead of the word *in* when referring to angular distance between celestial objects comes about because all of the objects appear to be *on* the celestial sphere and at an indeterminable distance. While we know that objects are at different distances *in* the sky, their distance from Earth is irrelevant in determining the angular distance between the two objects as viewed from Earth.

10. The celestial poles and celestial equator exist because Earth rotates on an axis. If Earth did not rotate we could define the ecliptic and the poles of the ecliptic, but there would not be a separate set of celestial poles and celestial equator. Under such a circumstance, we would have difficulty defining a geographic equator and geographic poles. The geographic equator would most likely be defined as the intersection between the ecliptic and Earth's surface and the geographic poles would be 90° from this equator.

11. To see the north and south celestial poles at the same time, one needs to be at Earth's equator. Due to the refraction of light by the atmosphere, an observer on the equator would observe the north celestial pole approximately 0.5° above the northern horizon and the south celestial pole about 0.5° above the southern horizon. An observer at latitudes between 0.5° S and 0.5° N could see both celestial poles above their horizon.

12. A celestial pole will be on your zenith if you are at a latitude of 90° N, the north geographic pole, or at 90° S, the south geographic pole.

13. Your latitude can be determined by observing 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.

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14. Circumpolar constellations are those constellations close enough to the celestial pole so that they never pass below an observer's horizon, but instead pass directly between the observer's celestial pole and northern or southern horizon at their lowest points in the sky. At different latitudes the celestial pole will be at different distances above an observer's horizon. 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.

15. One of the easiest ways to detect the existence of precession by examining ancient Egyptian star charts would be to look at which stars they show as circumpolar and which are circumpolar in Egypt now. Since the location of the north celestial pole moves relative to the stars because of precession, the stars that appear within the circumpolar zone also changes. If on the ancient charts, Thuban is listed as "nearest the pole", then at the latitude of approximately 30° N, Polaris would have been circumpolar, but would have been very near the horizon at its lowest point. Additionally, all of the Big Dipper asterism would have been circumpolar, while today only one of the seven bright stars forming the Big Dipper is circumpolar at Egypt's latitude.

16. How Do We Know? In contrast to the more formal serious term, “theory,” the less serious term, “model,” is not a statement of truth; it does not have to be precisely true to be useful. In an idealized model, some complex aspects of nature can be simplified or omitted. A model gives scientists a way to think about some aspect of nature but need not be true in every detail. An example would be considering the Earth to be a round ball.

ANSWERS TO PROBLEMS

1. 4
2. 2800
3. Star A is the brightest, Stars A and B are visible to the unaided eye, Star A is 16 times brighter than Star B.
4. The sun is about 1,000,000 (1 million) times brighter than the full moon.
5. Angle from northern horizon to north celestial pole is 35°; angle from southern horizon to south celestial pole is 35°.

ANSWERS TO LEARNING TO LOOK

1. Use Figure 2-1 to help you find the stars of the two constellations in the photograph.

2. The view is from Antarctica, the southernmost continent. Because you are just about as far south as possible, Orion appears upside down since the observer is standing upside down relative to an observer in the northern hemisphere.

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