Unit 2: INTRODUCING THE SKY

Unit 2 prepares students for making visual observations. Going out and looking into the night sky will introduce students to the wonders of the universe from their own backyards. In Chapter 3, "Familiarizing Yourself With the Night Sky," students will become acquainted with the constellations by constructing and using a simple astronomical tool, the planisphere. They will also learn how to obtain additional information by using the Sky Gazer's Almanac. Chapter 4, "Our Bearings in the Sky," helps explain the motions of objects across the sky by having students make and record observations using quadrants and shadow sticks. Students will learn about the celestial sphere, and use the equatorial coordinate system to plot constellations.

CONTENTS FOR UNIT 2

Poster Page: Astrology or Astronomy? (Horoscopes and Precession)
Space Talk on Lunar Libration

Relationship to National Science Standards and Benchmarks

This unit addresses three of the five unifying concepts and processes underlying the national science standards: the order and organization of the Solar System, constructing and explaining models, and understanding patterns of change by direct observation and measurement. The *History and Nature of Science* content standard states that 7^{th} through 12^{th} grade students should understand that diverse cultures have contributed to scientific knowledge and technological advances, and that the beliefs of each culture have added their own unique perspective to the scientific enterprise. Some of the simple astronomical tools used today have changed little since their conception, and the development of these tools was motivated by the desire to understand the natural world. Today, this is still the driving force for the development of increasingly sophisticated tools. Learning to see these historical connections between technology and the acquisition of knowledge supports the *Science and Technology* content standard. Investigations and activities that take place over long periods of time, take place outside of the classroom, and deal with real world conditions, emphasize and promote inquiry learning as set forth in the *Science as Inquiry* standard. During the inquiry process of observing and collecting data, students learn about the motions observed from Earth and the Earth's place within the Solar System, as stated in the *Physical Science* and *Earth and Space Science* content standards. This unit supports concepts from Benchmark's *Nature of Mathematics,* as students record data and transform it into graphs and tables to show relationships among different variables and to determine patterns.

Chapter 3: Familiarizing Yourself With the Night Sky

Summary

This chapter introduces you to techniques of sky observation and what you will see. It emphasizes how to use star charts to find your way around the sky by "star-hopping," and how to use planispheres to determine what constellations are in the sky for any particular date and time. The *Sky Gazer's Almanac* helps to determine such information as rise and set times for the Moon, and what planets will be in the sky for any day of the year.

Terminology

asterism	heliacal rising	meridian	solstice
astronometry	horizon	planisphere	star chart
constellation	horizon window	Polaris	transit
ecliptic	local mean time	*Sky-Gazer's Almanac*	zenith

Common Misconceptions

1. *Stars and constellations always travel directly from East to West.*
2. *The Sun rises due East and sets due West.*

SUGGESTIONS FOR THE POSTER PAGES, INVESTIGATIONS, AND ACTIVITIES

Investigation 3.1: Drawing a Star Map

The students do not need to know the names of any stars or constellations or any cardinal directions to do this activity. It will give them practice at observing and drawing the apparent magnitudes of stars in the real sky, and the opportunity to locate a good observation site for Core Activity 3.4: Searching For Constellations. If they draw their maps carefully with good reference points, they should be able to see the sky changes in their map within a week's time. Have the students exchange their maps with each other and try to match the drawing on the map with what they see in the sky. Earthbound reference points are vital (trees, buildings, and so on), and provide a good scale for the drawings. Students should give a magnitude key on the map to explain the sizes of their points. Exact magnitudes are not important, just what star is brighter and by how much. Later on in the chapter, you may have them compare their maps with other sky charts of the same parts of the sky. You may choose to have the students explain their charts to each other. It would be an excellent introduction on why it is important to have a coordinate system to locate objects in the sky. *Note:* Here we use the terms "map" and "chart" interchangeably, although the word "chart" is used more frequently in astronomy.

Core Activity 3.2: Using the Planisphere

Spend some time having your students become familiar with some simple astronomical tools to aid them in their observations. Included are activities involving the planisphere and the *Sky Gazer's Almanac* (for more advanced students). For a helpful discussion on how to use the planisphere, show your students the section of the HOA video entitled "How to Observe Variable Stars." If you have a nearby planetarium, the staff can usually provide programs to help students learn their way around the sky before actual observations are made. Have students keep an observational log, entering date, time, direction, and weather conditions, as well as drawing what they see. This is an excellent beginning exercise to learn the skill of data collection.

HOA VIDEO

The planisphere is a map of the stars with correct illustrations of the night sky for any particular date. The star map or star wheel is viewed through an elliptical opening called the *horizon window.* Around the outside of the star wheel is a calendar which can be aligned with the hour markings on the frame. Note that the star map on the make-it-yourself planisphere includes constellations and star magnitudes (the apparent brightness). The ready-made versions may also include the names of major stars, clusters, nebulae, galaxies, the Milky Way, the equatorial coordinate system of right ascension and declination, and the ecliptic. The Sun, Moon, and planets change their apparent position among the stars, so they are not located on the planisphere. Planets move along the ecliptic and look like very bright stars which are not marked on the chart. The *ecliptic* is the dashed line on the planisphere that marks the apparent path of the Sun, Moon, and planets in the sky.

You may choose to use a ready-made planisphere or have the students construct their own—a template is included in the student section. If you use the ready-made planisphere, the best source for them is given in the Resource List. Sky charts for any date and time can be obtained from several software packages, also listed in the Resource List. *(Note:* You can wait until the following chapter on celestial coordinates to introduce the students to the terms *right ascension, declination,* and *ecliptic*—they are not necessary to know for the activities within this chapter. You also can ignore the deep-sky objects and their celestial coordinates until the next chapter.)

RESOURCE

If you are not familiar with planispheres, the following instructions will be beneficial:

To set the planisphere to show tonight's sky at 9:00 PM, rotate the wheel so that today's date, at the edge of the wheel, lines up with the 9:00 PM mark on the frame.

Locate the stars and constellations that will be on your *meridian,* an imaginary line that runs from North to South directly over your head. With the ready-made version, it is easy to locate your *zenith,* the point directly overhead on your meridian, because the lines of latitude are labeled. For example, if you are at 35° latitude (called declination), your zenith is also at 35° latitude in the sky above. Note that Polaris, the North Star, is in the center of the planisphere (the gold circle or rivet on the ready-made version), but NOT at the center of the horizon window, and does not appear to move in the night sky. Now set the planisphere for 12:00 midnight tonight. Notice the apparent motion of the stars. The stars are not in fact moving; it is the rotation of the earth that makes the stars appear to have moved across the sky. You now know how to operate the planisphere. Make sure the students understand the terms *meridian, zenith,* and *horizon.*

Answers

1.–4. (The first four depend upon the season; the first two are also dependent upon the date selected.)

5. West

6. The northern hemisphere's counterclockwise rotation from West to East.

Extension

If using the ready-made planisphere and working with older students, the extension questions can be added to those above if you want to introduce the terms *ecliptic,* which is the apparent path of the Sun, and *zodiac,* which describes constellations along the ecliptic. For these questions, the students are provided with the dates that the Sun is occupying each zodiacal constellation. NOTE: These are the actual positions of the Sun at this time, not the incorrect positions which students associate with their horoscope.

Answers

7. The Earth's orbit around the Sun.

8. (Depends upon date)

9. In the summer the Sun rises North of East, during the winter it rises South of East.

10. Along the ecliptic.

Activity 3.3: Searching for Constellations

If students have not yet been introduced to nighttime observing, now is the time. It is essential to the variable star program, which is the heart and soul of this curriculum. Organizing nighttime observations can be difficult, especially with younger students. Keeping groups small, or having students work individually works better. Getting parents involved is also helpful, as they can organize small star parties in backyards and local parks. Sometimes local amateur astronomy clubs can be helpful, or science centers and museums. Whatever method works for you, getting students out and looking up is what makes astronomy fun. Just a few of the brightest stars and easiest constellations in the summer and the winter sky are included in this activity. Once you and your students have located a few constellations and have an idea of how they appear in the sky compared to how they look on the planisphere, it becomes easier to locate others. An excellent aid for learning the constellations is the game *Stellar 28,* which uses a board and cards both with and without the constellation lines drawn in. There is also a software version of this game. (See Resource List.) RESOURCE

Poster Page: Where to Go, What to Do... (Navigating by the Stars)

The *Follow the Drinking Gourd* song is one instance where practical observational astronomy transcended into the spiritual domain. The meaning of this song, which was actually a disguised sky and land map for escaping slaves heading north toward freedom, has only recently become known; there are probably other examples yet to be discovered. Conversely, there are many examples of astronomical phenomena which were initially considered only from a spiritual perspective, and then became a focus for practical applications. Celestial objects and events that were once worshiped or feared have become useful tools with which to gain knowledge of celestial motions and properties. Solar eclipses, thought at one time to be punishment from vengeful gods, are now used to study the chromosphere, an atmospheric layer of the Sun which becomes visible only during a total eclipse. Similarly, comets aroused great alarm in past times, but scientists now study them to discover indicators of the conditions present during the formation of the Solar System. Sirius, the bright star in Canis Major, was both venerated and dreaded by the Egyptians; eventually its appearance in the predawn sky became merely an indicator of when to plant crops along the Nile, and so a friendly reminder of spring.

Activity 3.4: Using the *Star-Gazers' Almanac*

The planisphere will enable students to determine what constellations are in the night sky on the date and time they plan to observe. Another useful tool, although more complicated, is the *Sky-Gazer 's Almanac* (SGA) (see Resource List.) The SGA is an astronomical graphic time table: a picture or graph of the times at which astronomical events occur. The Almanac shows the times for sunrise and sunset, and the rising, transiting, and setting times for the planets, several stars, and some other celestial objects. It also includes information about moonrise, moonset, and lunar phases. It is a more extensive aid in planning astronomical observations. Although the planisphere may ensure that the constellations you want to see are in the sky on the night you plan to observe, that will not be much help if the Moon is full that evening. With the SGA, you will be able to determine what planets are observable on any night of the year you RESOURCE choose, as well as the best nights for observing them.

More advanced students can read the explanation for using the SGA on the back of the graph itself. Note, however, that it contains two types of time corrections: one adjusts for daylight-savings time, and the other for how far East or West you are of the longitude marking your time zone. You will want to use the time corrections in Core Activity 3.3, as we have simplified them for you. Also, the activity is broken up into sections on the Sun, stars, Moon, planets, and meteor showers. You may prefer to introduce one section at a time or eliminate some altogether, depending on how much of the SGA you want your students to use.

The answers to some of the questions in the *Sky Gazer's Almanac* activity cannot be provided here, as they depend upon your particular geographical location for the time corrections. NOTE: The answers that are provided are accurate only for the 1998 Almanac. Some of the questions provided are not appropriate for other years; for instance, transit times of objects will change, different objects will transit, and planets do not appear in the sky at the same times or locations every year.

Starting in 1998, *Sky & Telescope* will be publishing a European *Sky Gazer's Almanac.* You could have some groups use both almanacs and compare the events in a single night, or over an entire year, for people living on opposite sides of the globe. Would your students expect many differences, or only a few? Can they predict what some of the differences might be?

Some possible answers

The Sun

1. Depends upon location.

2. Depends upon location.

3. The right side.

4. Eastern sky (actually somewhat north of east during winter, and south of east during summer.)

5. Depends upon location. Example: 6:00 AM with no time correction; ~5:44 AM in Boston.

6. Depends upon location. Example: 5:50 PM with no time correction; ~6:34 PM in Boston.

7. ~ Dec. 20^{th}.

8. ~15 hours, including twilight. (~11½ hours, excluding twilight).

9. ~June 21st.

10. ~9 hours, including twilight. (~5 hours, 10 minutes, excluding twilight).

11. The length of night varies throughout the year due to the tilt of the Earth as it orbits the Sun.

The stars

1. It will lie along your meridian, the imaginary line drawn across the sky from North to South. Therefore it will also be as close to your zenith as possible, since your meridian marks the midpoint of your sky and the highest point to which objects can rise before beginning their descent.

2. ~December 14th–15th.

3. ~11:30 PM with no time corrections.

4. Stars are so far away that we cannot readily see their own motions through space. It is only their *apparent* movement we see, which is due to the rotation of the Earth in the course of an evening. In this apparent motion they all trace their own unique path straight up to the meridian and back down to the horizon without crossing each other.

The Moon

1. ~1:45 AM with no time corrections, third quarter in phase.

2. ~ September 4th–5th at 6:15 AM with no time corrections.

3. ~January 4th ~11:45 PM with no time corrections.

4. No. The Moon's location may not be in the same part of the sky as the Pleiades when it crosses the observer's meridian.

5. Various answers: i.e., January 11th at ~10:10 PM or November 23rd at 1:55 AM with no time corrections.

The Planets

1. December 13^{th}–22^{nd} when Mercury is at greatest elongation and brilliancy; also September and January in the morning, and the beginning of July in the evening.

2. ~February 20^{th} or 21^{st}.

3. December 7^{th}.

4. September 7^{th} is one possibility.

5. Distant planets appear stationary in the sky during any single night against the background pattern of stars. Their transit lines are straight.

6. The closer the planet, the more noticeable the movement. The movements and locations of Mercury and Venus relative to the Earth make it impossible for them to transit our meridian. Mars, outside the Earth's orbit, is close enough that its motions across the sky are not straight.

Meteor Showers

1. Depends on the season you use. For example, Leonids, Taurids and Orionids in the fall.

2. Depends upon above. For example, in the fall Orionids occur before the Sun comes up, and during a moonless night.