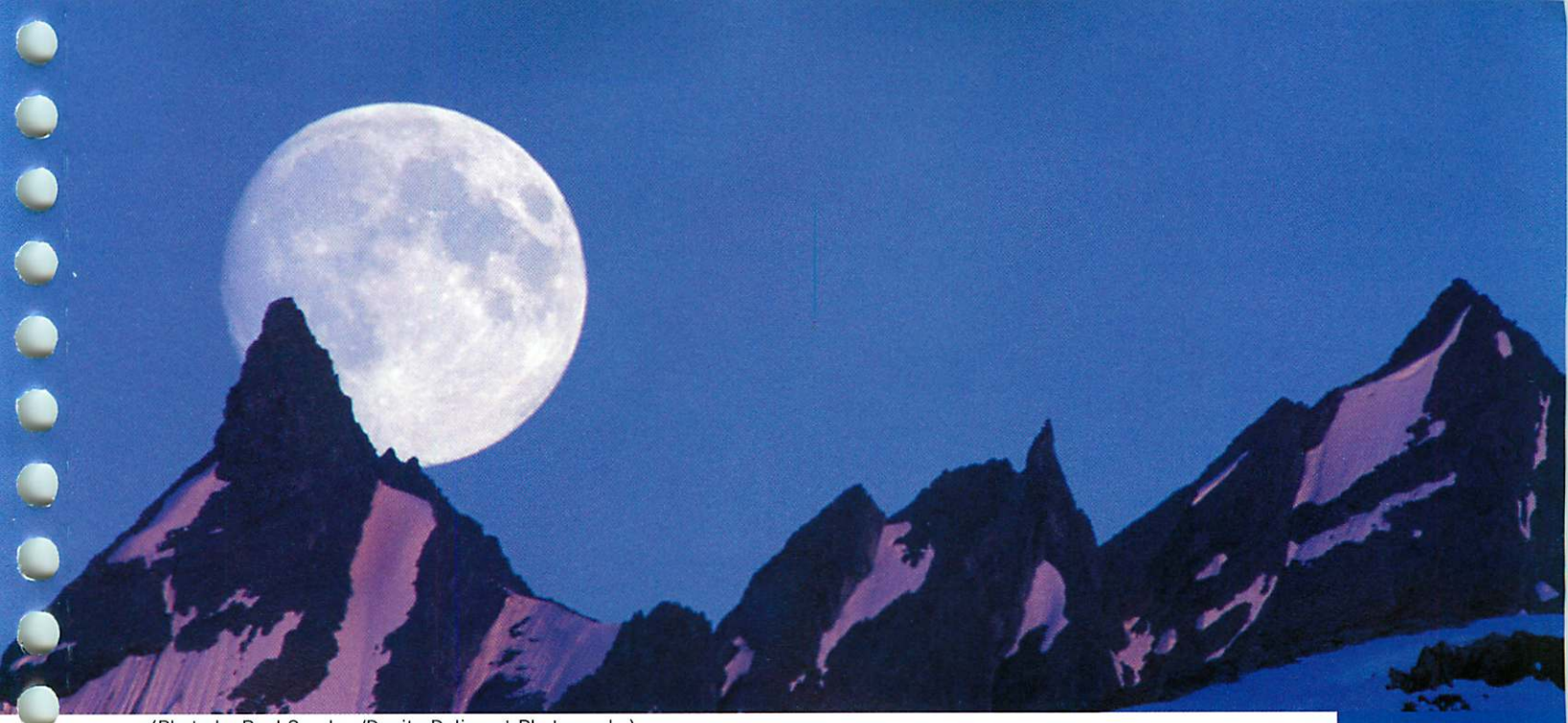


(Photo by Paul Souders/Danita Delimont Photography)

PART 4

Astronomy

EXERCISE 17

Astronomical Observations

Scientific inquiry often starts with the systematic collection of data from which hypotheses and general theories are developed. The study of astronomy, an observational science, begins by carefully observing and recording the changing positions of the Sun, Moon, planets, and stars. To become proficient in astronomy requires developing the skills necessary to become a keen observer, using both the unaided eye and the telescope.

In this exercise you will observe several celestial objects. Observing and recording the changing positions of the Sun, Moon, and stars will aid in the interpretation and understanding of their movements in future exercises.

Objectives

After you have completed this exercise, you will have:

1. Records of the changing position of the Sun as it rises or sets on the horizon.
2. Measurements of the angle of the Sun above the horizon at noon on several days.
3. A record of the phases of the Moon over a period of several weeks.
4. Data on the times that the Moon rises and sets.
5. Records of the position and motion of stars.
6. An understanding of the parts of a telescope.

Materials

meterstick (or yardstick)	star chart	small weight
ruler	protractor	
calculator	stringatlas	

Materials Supplied by Your Instructor

telescope(s) (optional)

Terms

revolution	altitude
astrolabe	rotation

Sun Observations

Many people are unaware that the Sun rises and sets at different locations on the horizon each day. As Earth **revolves** about the Sun, the orientation of its axis to the Sun continually changes. The result is that the location of the rising and setting Sun, as well as the **altitude** (angle above the horizon) of the Sun at noon, changes throughout the year.

Sunset (or Sunrise) Observations

Use the procedure presented in question 1 to make several observations and recordings of the Sun's location on the horizon at sunset or sunrise.

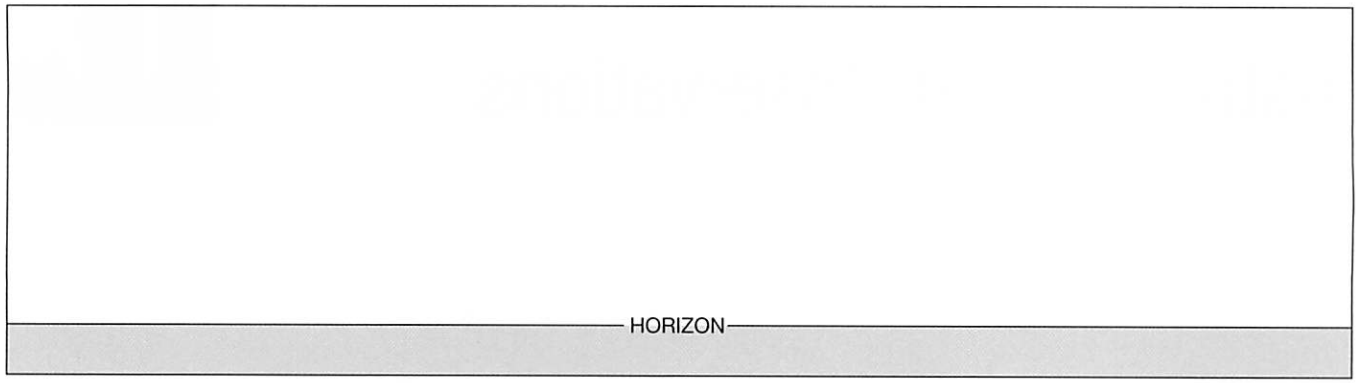
1. Following Steps 1–4, record at least four separate observations of the setting or rising Sun. Gather the data over a period of several weeks; *wait four or five days between each observation.* The directions are for sunset, although some minor adjustments will also allow their use for sunrise.

Step 1: Several minutes prior to sunset, estimate where the Sun will set on the western horizon. Draw the prominent features (buildings, trees, etc.) to the north and south of the Sun's approximate setting position on a sunset data sheet in Figure 17.1. (*Note:* As you observe the Sun setting in the west, south will be to your left and north to your right.)

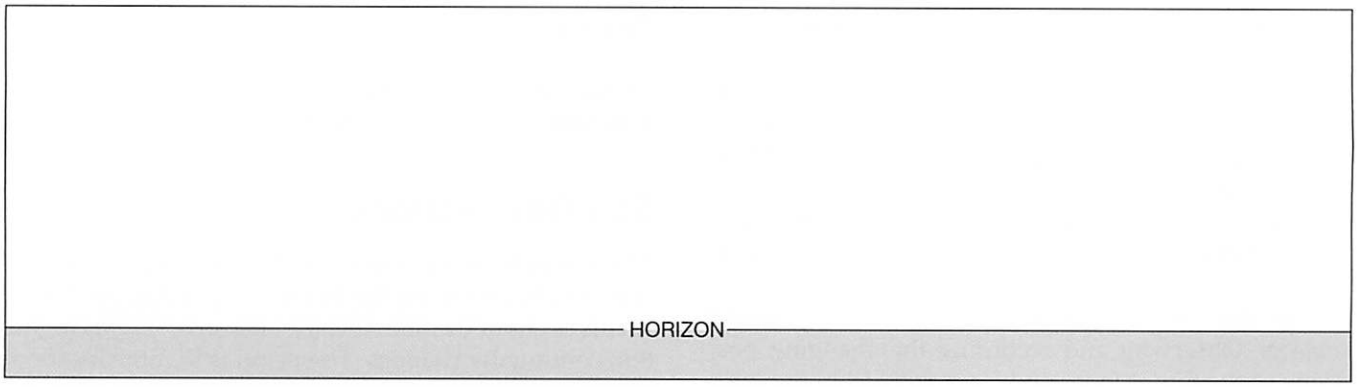
CAUTION: Never look directly at the Sun; eye damage may result.

Step 2: As the Sun sets, draw its position on the data sheet relative to the fixed features on the horizon.

SUNSET (Sunrise) DATA SHEETS



Date of observation _____ Time of observation _____



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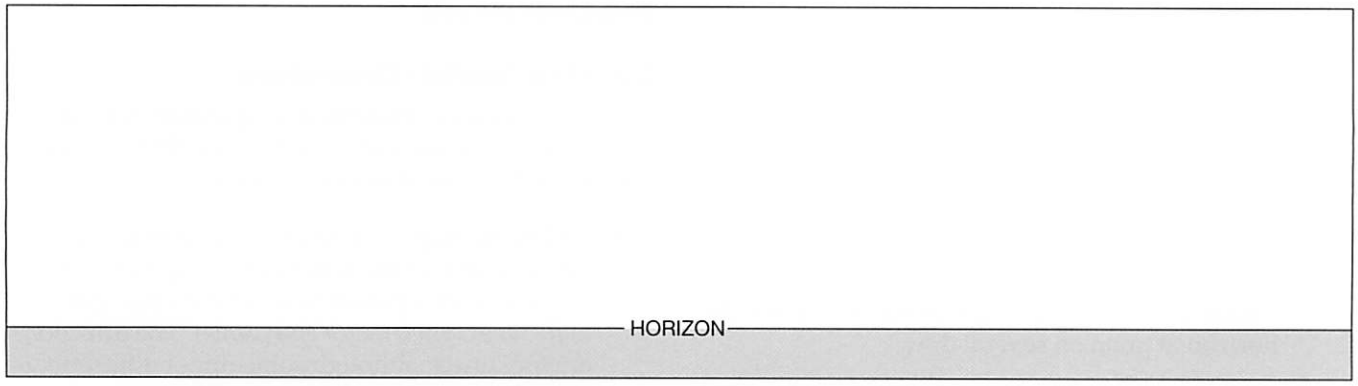
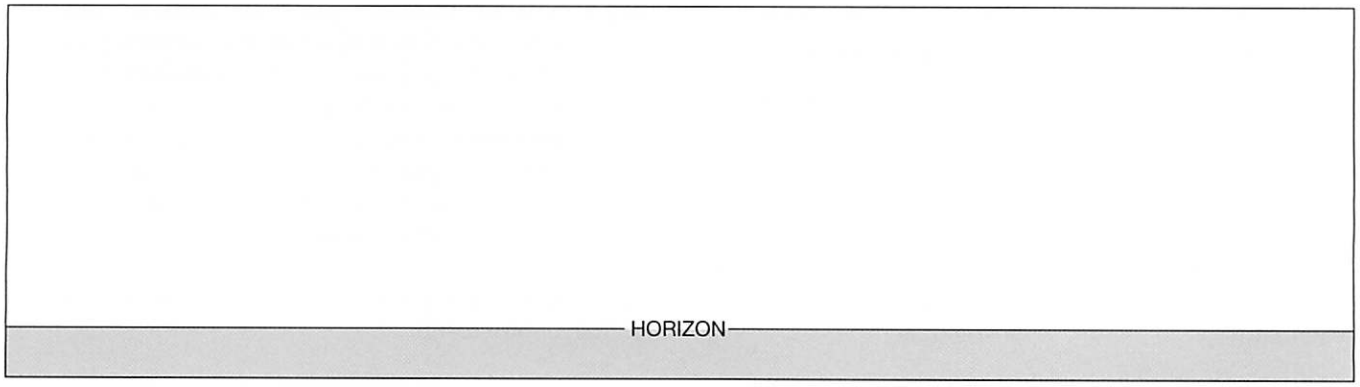


Date of observation _____ Time of observation _____



Date of observation _____ Time of observation _____

Figure 17.1 Sunset (sunrise) data sheets.

Step 3: Note the date and time of your observation on the data sheet.

Step 4: Return to the same location several days later. Repeat your observation and record the results on a new data sheet.

2. After you complete your observations, describe the changing location of the Sun at sunset, or sunrise, that you have observed over the past several weeks.

_____

_____

_____

_____

Measuring the Noon Sun Angle

Observe the method for measuring the altitude (angle) of the noon Sun above the horizon illustrated in Figure 17.2. Then, following the steps listed in question 3, determine the altitude of the Sun at noon on several days.

3. To determine the altitude (angle) of the Sun at noon:

Step 1: Place a yardstick (a meterstick or ruler will do) perfectly vertical to the ground or a table top.

Step 2: When the Sun is at its highest position in the sky (noon, standard time, or 1 P.M. daylight savings time, will be close enough), accurately measure the length of the shadow.

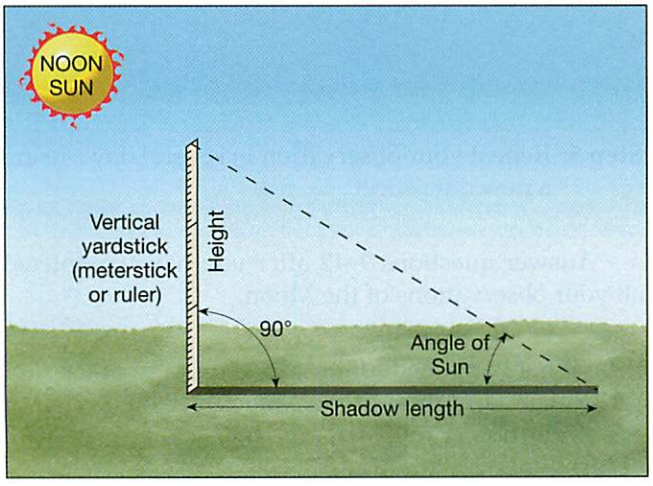


Figure 17.2 Illustration of the method for measuring the angle of the Sun above the horizon at noon. With each observation, be certain that the yardstick is perpendicular (at a 90° angle) to the ground or table top.

CAUTION: Never look directly at the Sun; eye damage may result.

Step 3: Divide the height of the stick by the length of the shadow.

Step 4: Consult Table 17.1 to determine the Sun angle. To find the Sun angle, locate the number on the table that comes closest to your answer from Step 3, and read the angle listed next to it.

Step 5: Repeat the measurement at exactly the same time on several different days over a period of four or five weeks. Record the dates and results of the measurements in the following spaces.

Date: _____ Noon Sun angle: _____°

Date: _____ Noon Sun angle: _____°

Date: _____ Noon Sun angle: _____°

Date: _____ Noon Sun angle: _____°

Answer questions 4–6 after you have completed your measurements of the altitude of the noon Sun.

4. The altitude of the noon Sun has (increased, decreased) over the period of the measurements. Circle your answer.
5. How many degrees has the noon Sun angle changed over the period of your observations?

_____°

6. What is the approximate average change of the noon Sun angle per day?

_____° per day

7. Based on your answer in question 6, how many degrees will the noon Sun angle change over a six-month period?

_____° over a six-month period

Moon Observations

Most people have noticed that the shape of the illuminated portion of the Moon as observed from Earth changes regularly. However, few take the time to systematically record and explain these changes. Following the procedure presented in question 8, begin your study of the Moon by observing its phases and recording your observations.

8. Record at least four observations of the Moon by completing each of the following steps regularly at a two- or three-day interval.

Step 1: On a Moon observation data sheet provided in Figure 17.3, indicate the approximate east–west

Table 17.1 Data Table for Determining the Noon Sun Angle. Select the nearest number to the quotient determined by dividing the height of the stick by the length of the shadow. Read the corresponding Sun angle.

IF $\frac{\text{HEIGHT OF STICK}}{\text{LENGTH OF SHADOW}}$	THEN SUN ANGLE IS	IF $\frac{\text{HEIGHT OF STICK}}{\text{LENGTH OF SHADOW}}$	THEN SUN ANGLE IS
0.2679	15°	1.235	51°
0.2867	16°	1.280	52°
0.3057	17°	1.327	53°
0.3249	18°	1.376	54°
0.3443	19°	1.428	55°
0.3640	20°	1.483	56°
0.3839	21°	1.540	57°
0.4040	22°	1.600	58°
0.4245	23°	1.664	59°
0.4452	24°	1.732	60°
0.4663	25°	1.804	61°
0.4877	26°	1.881	62°
0.5095	27°	1.963	63°
0.5317	28°	2.050	64°
0.5543	29°	2.145	65°
0.5774	30°	2.246	66°
0.6009	31°	2.356	67°
0.6249	32°	2.475	68°
0.6494	33°	2.605	69°
0.6745	34°	2.748	70°
0.7002	35°	2.904	71°
0.7265	36°	3.078	72°
0.7536	37°	3.271	73°
0.7813	38°	3.487	74°
0.8098	39°	3.732	75°
0.8391	40°	4.011	76°
0.8693	41°	4.332	77°
0.9004	42°	4.705	78°
0.9325	43°	5.145	79°
0.9657	44°	5.671	80°
1.0000	45°	6.314	81°
1.0360	46°	7.115	82°
1.0720	47°	8.144	83°
1.1110	48°	9.514	84°
1.1500	49°	11.430	85°
1.1920	50°		

position of the Moon in the sky by drawing a circle at the appropriate location. (*Note:* As you look to the south to observe the Moon, east will be to your left and west to your right.)

Step 2: By shading the circle, indicate the shape of the illuminated portion of the Moon you observe.

Step 3: Note the date and time of your observation on the data sheet.

Step 4: Keep in mind that the approximate time between moonrise on the eastern horizon and moonset on the western horizon is twelve hours. Estimate when the Moon may have risen and when it may set. Write your estimates on the data sheet.

Step 5: Repeat your observation in several days, using a new data sheet.

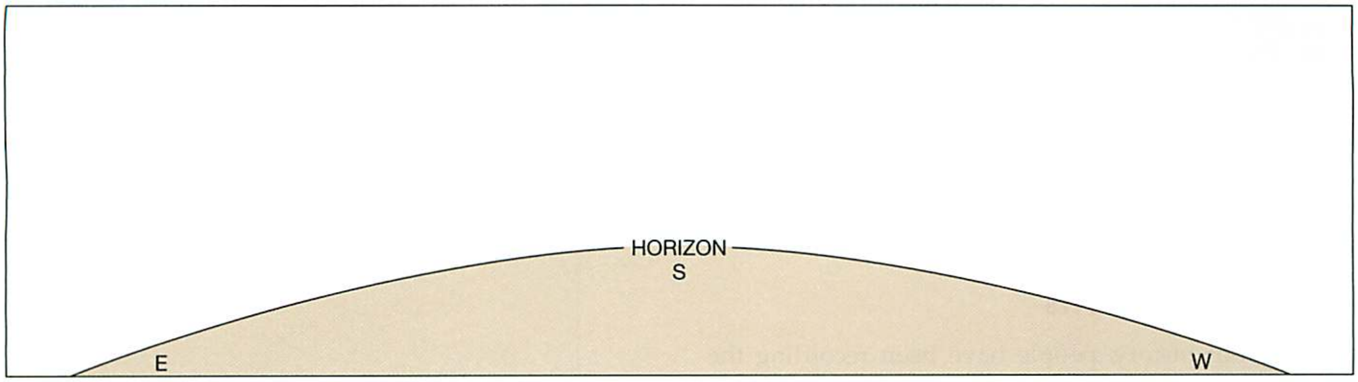
Answer questions 9–12 after you have completed all your observations of the Moon.

9. What happened to the size and shape of the illuminated portion of the Moon over the period of your observations?

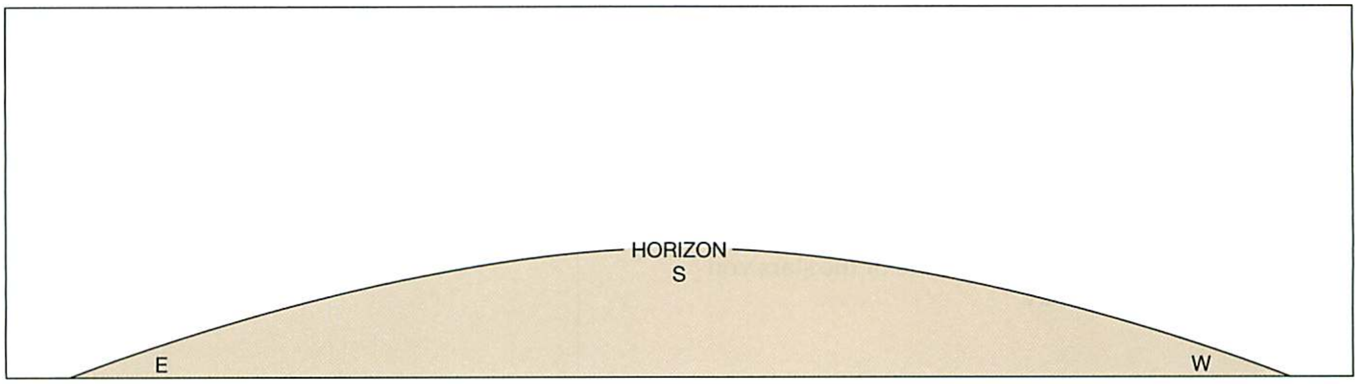
_____

_____

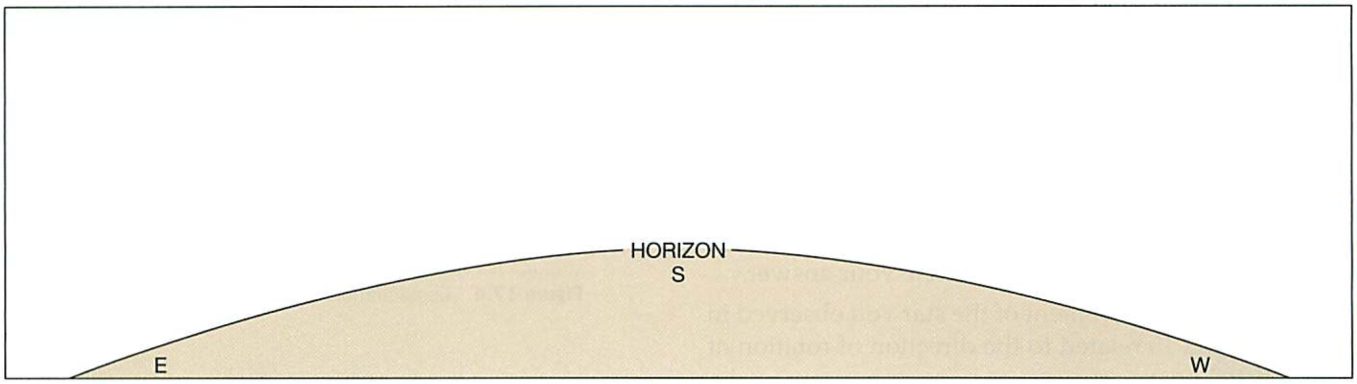
MOON OBSERVATION DATA SHEETS



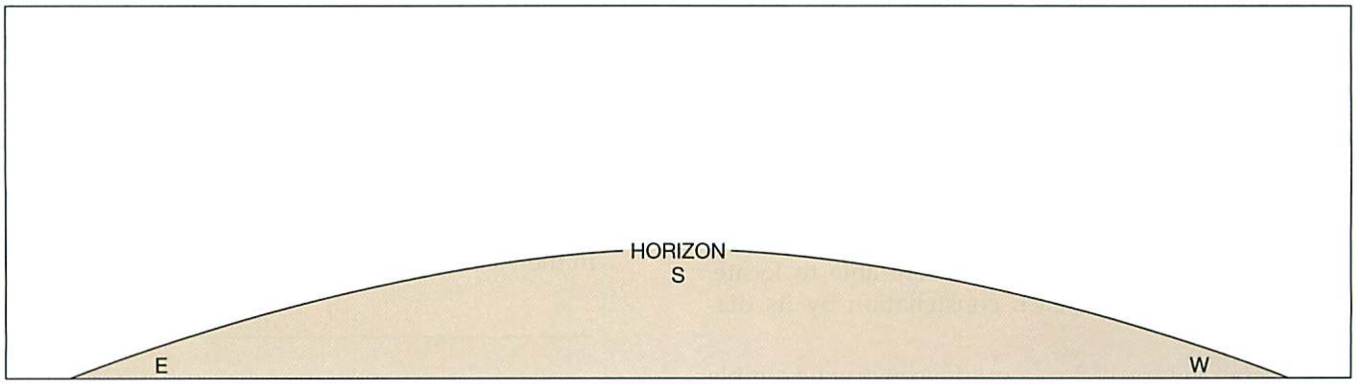
Date of observation ________ Time of observation ________ Time of moonrise ________ Time of moonset ________



Date of observation ________ Time of observation ________ Time of moonrise ________ Time of moonset ________



Date of observation ________ Time of observation ________ Time of moonrise ________ Time of moonset ________



Date of observation ________ Time of observation ________ Time of moonrise ________ Time of moonset ________

Figure 17.3 Moon observation data sheets.

10. The Moon moved farther (eastward, westward) in the sky with each successive observation. Circle your answer.
11. The times of moonrise and moonset became (earlier, later) with each successive observation. Circle your answer.
12. Based upon your observations and your answers to questions 10 and 11, the Moon revolves around Earth from (east to west, west to east).

Star Observations

Throughout history, people have been recording the positions and nightly movement of stars that result from Earth's **rotation**, as well as the seasonal changes in the constellations as Earth revolves about the Sun. Early astronomers offered many explanations for the changes before the true nature of the motions was understood in the 17th century.

To best observe the stars, select a suitable dark area on a clear, moonless night. Then complete questions 13–22.

13. Make a list of the different colors of the stars you can observe in the sky.

_____

Select one star that is overhead, or nearly so, and observe its movement over a period of one hour.

14. With your arm extended, approximately how many widths of your fist has the position of the star changed?

_____ fist widths

15. The star appears to move (eastward, westward) over a period of one hour. Circle your answer.
16. How is the movement of the star you observed in question 15 related to the direction of rotation of Earth?

_____

_____

Use a suitable star chart to locate several constellations and the North Star (Polaris).

17. Refer to Figure 17.4. Sketch the pattern of stars for two constellations you were able to locate. List the name of each constellation by its diagram.
18. Using Figure 17.5 as a guide, construct a simple **astrolabe** and measure the angle of the North Star (Polaris) above the horizon as accurately as possible.

_____° above the (north, south) horizon

Constellation Star Pattern

Constellation name: _____

Constellation Star Pattern

Constellation name: _____

Figure 17.4 Constellation sketches.

Over a period of several hours, observe the motion of the stars in the vicinity of Polaris.

19. Write a brief summary of the motion of the stars in the vicinity of Polaris.

_____

_____

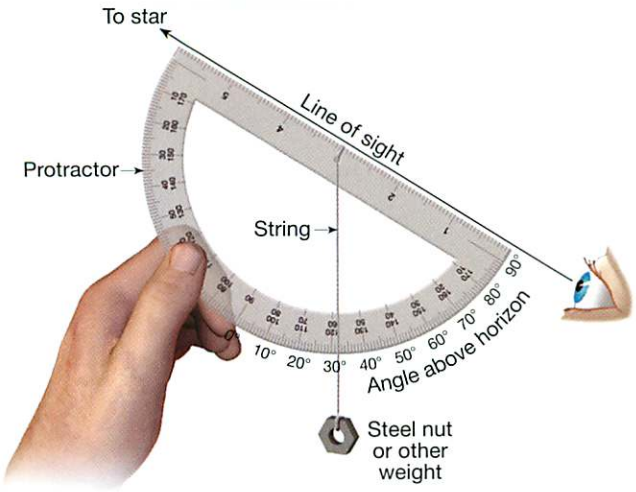


Figure 17.5 Simple astrolabe, an instrument used to measure the angle of an object above the horizon. The angle is read where the string crosses the outer edge of the protractor, 32° in the example illustrated. Notice that the angle above the horizon is the difference between 90° and the angle imprinted on the protractor.

If you can, come back to the same location at the exact same time, several weeks later.

20. The same star you observed overhead several weeks earlier (is still overhead, has moved to the east, has moved to the west). Circle your answer.

21. How is the change in position of the star you observed overhead several weeks earlier related to the revolution of Earth?

22. Using the astrolabe you constructed in question 18, repeat your measurement of the angle of the North Star (Polaris) above the horizon. List your new measurement and compare it to the measurement you obtained several weeks earlier. Explain your result(s).

Astronomical Observations on the Internet

Continue your analyses of the topics presented in this exercise by completing the corresponding online activity on the *Applications & Investigations in Earth Science* website at http://prenhall.com/earthsciencelab

Notes and calculations.

Astronomical Observations

Date Due: _____

Name: _____

Date: _____

Class: _____

After you have finished Exercise 17, complete the following questions. You may have to refer to the exercise for assistance or to locate specific answers. Be prepared to submit this summary/report to your instructor at the designated time.

1. On Figure 17.6, prepare a single sketch illustrating your observed positions of the setting (or rising) Sun on the horizon during the past several weeks. Show the reference features you used on the horizon. Label each position of the Sun with the date of the observation. Write a brief summary of your observations below the diagram.
2. From question 3, step 5, in the exercise, list the noon Sun angle that you calculated for the first and last day of your measurements.

   Noon Sun angle on the first day: _____°

   Date of observation: _____

   Noon Sun angle on the last day: _____°

   Date of observation: _____
3. Draw two sketches of the Moon—the first illustrating the Moon as you saw it on your first lunar observation, the second as you saw it on your last observation. Label the date and time of each observation.

FIRST MOON OBSERVATION	LAST MOON OBSERVATION
Date: _____	Date: _____
Time: _____	Time: _____

4. Did the Moon rise earlier or later each night that you observed it?

   _____

_____ Horizon _____

Summary: _____

_____

Figure 17.6 Sunset (sunrise) observations.

5. List the different colors of stars that you observed.

_____

6. Approximately how many widths of your fist, with your arm extended, will a star appear to move in one hour? Toward which direction do the stars appear to move throughout the night and what is the reason for the motion?

_____

_____

_____

7. What was your measured angle of the North Star (Polaris) above the horizon at your location? Did the angle change over a several-week period? Explain why.

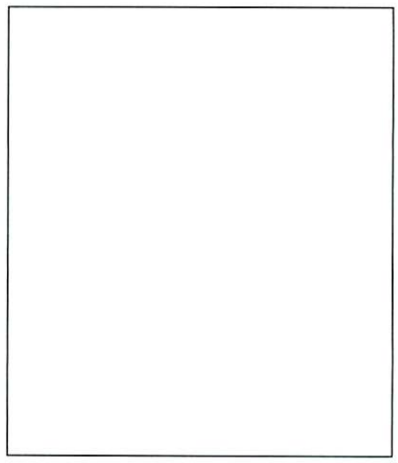
_____

_____

_____

8. Refer to Figure 17.7. Sketch the pattern of stars for any constellation you have been able to locate in the sky. What is the name of the constellation?

Constellation Star Pattern



Constellation name: _____

Figure 17.7 Constellation sketch.