7.1 Ancient Astronomy

Key Terms
calendar
celestial object
astronomer
revolution
rotation

The first people to notice the sky must have been very impressed with its reliability. The Sun sets every night and rises every morning. The Moon goes through the same phases every month. The stars sweep across the night sky with the changing seasons and return with exact timing to the same position in the sky every year.

People began developing technologies based on observations of the sky. For example, the Maya civilization in Mexico's Yucatan region built the pyramid in **Figure 7.1** around 1000 years ago. As the Sun sets on the first day of spring and fall, the light and shadow create the appearance of a diamond-backed snake gradually moving down the stairs of the pyramid. The shadows end at a statue of a snake's head. This phenomenon does not happen on the first day of winter and summer.

Human survival depends on the reliability of the Sun rising every morning and the seasons returning every year. It must have been very frightening for early sky watchers when unexpected events, such as a solar eclipse, occurred in the sky. During a solar eclipse, the Moon passes in front of the Sun and temporarily blocks the Sun's light. (You will learn more about eclipses in Section 7.3.) If unexpected events can occur in the sky, then maybe the reliability of the Sun and the changing seasons were not as dependable as the early sky watchers had hoped.

Figure 7.1 This pyramid has four stairways, each with 91 stairs. These stairs, plus the platform on top, add to a total of 365, representing the 365 days of the year.

Early Calendars and Sky Observations

calendar a way of showing days, organized into a schedule of larger units of time, such as weeks, months, seasons, or years; usually a table or a chart

Careful long-term observations of the sky by early sky watchers led to the first calendars. A **calendar** is a way of showing days. The days are organized into a schedule of larger units of time, such as weeks, months, seasons, or years. Calendars like the stepped pyramid in **Figure 7.1** allowed people to predict yearly events, such as when the seasons change. This, in turn, allowed people to predict other important events, such as spring rains, the annual flooding of rivers and lakes, and the migration of birds, insects, and herds of animals. Predicting rains and floods allowed some cultures to plan watering for agriculture (farming). Predicting locations of herds of animals allowed other cultures to plan hunting.

Fishers, mariners, and travellers knew the fixed patterns of the stars in the sky and used them to help them find their way, or navigate, on land and water. The ancient Egyptians relied on a star called Sirius to let them know when the Nile river was about to flood. Sirius rises just before dawn at the same time every year before the annual flooding of the Nile.

Early Astronomers

Our earliest ancestors paid a great deal of attention to the sky and took great care not to offend the deities (gods) who they believed ruled the skies. The sky watchers closely watched the sky for signs that the deities might be getting restless. If something unusual happened, such as the eclipse in **Figure 7.2**, people interpreted this to mean that they needed to do something to please the deities and return order to the sky. From these early needs grew the role of celestial priests and priestesses. Celestial priests and priestesses studied **celestial objects**, such as the Sun and other stars, the Moon, and the planets. They learned to predict celestial events, such as seasons and eclipses.

celestial object any object that exists in space, such as a planet, a star, or the Moon

Figure 7.2 Scientists know from historical records that early sky watchers were terrified by the sight of the Moon blocking the Sun's light and sending Earth into darkness. They did not understand what was happening, and they were afraid of the unknown.

Mesopotamian Astronomers

Over 6000 years ago, civilizations developed in the region between the Tigris and Euphrates Rivers. These two rivers flow through what is now the country of Iraq. The civilizations that developed in this region—the Assyrians, the Babylonians, and the Sumerians—were called Mesopotamians. The Mesopotamians were the first **astronomers** for whom we have evidence of detailed astronomical observations. They kept detailed records of the sky as early as 6000 years ago. Their calendars were thorough although not perfectly accurate.

With the invention of the calendar, the first civilizations were born. Having a calendar meant that organized agriculture was possible. Having organized agriculture meant that societies could produce extra food. Producing extra food meant that other people in these societies could be freed up from farming to focus on specializing their skills in diverse areas such as woodworking and metallurgy (the science of working with metals).

astronomer a scientist who studies astronomy, which is the study of the night sky

Today's Year

Today, our year is determined by counting the number of days required for the Sun to return to exactly the same place in the sky with respect to the background stars. In other words, our year is determined by the amount of time it takes for Earth to make one **revolution** around the Sun. This means that the year is 365.24 days long. The year is further divided into 12 months and 52 weeks, with seven days in each week.

The months have different numbers of days. If you add up the total number of days in each month, you actually get only 365 days. Every four years, an extra day is added in February to account for the accumulation of the quarter days. The year in which this happens is called a leap year.

revolution the time it takes for an object to orbit another object; Earth's revolution around the Sun is 365.24 days

Early Clocks

People were also interested in understanding and recording time during a single day. One day is the average time it takes for Earth to make one **rotation** on its axis with respect to the Sun, for example, from noon until noon.

The first clocks were simply pillars and sticks in the ground. People used the shadows they cast to tell the time of day. Early sky watchers had to use shadows because watching the Sun directly is dangerous. The sunlight can damage the eyes and even cause blindness. People monitored the position and length of the shadow cast by a stick or pillar as the Sun moved across the sky. As cultures progressed, they replaced the early stick "clocks" with sundials, such as the one shown in **Figure 7.3**.

rotation the turning of an object around an imaginary axis running through it

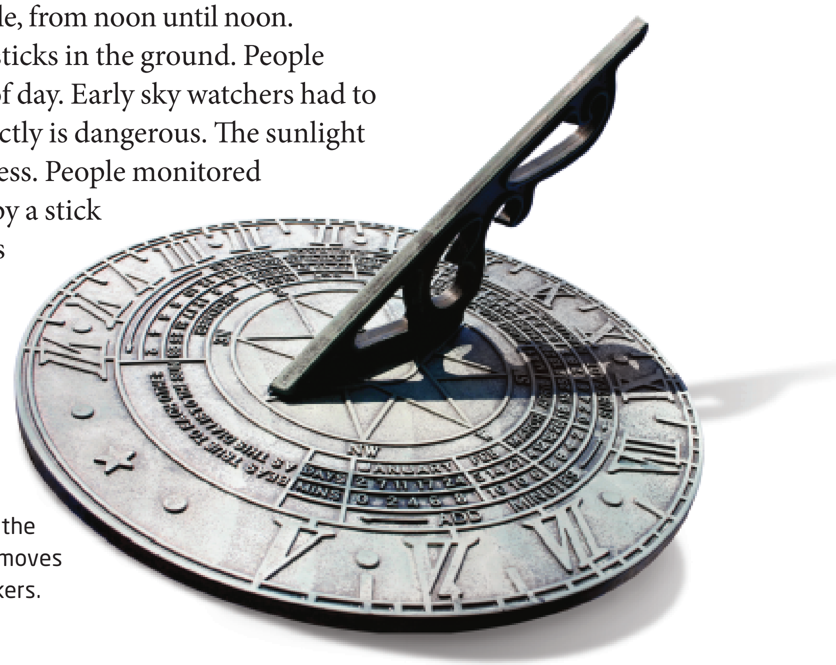

Figure 7.3 As Earth rotates, the shadow of the straight edge moves and aligns with the hour markers.

Learning Check

1. What unit of time does one rotation of Earth correspond to?
2. Who were the first astronomers for whom we have evidence of detailed astronomical observations?
3. How did the invention of calendars lead to having extra food?
4. Computerized calendars allow us to keep time without making observations in nature. How has this changed our relationship to both time and space? Consider **Figure 7.1** in your answer.

Inferring Earth's Spherical Shape

Today, you can look at photographs of Earth taken from space and see that Earth is a sphere. This is not obvious when standing on Earth's surface. Earth is so large that it looks flat. The ancient Egyptians thought that Earth was flat and supported by mountains at four different places. The ancient Inuit also thought that Earth was flat, stationary, and at the centre of the universe. The ancient Chinese believed that Earth was a square surrounded by one huge ocean.

Originally, the ancient Greeks thought that Earth floated in the ocean like a piece of wood floats in water. Two ancient Greek philosophers, Eratosthenes and Aristarchus (310–230 B.C.E.), hypothesized that Earth is spherical. They also hypothesized that the apparent flatness of Earth is an illusion created by Earth's enormous size. Their hypotheses were based on three pieces of evidence.

Disappearing Ships

The first piece of evidence was well known in the time of the ancient Greeks (and probably much earlier, but not recorded). Look at **Figure 7.4**. As a ship sailed out into the Mediterranean Sea, the hull disappeared below the horizon (the line where the sky and Earth seem to meet). But the masts and the sails of the ship were still visible. Eventually, the masts and the sails also disappeared below the horizon as the ship moved farther away.

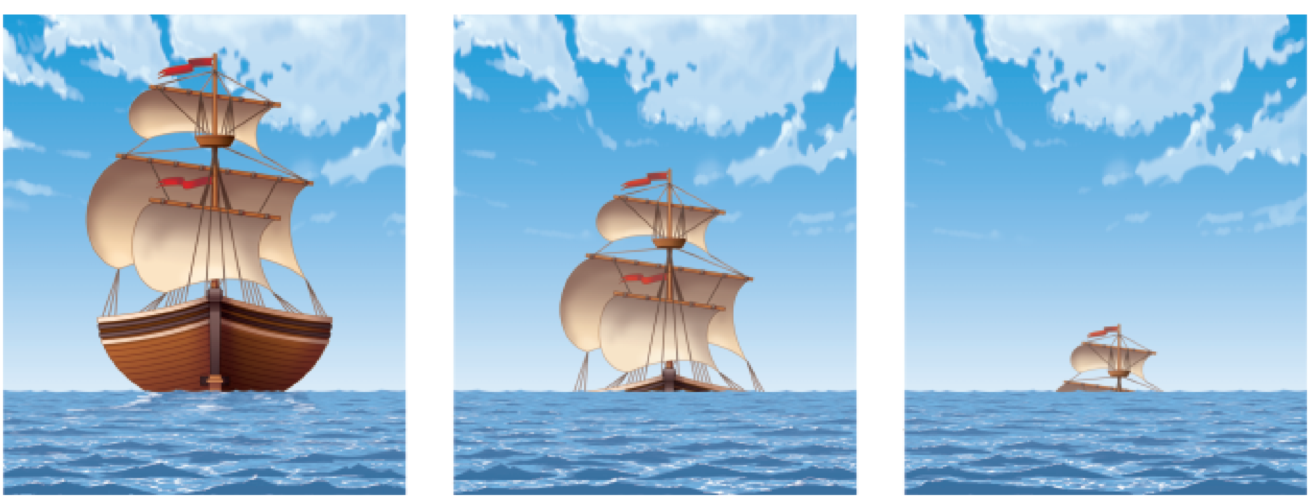

Figure 7.4 Ancient Greek philosophers observed that the hull of a ship drops out of sight and appears to descend below the horizon as the ship sails farther away.

The Changing Sky

The second piece of evidence was the changing appearance of the sky as travellers journeyed farther north and south. When travelling farther north, travellers saw stars rising farther above the northern horizon. When travelling farther south, they saw stars they had never seen before rising above the southern horizon. This is shown in **Figure 7.5**.

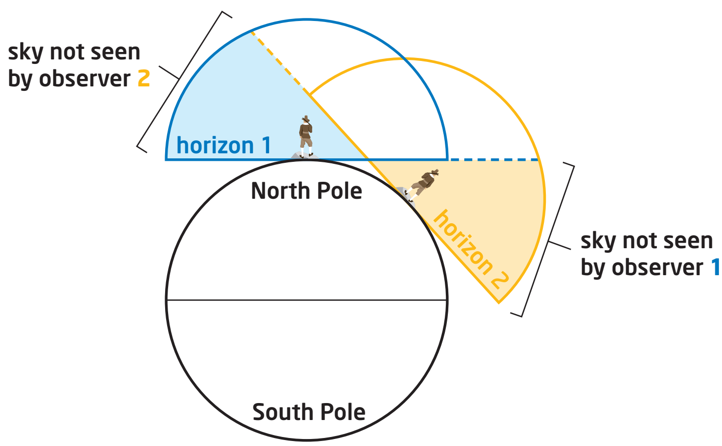

Figure 7.5 As ancient travellers moved in a north-south direction, they noticed changes in their view of the sky. Observer 1 sees a different view of the sky than observer 2.

Earth's Curved Shadow

The third piece of evidence was the shape of Earth's shadow. During an eclipse of the Moon, the Moon passes through Earth's shadow. The ancient Greeks knew about eclipses of the Moon. They noticed that the shape of Earth's shadow is always curved, as shown in **Figure 7.6**. Only a circular or spherical object can cast a curved shadow. In addition, using this knowledge, Aristarchus calculated the relative sizes of the Moon and Earth. Aristarchus also figured out the relative size of the Sun and its relative distance from Earth compared with Earth's distance from the Moon.

Study Toolkit

Identifying Cause and Effect The three pieces of evidence leading to the realization that Earth is a sphere can be seen as effects. You can use a cause-and-effect graphic organizer, such as the one on page 270, as an aid to show this. How does using a graphic organizer help you better understand the material?

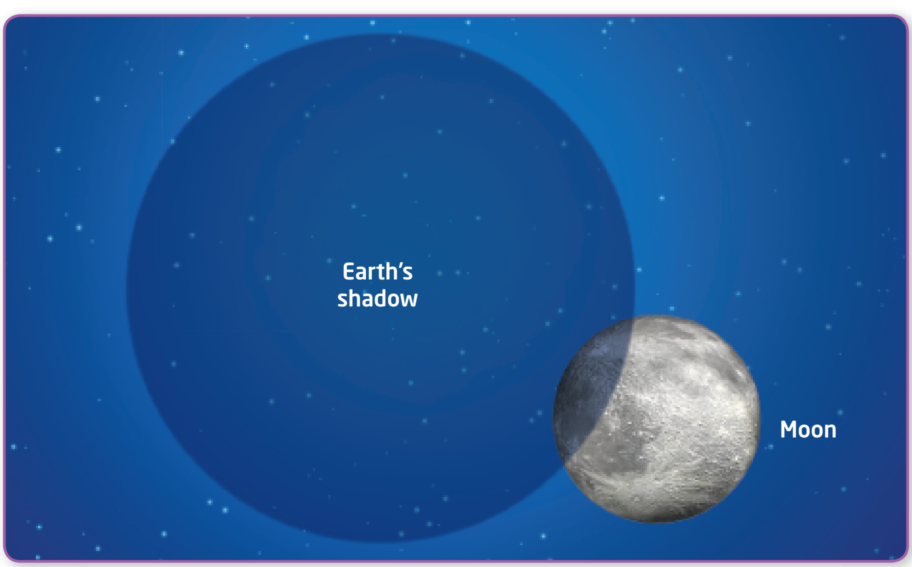

Figure 7.6 During a lunar eclipse, the Moon passes through Earth's shadow.

Section 7.1 Review

Section Summary

- Early sky watchers paid a lot of attention to the sky. This enabled them to develop accurate calendars, which they used to predict the seasons and other events that were important to them in their daily lives.
- Different cultures have different reasons for watching the sky. For example, the ancient Egyptians watched for a star called Sirius to rise every year because they knew that the Nile River would flood soon after.
- Earth's revolution around the Sun takes 365.24 days. Earth's rotation on its axis takes 24 hours.
- Careful observations of ships "disappearing" below the horizon, the changing appearance of the sky when travelling, and Earth's shadow viewed during eclipses led the early Greeks to infer that Earth is a sphere.

Review Questions

K/U **1.** What does the term *celestial object* mean? Give two examples.

C **2.** What unit of time does one revolution of Earth around the Sun correspond to? Include a simple diagram in your answer.

K/U **3.** Give two examples of why early cultures depended on their observations of the sky.

C **4.** In an email to a friend, explain how calendars were helpful to ancient civilizations.

C **5.** A friend believes that Earth is flat. Construct an argument to convince your friend that Earth is a sphere.

A **6.** What do you think a ship would look like if it sailed farther and farther away on a flat surface? How do you think this observation helps to prove that Earth is not flat?

T/I **7.** Imagine that you are standing at the North Pole and see a star directly overhead. Where do you think the star would be if you were standing at the equator? Review **Figure 7.5**.

T/I **8.** Large sailing ships have a lookout post, called a crow's-nest, on one of their masts. Why is the crow's-nest as high on a mast as possible?