SECTION 1

Stars

As You Read

What You'll Learn

- **Explain** why the positions of constellations change throughout the year.
- **Distinguish** between absolute magnitude and apparent magnitude.
- **Describe** how parallax is used to determine distance.

Vocabulary

constellation
absolute magnitude
apparent magnitude
light-year

Why It's Important

Each of the thousands of stars you see in the night sky is a sun.

Constellations

It's fun to look at cloud formations and find ones that remind you of animals, people, or objects that you recognize. It takes much more imagination to play this game with celestial bodies. Ancient Greeks, Romans, and other early cultures observed patterns of stars in the sky called **constellations** and imagined that they represented mythological characters, animals, or familiar objects.

From Earth, a constellation looks like spots of light arranged in a particular shape against the dark night sky. **Figure 1** shows how the constellation of the mythological Greek hunter Orion appears from Earth. It also shows how stars in the constellation have no relationship to each other in space.

Stars in the sky can be found at specific locations within a constellation. For example, you can find the star Betelgeuse (BEE tul jooz) in the shoulder of the mighty hunter Orion. Orion's faithful companion is his dog, Canis Major. Sirius, the brightest star visible from the northern hemisphere, is in Canis Major.

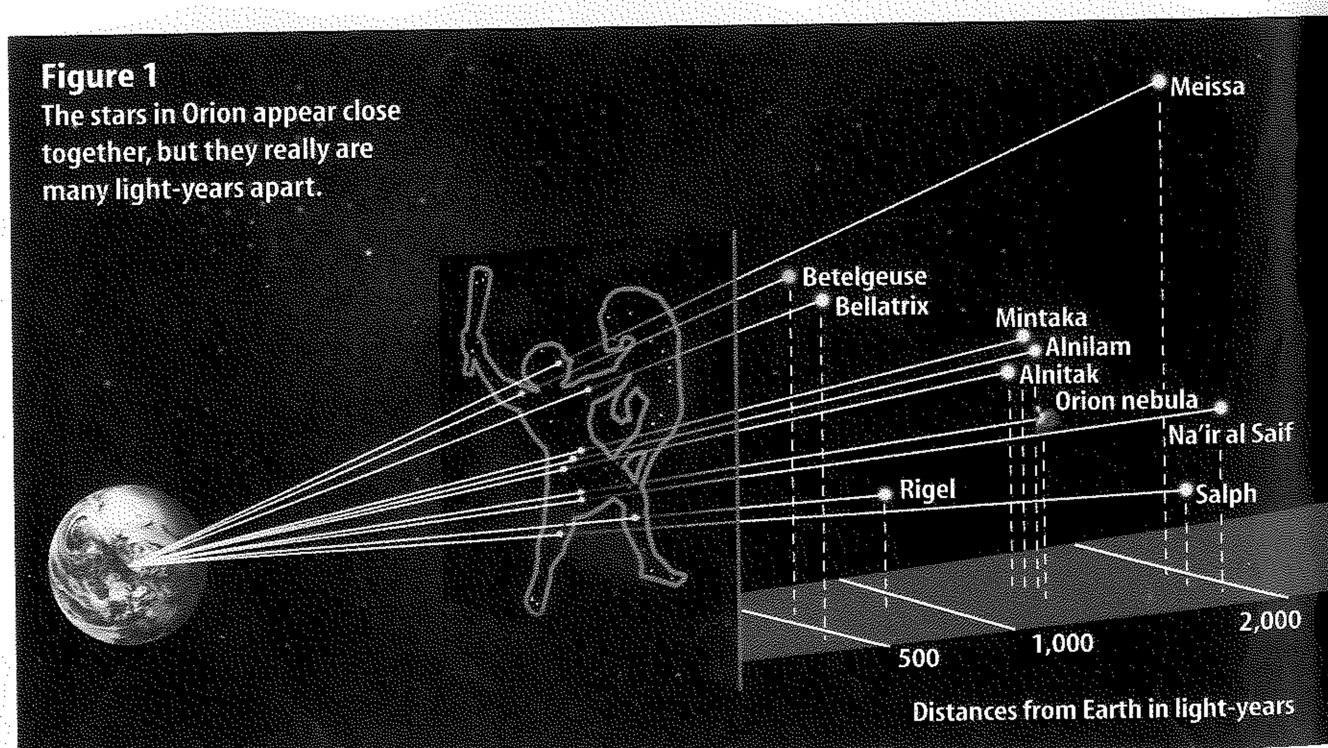

Figure 1
The stars in Orion appear close together, but they really are many light-years apart.

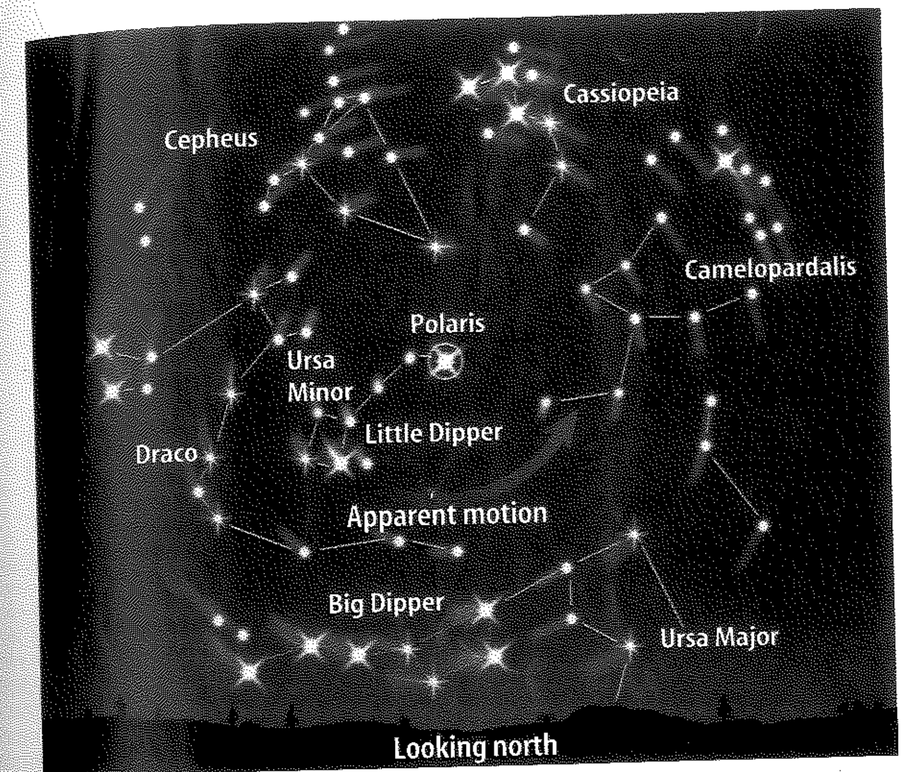

Figure 2
The Big Dipper, in red, is part of the constellation Ursa Major. It is visible year-round in the northern hemisphere. Constellations close to Polaris rotate around Polaris, which is almost directly over the north pole.

Modern Constellations Modern astronomy divides the sky into 88 constellations, many of which were named by early astronomers. You probably know some of them. Can you recognize the Big Dipper? It's part of the constellation Ursa Major, shown in **Figure 2.** Notice how the front two stars of the Big Dipper point almost directly at the North Star, Polaris, which is located at the end of the Little Dipper in the constellation Ursa Minor. Polaris is positioned almost directly over Earth's north pole.

Circumpolar Constellations As Earth rotates, Ursa Major, Ursa Minor, and other constellations in the northern sky circle around Polaris. Because of this, they are called circumpolar constellations. The constellations appear to move, as shown in **Figure 2,** because Earth is in motion. The stars appear to complete one full circle in the sky in less than 24 h as Earth rotates on its axis. One circumpolar constellation that's easy to find is Cassiopeia (kas ee uh PEE uh). You can look for five bright stars that form a big W or a big M in the northern sky, depending on the season. In spring and summer, Cassiopeia forms an M, and in fall and winter, it forms a W.

As Earth orbits the Sun, different constellations come into view while others disappear. Because of their unique position, circumpolar constellations are visible all year long. Other constellations are not. Orion, which is visible in the winter in the northern hemisphere, can't be seen there in the summer because the daytime side of Earth is facing it.

TRY AT HOME
Mini LAB

Observing Star Patterns

Procedure

1. On a clear night, go outside after dark and study the stars. Take an adult with you and help each other find some common constellations.
2. Let your imagination flow to find patterns of stars that look like something familiar.
3. Draw the stars you see, note their positions, and include a drawing of what you think each star pattern resembles.

Analysis

1. Which of your constellations match those observed by your classmates?
2. How can recognizing star patterns be useful?

Absolute and Apparent Magnitudes

When you look at constellations, you'll notice that some stars are brighter than others. For example, Sirius looks much brighter than Rigel. Is Sirius a brighter star, or is it just closer to Earth, making it appear to be brighter? As it turns out, Sirius is 100 times closer to Earth than Rigel is. If Sirius and Rigel were the same distance from Earth, Rigel would appear much brighter in the night sky than Sirius would.

When you refer to the brightness of a star, you can refer to its absolute magnitude or its apparent magnitude. The **absolute magnitude** of a star is a measure of the amount of light it gives off. A measure of the amount of light received on Earth is called the **apparent magnitude.** A star that's rather dim can appear bright in the sky if it's close to Earth, and a star that's bright can appear dim if it's far away. If two stars are the same distance away, what might cause one of them to be brighter than the other?

Field GUIDE

Which constellations are visible during different seasons? To find out, see the **Backyard Astronomy Field Guide** at the back of the book.

Reading Check *What is the difference between absolute and apparent magnitude?*

Problem-Solving Activity

Are distance and brightness related?

The apparent magnitude of a star is affected by its distance from Earth. This activity will help you determine the relationship between distance and brightness.

Identifying the Problem

Luisa conducted an experiment to determine the relationship between distance and the brightness of stars. She used a meterstick, a light meter, and a lightbulb. She placed the bulb at the zero end of the meterstick, then placed the light meter at the 20-cm mark and recorded the distance and the light-meter reading in her data table. Readings are in luxes, which are units for measuring light intensity. Luisa then increased the distance from the bulb to the light meter and took more readings. By examining the data in the table, can you see a relationship between the two variables?

Effect of Distance on Light

Distance (cm)	Meter Reading (luxes)
20	4150.0
40	1037.5
60	461.1
80	259.4

Solving the Problem

1. What happened to the amount of light recorded when the distance was increased from 20 cm to 40 cm? When the distance was increased from 20 cm to 60 cm?
2. What does this indicate about the relationship between light intensity and distance? What would the light intensity be at 100 cm? Would making a graph help you visualize the relationship?

Measurement in Space

How do scientists determine distance to stars from the solar system that Earth is part of? One way is to measure its parallax—the apparent shift in the position of an object when viewed from two different positions. Extend your arm and look at your thumb first with your left eye closed and then with your right eye closed, as the girl in **Figure 3A** is doing. Your thumb appears to change position with respect to the background. Now do the same experiment with your thumb closer to your face, as shown in **Figure 3B.** What do you observe? The nearer an object is to the observer, the greater its parallax is.

Astronomers can measure the parallax of relatively close stars to determine their distances from Earth. **Figure 4** shows how a close star's position appears to change. Knowing the angle that the star's position changes and the size of Earth's orbit, astronomers can calculate the distance of the star from Earth.

Because space is so vast, a special unit of measure is needed to record distances. Distances between stars and galaxies are measured in light-years. A **light-year** is the distance that light travels in one year. Light travels at 300,000 km/s, or about 9.5 trillion km in one year. The nearest star to Earth, other than the Sun, is Proxima Centauri. Proxima Centauri is a mere 4.3 light-years away, or about 40 trillion km.

Figure 3
A Your thumb appears to move less against the background when it is farther away.
B It appears to move more when it is closer.

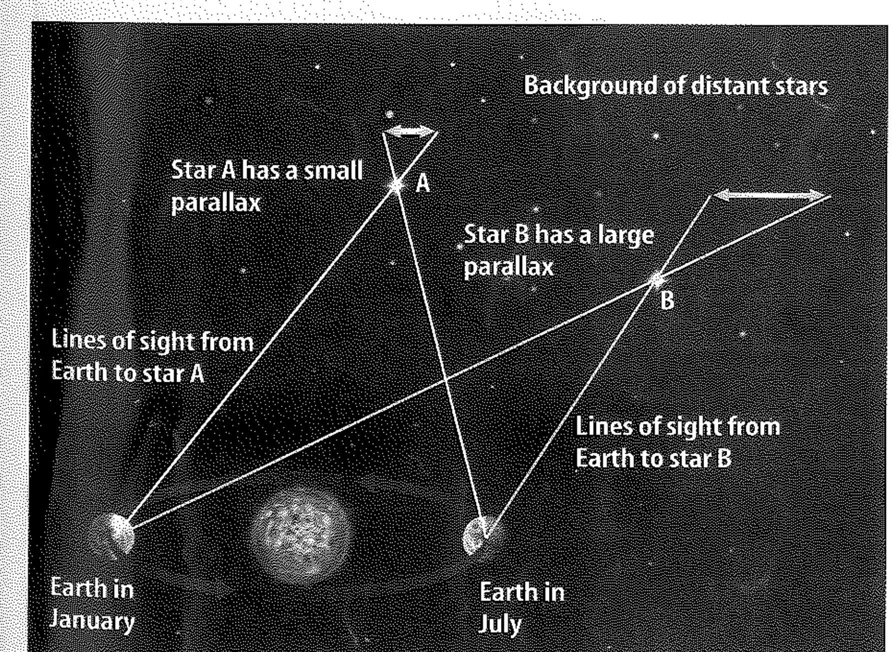

Figure 4
Parallax can be seen if you observe the same star when Earth is at two different points during its orbit around the Sun. The star's position relative to more distant background stars will appear to change. *Is star A or B farther from Earth?*

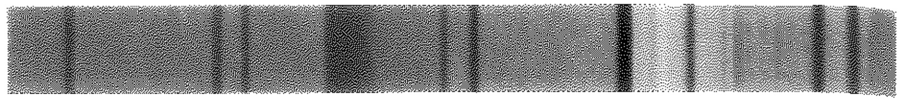

Figure 5
These star spectra were made by placing a diffraction grating over a telescope's objective lens. A diffraction grating produces a spectrum by causing interference of light waves. *What causes the lines in spectra?*

Properties of Stars

The color of a star indicates its temperature. For example, hot stars are a blue-white color. A relatively cool star looks orange or red. Stars that have the same temperature as the Sun have a yellow color.

Astronomers study the composition of stars by observing their spectra. When fitted into a telescope, a spectroscope acts like a prism. It spreads light out in the rainbow band called a spectrum. When light from a star passes through a spectroscope, it breaks into its component colors. Look at the spectrum of a star in **Figure 5.** Notice the dark lines caused by elements in the star's atmosphere. Light radiated from a star passes through the star's atmosphere. As it does, elements in the atmosphere absorb some of this light.The wavelengths of visible light that are absorbed appear as dark lines in the spectrum. Each element absorbs certain wavelengths, producing a certain pattern of dark lines. Every chemical element produces a unique pattern of dark lines. Like a fingerprint, the patterns of lines can be used to identify which elements are in a star's atmosphere.

Section 1 Assessment

1. What is a constellation?
2. How does Earth's revolution affect the viewing of constellations throughout the year?
3. If two stars give off equal amounts of light, why might one look brighter?
4. If the spectrum of a star shows the same absorption lines as the Sun, what can be said about the star's composition?
5. **Think Critically** Several thousand stars have large enough parallaxes that their distances can be studied using parallax. Most of these stars are invisible to the naked eye. What does this indicate about their absolute magnitudes?

Skill Builder Activities

6. **Recognizing Cause and Effect** Suppose you viewed Proxima Centauri through a telescope today. How old were you when the light that you see left Proxima Centauri? Why might Proxima Centauri look dimmer than Betelgeuse, a large star that is 520 light-years away? **For more help, refer to the** Science Skill Handbook.
7. **Using Graphics Software** Use graphics software on a computer to make a star chart of major constellations visible from where you live during the current season. Include several reference points to help others find the charted constellations. **For more help, refer to the Technology Skill Handbook.**