Name _____ Class _____ Date _____

CHAPTER 18 Studying Space

SECTION 3

Mapping the Stars

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What are constellations?
- How can we precisely locate stars in the night sky?

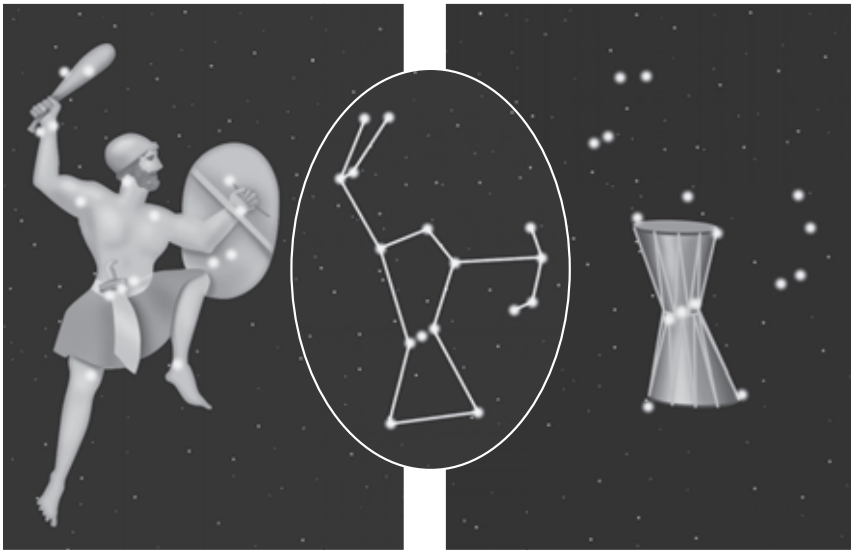
What Are Constellations?

People in ancient cultures grouped stars into patterns and named sections of the sky based on those patterns. **Constellations** are sections of the sky that contain recognizable star patterns.

Different civilizations had different names for the same constellations. For example, the Greeks saw a hunter (Orion) in the northern sky, but the Japanese saw a drum. Today, different cultures still see different shapes in the stars in the sky. However, astronomers have agreed on the names and locations of the constellations.

STUDY TIP

Summarize in Pairs Read this section quietly to yourself. With a partner, talk about what you learned. Together, try to figure out things that you don't understand.



The ancient Greeks saw a hunter in this set of stars. The Japanese saw the same set of stars as a drum.

Say It

Infer Why is it important for modern astronomers to agree on the names and locations of the constellations? In a small group, talk about what might happen if astronomers did not agree on these things. How might the science of astronomy be different?

CONSTELLATIONS: ORGANIZING THE SKY

Many people think of constellations as stick figures made by connecting bright stars with imaginary lines. However, to an astronomer, a constellation is an entire section of the sky. Just as Texas is a region of the United States, Ursa Major is a region of the sky. Each constellation shares a border with a neighboring constellation. Every star or galaxy in the sky is located within one of 88 constellations. ☑

READING CHECK

1. Identify How many regions do astronomers break the sky into?

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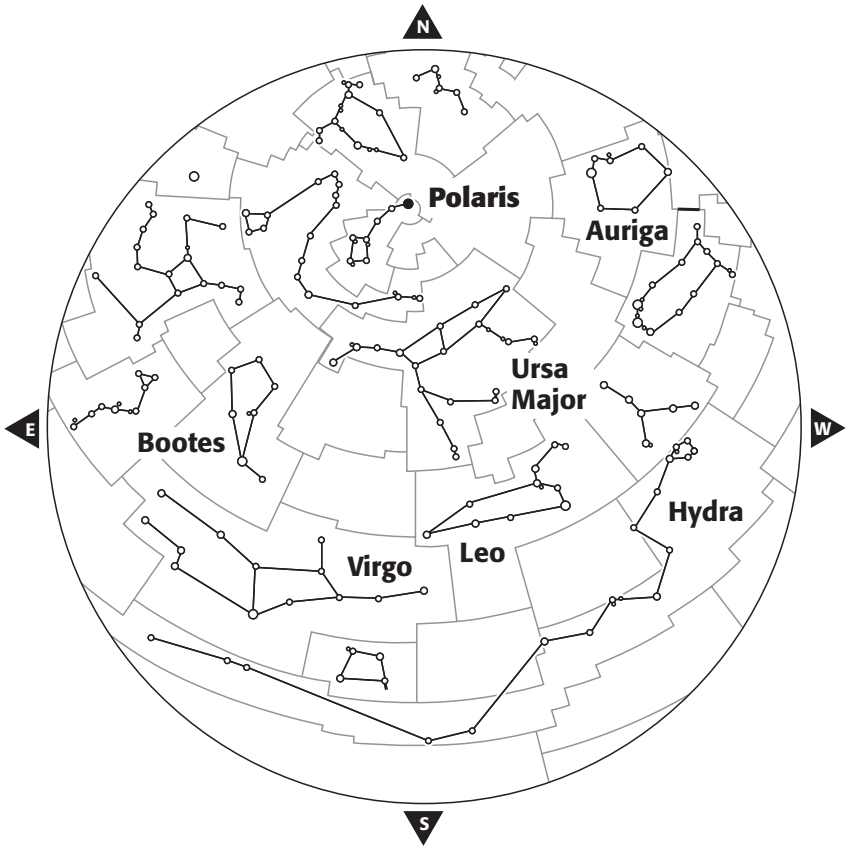

This sky map shows some of the constellations that are visible in the Northern Hemisphere at midnight in the spring.

TAKE A LOOK

2. Identify Which constellation takes up a large part of the southern and southwestern sky in the spring in the Northern Hemisphere?

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SEASONAL CHANGES

The figure above shows what the midnight sky in the Northern Hemisphere looks like in the spring. However, as the Earth travels around the sun, different areas of the universe are visible. In addition, different constellations are visible from different points on the Earth. Therefore, this map is not accurate for the Northern Hemisphere during seasons other than spring, or for the Southern Hemisphere. ☑

READING CHECK

3. Explain Why can't you use the same star map to show all of the stars that are visible to everyone on the Earth?

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THE PATH OF STARS ACROSS THE SKY

You know that the sun seems to move across the sky during the day. In the same way, the stars and planets rise and set during the night. This apparent motion is caused by Earth's rotation. As the Earth rotates, different parts of the universe become visible to people on the Earth. ☑

Near the poles, some stars can be seen at all times of year and all times of night. These stars are called *circumpolar stars*. *Circum* means "around" or "circling." Circumpolar stars seem to move through the sky in circles around the poles.

READING CHECK

4. Identify Why do the stars seem to move across the sky?

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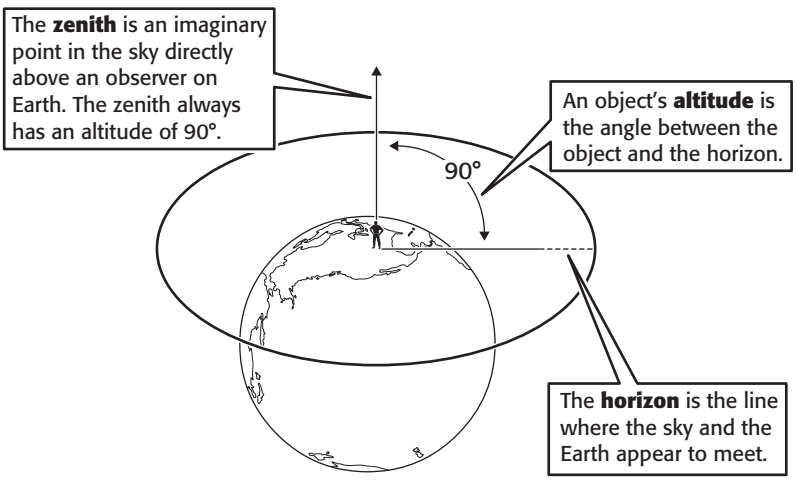
How Can You Describe the Location of a Star?

Have you ever tried to point out a star to someone? It can be very difficult to describe the exact location of an object in the sky. You can use a tool called an *astrolabe* to help you describe the location of such an object.

To use an astrolabe, you need to understand the differences between horizon, altitude, and zenith. The **horizon** is the line where the Earth and the sky seem to meet. An object's **altitude** is the angle between the object and the horizon. The **zenith** is an imaginary point in the sky that is directly above your head. The zenith always has an altitude of 90°. The figure below shows these three reference points.



Math Focus

5. Estimate Angles On the figure, draw a star to show the location of an object with an altitude of about 45°.

THE CELESTIAL SPHERE

To talk to each other about a star, astronomers must have a common method of describing the star's location. The method that astronomers use is based on the celestial sphere. The *celestial sphere* is an imaginary sphere that surrounds the Earth. Remember that we use latitude and longitude to describe the location of objects on the Earth's surface. In the same way, astronomers use declination and right ascension to plot positions in the sky.

Remember that latitude is a measure of the distance north or south of the equator. *Declination* is the distance of an object north or south of the celestial equator. The *celestial equator* is an imaginary circle formed by extending the Earth's equator into space, as shown in the figure below.

Remember that longitude is a measure of the distance east or west of the prime meridian. *Right ascension* is a measure of how far east an object is from the vernal equinox. The *vernal equinox* is the position of the sun on the first day of spring.

Critical Thinking

6. Compare How is latitude similar to declination? How are they different?

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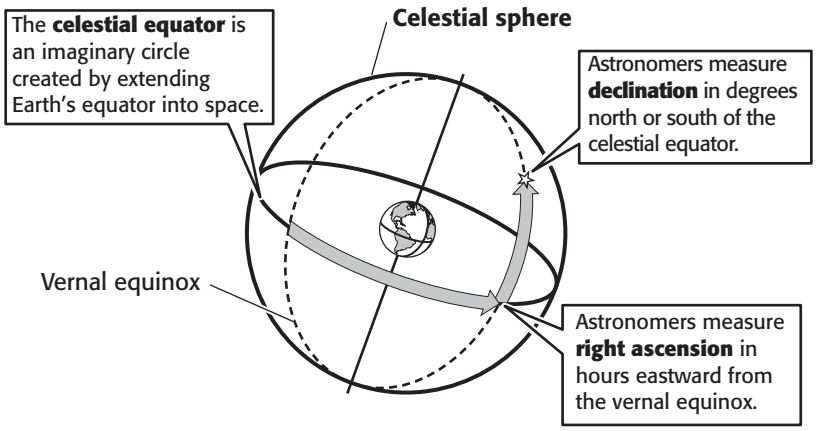
The Celestial Sphere



TAKE A LOOK

7. Define What is the celestial equator?

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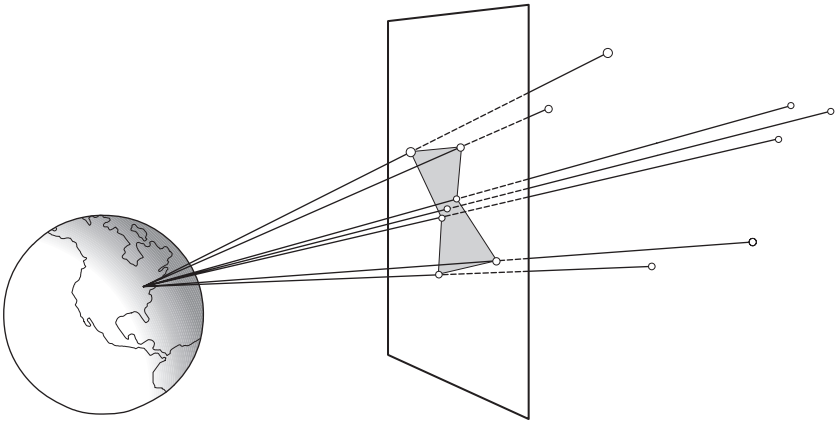
How Big Is the Universe?

In the 1500s, Nicolaus Copernicus noticed that the planets appeared to move, but the stars did not. He thought the stars must be farther away than the planets. Stars are so distant that a new unit of length, the light-year, was invented to measure their distance. A **light-year** is the distance that light travels in 1 year. One light-year is equal to 9.46 trillion kilometers. The farthest objects we can observe are more than 10 billion light-years away! ☑

Many of the stars in the sky look the same. For example, the stars in Orion all seem to be about the same size in the sky. However, some stars are much closer than others. The figure below shows how stars that are very far apart can look the same to people on the Earth.



The stars in Orion seem to be very close together. However, they are actually very far apart.

THE SCALE OF THE UNIVERSE

When you think about the universe, it is important to think about scale. For example, stars appear to be very small when you see them in the sky. However, we know that most stars are much larger than the Earth. They look small in the sky because they are very far away. The figure on the next page shows how distance can affect the apparent size of objects. ☑

READING CHECK

8. Define What is a light-year?

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TAKE A LOOK

9. Infer How might the pattern of stars that we see in Orion change if the Earth were further away from the stars than it is?

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READING CHECK

10. Explain Why do stars look very small, even though they are actually larger than the Earth?

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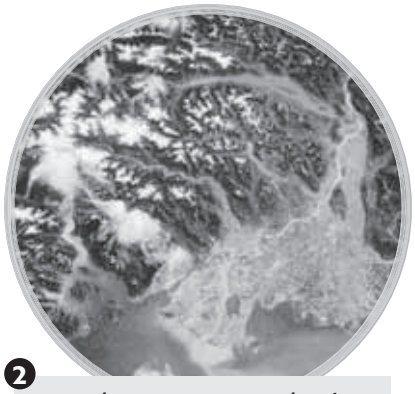
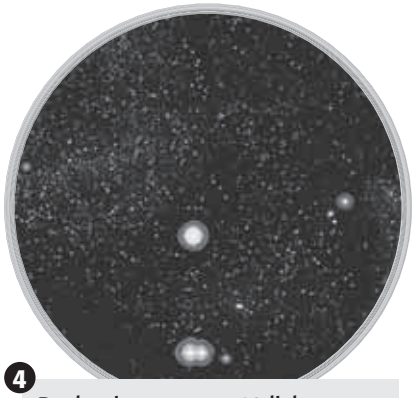
1 Let's start with home plate in a baseball stadium. You are looking down from a distance of about 10 m.



2 At 100 km away, you see the city that contains the stadium and the countryside around the city.

3 At 1,500,000,000 km (83 light-minutes) away, you can look back at the sun and the inner planets.



4 By the time you are 10 light-years away, the sun looks like any other star in space.

TAKE A LOOK

11. Infer What is a light-minute?

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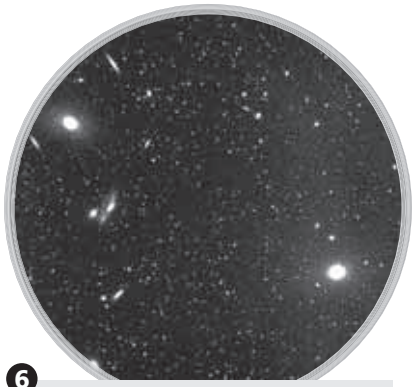
5 At 1 million light-years away, our galaxy looks like the Andromeda galaxy, a cloud of stars set in the blackness of space.



6 At 10 million light-years away, you can see a handful of galaxies called the *Local Group*.

TAKE A LOOK

12. Identify What is the local group?

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How Do Scientists Know That the Universe Is Expanding?

We see stars and galaxies because they *emit*, or give off, visible light. The color of light that we see from stars can change if the stars are moving compared to the Earth. When stars or galaxies are moving away from the Earth, the light from them looks redder than normal. This effect is called *redshift*. When stars or galaxies are moving toward the Earth, the light from them looks bluer than normal. This effect is called *blueshift*. ☑

READING CHECK

13. Explain Why do we see stars and galaxies?

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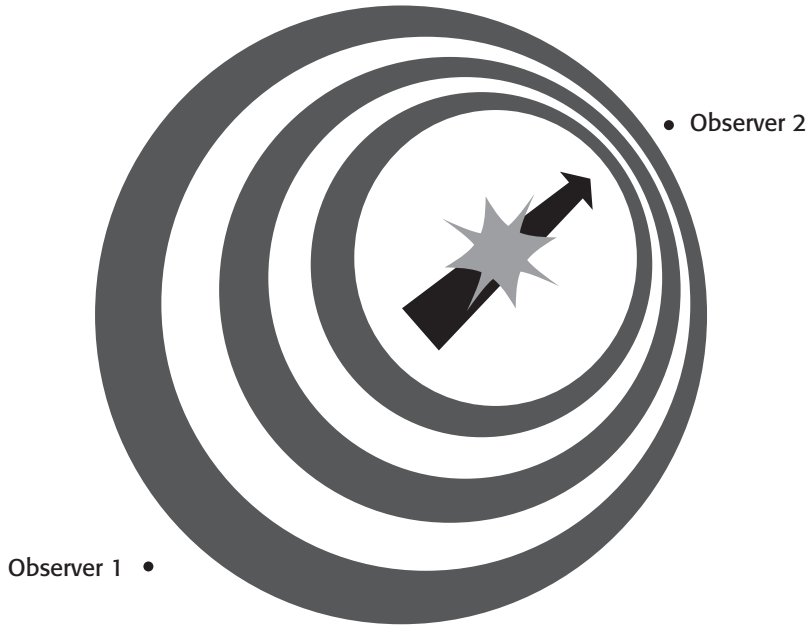

The galaxy is moving away from Observer 1 and toward Observer 2. To Observer 1, the light from the galaxy looks redder than normal. The waves of light are more spread out, so the wavelength is longer. To Observer 2, the light from the galaxy looks bluer than normal. The waves of light are closer together, so the wavelength is shorter.

TAKE A LOOK

14. Identify Which observer is seeing light that is affected by redshift?

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Redshift and blueshift affect light only from objects that are moving very quickly. This is why cars and airplanes do not look redder or bluer when they pass by you. They are not traveling fast enough for you to see redshift or blueshift effects.

The astronomer Edwin Hubble studied the light from stars and galaxies in the universe. He discovered that light from all of these objects, except the ones closest to the Earth, is affected by redshift. This means that the stars and galaxies in the universe are moving away from each other and from the Earth. In other words, the universe is expanding. ☑

READING CHECK

15. Explain How did Edwin Hubble show that the universe is expanding?

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Name _____ Class _____ Date _____

Section 3 Review

SECTION VOCABULARY

altitude the angle between an object in the sky and the horizon **constellation** a region of the sky that contains a recognizable star pattern and that is used to describe the location of objects in space	**horizon** the line where the sky and the Earth appear to meet **light-year** the distance that light travels in one year; about 9.46 trillion kilometers **zenith** the point in the sky directly above an observer on Earth

1. Define Write your own definition for *constellation*.

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2. Explain Why can we see different constellations in the fall than in the spring?

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3. Identify Fill in the spaces in the table below.

Term	Description
Declination	
Right ascension	
Celestial sphere	

4. Calculate About how many kilometers are in 0.5 light-years? Show your work.

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5. Apply Concepts Suppose that Edwin Hubble had observed that light from most stars and galaxies was affected by blueshift. What conclusion about the universe could be drawn from this observation? Explain your answer.

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