Name _____ Class _____ Date _____

SECTION 1 Stars

BEFORE YOU READ

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

- Why are stars different colors?
- How can scientists learn what stars are made of?
- How can we measure the distance between stars?
- Why do stars seem to move across the sky?

Why Are Stars Different Colors?

Stars look like tiny points of light in the sky. However, they are actually huge, bright balls of burning gas. If you look closely at the night sky, you might see that stars are different colors. Scientists can tell how much heat a star gives off by studying its color.

Compare the yellow flame of a candle to the blue flame of a Bunsen burner. A blue flame is much hotter. Stars are similar: blue stars burn hotter than yellow ones. Red stars are coolest.

A blue flame is hotter than a yellow one.

STUDY TIP

Ask Questions Read this section quietly to yourself. Write down questions that you have about this section. Discuss your questions in a small group.

TAKE A LOOK

1. Color Use colored pencils to make these flames the correct color.

2. Identify Which of the flames is cooler?

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What Are Stars Made Of?

Stars are made of gas. Hydrogen and helium are the two main elements that make up a star. Stars also contain small amounts of other elements, such as carbon, nitrogen, and oxygen. Each star is made up of a different mix of elements.

Most stars are trillions of miles away from Earth. Because scientists cannot visit the stars, they need to study stars from Earth. To find out what a star is made of, scientists study the light from the stars. ☑

READING CHECK

3. Explain How do scientists learn about stars?

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How Can Scientists Learn About Stars from Their Light?

Light takes time to travel through space. Stars are so far away that their light takes millions of years to travel to Earth! When scientists look through telescopes, it is as if they are looking back in time. The light we see from stars today was made millions of years ago. Some stars that we see might have already burned out. However, we can still see them because their light is just reaching Earth.

Critical Thinking

4. Apply Concepts When we look at the night sky, are we seeing the universe exactly as it is?

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What Can Scientists Learn from a Star's Light?

Scientists use the light from stars to find out what the stars are made of. When you look at white light through a glass prism, you can see a rainbow of colors. This rainbow is called a **spectrum** (plural, *spectra*). Millions of colors make up a spectrum, including red, orange, yellow, green, blue, indigo, and violet. Scientists use a machine called a *spectrograph* to break up a star's light into a spectrum.

Each element has a particular pattern of lines that appear in an *emission spectrum*. The emission spectrum shows scientists what elements are in the star.

Hydrogen

Helium

These are the emission spectra for the elements hydrogen and helium. These two elements make up most stars. Each line represents a different color of visible light.

TAKE A LOOK

5. Compare Which emission spectrum contains more colors of visible light, hydrogen or helium?

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How Do Scientists Classify Stars?

Stars can be classified in several ways. Scientists classify stars most commonly by temperature and brightness.

TEMPERATURE

In the past, scientists classified stars by the elements they contained. Today, stars are classified by temperature. Each group of stars is named with a letter of the alphabet. The table on the next page shows the features of different groups of stars.

Class	Color	Temperature (°C)	Elements detected
O	blue	above 30,000	helium
B	blue-white	10,000 to 30,000	hydrogen, helium
A	blue-white	7,500 to 10,000	hydrogen
F	yellow-white	6,000 to 7,500	hydrogen and heavier elements
G	yellow	5,000 to 6,000	calcium and heavier elements
K	orange	3,500 to 5,000	calcium and iron
M	red	less than 3,500	molecules, such as titanium dioxide

TAKE A LOOK

6. Identify A scientist discovers a star that is blue-white and is made of hydrogen. Which class should the scientist put the star in?

7. Identify Which class has hotter stars—G or B?

BRIGHTNESS

Before telescopes were invented, scientists judged the brightness of the stars with their naked eyes. They called the brightest stars they could see first-magnitude stars, and the dimmest stars, sixth-magnitude stars.

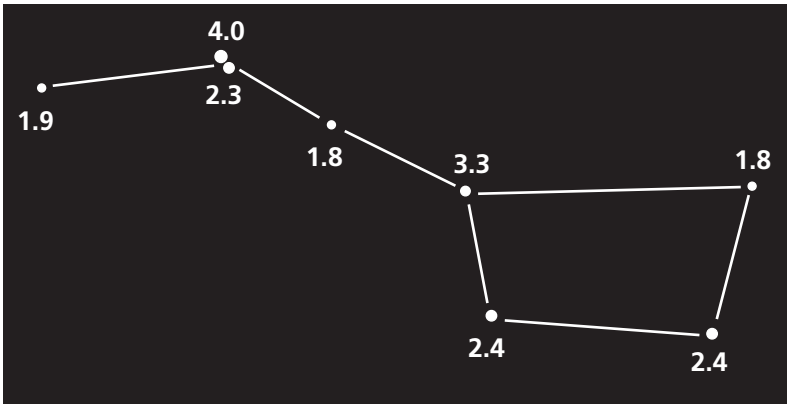
When telescopes were developed, scientists discovered this system had flaws. They could see more stars with the telescope than with the naked eye. They could also see the differences in brightness more clearly. The old system for classifying brightness was too general to include the dimmest stars that scientists were finding. A new system had to be created.

Today, scientists give each star a number to show its brightness, or *magnitude*. The dimmest stars have the largest numbers. The brightest stars have the smallest numbers. The magnitude of a very bright star can even be a negative number!

Critical Thinking

8. Apply Concepts Which star is brighter: one with a magnitude of 6.3 or one with a magnitude of −1.4?

Magnitudes of Stars in the Big Dipper



TAKE A LOOK

9. Identify Circle the brightest stars in the Big Dipper. What is their magnitude?

Does Distance Change a Star's Brightness?

If you look at a row of street lights, do all of the lights look the same? The nearest lights look brightest, and the farthest ones look dimmest.

The closer a light is, the brighter it looks.

TAKE A LOOK

10. Identify Circle the dimmest light in the picture. Put a box around the brightest light.

11. Explain The street lights are all equally bright. Why do they appear different?

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The brightness of a star as we see it from Earth is the star's **apparent magnitude**. A bright star can look very dim if it is very far away from Earth. A dim star can appear bright if it is closer to Earth.

A star's **absolute magnitude** is the actual brightness of the star. If all stars were the same distance away, their absolute magnitudes would equal their apparent magnitudes. For example, the sun's absolute magnitude is +4.8, but because it is close to Earth, its apparent magnitude is −26.8.

How Do Scientists Measure Distance to a Star?

Math Focus

12. Calculate What is the distance in kilometers from Earth to a star that is 30 light years away?

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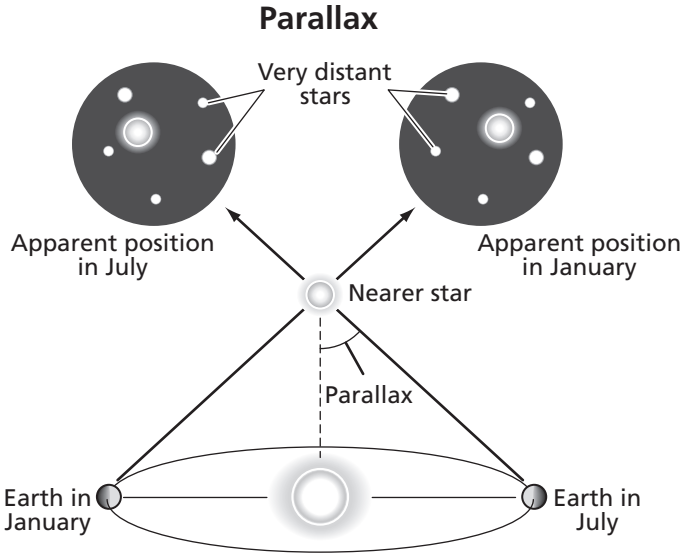
The distance between Earth and the stars is too large to be measured in miles or kilometers. Instead, scientists use a unit called a **light-year**, which is the distance that light can travel in one year. One light year equals 9.46 trillion kilometers. How can scientists measure such a large distance?

As Earth revolves around the sun, stars close to Earth seem to move, but far-off stars do not. This is called **parallax**. Scientists use parallax and math to find the distance between Earth and stars. To understand parallax, think about riding in a car past a large mountain. As you drive past the mountain, it seems to move. However, the mountain is not actually moving. It is your motion compared to the mountain that makes the mountain seem to move.



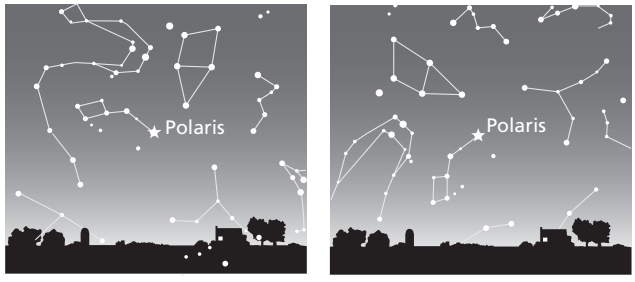
As the Earth revolves around the sun, a star's position seems to change.

Do Stars Move?

Stars move, but because they are so far away and move so slowly, we cannot see their movement easily. Every night stars seem to rise and set, but it is not the stars that are moving. It is the Earth.

The rotation of Earth causes daytime and nighttime. Because of Earth's rotation, the sun moves across the sky during the daytime. For this same reason, the stars seem to move across the sky at night. All of the stars that you see appear to rotate around Polaris, the North Star. The stars seem to make a full circle around Polaris every 24 hours.

Earth's tilt and revolution cause the seasons. During each season, any point on Earth faces a different part of the sky at night. That means that different stars appear in the night sky at different times of the year.



Because of the Earth's rotation, the stars seem to move across the sky.

In addition to their apparent motion, stars are moving through space. Because the stars are so far away, it is difficult for us to see their motions. Over thousands of years, however, the movements of the stars can cause the shapes of constellations to change.

TAKE A LOOK

13. Explain What causes parallax?

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TAKE A LOOK

14. Compare Circle one star, other than Polaris, in the picture on the left. Then circle the same star in the picture on the right. Draw a curved arrow in the first picture that shows the direction that the star seemed to move.

Name _____ Class _____ Date _____

Section 1 Review

SECTION VOCABULARY

absolute magnitude the brightness that a star would have at a distance of 32.6 light-years from Earth **apparent magnitude** the brightness of a star as seen from Earth	**light-year** the distance that light travels in one year; about 9.46 trillion kilometers **parallax** an apparent shift in the position of an object when viewed from different locations **spectrum** the band of colors produced when white light passes through a prism

1. **Identify** What are the two main elements that make up most stars?

2. **Apply Concepts** Put the following star classes in order from hottest to coolest: A, B, G, K, O.

3. **Analyze** Why do scientists use light-years to measure the distances between stars and Earth?

4. **Explain** Why do stars seem to move in the sky?

5. **Compare** What is the difference between apparent magnitude and absolute magnitude?

6. **Explain** Why is the actual movement of stars hard to see?