Stars and Galaxies

The View from Earth

Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	1. The night sky is divided into constellations.	
	2. A light-year is a measurement of time.	

Read to Learn

Looking at the Night Sky

Have you ever looked up at the sky on a clear, dark night and seen more stars than you could possibly count? If you have, you are lucky. Few people see a night sky dense with stars. Lights from towns and cities make the night sky too bright for people to see the faint stars.

If you look at a clear night sky for a long time, the stars seem to move. But what you are really seeing is Earth's movement. Earth spins, or rotates, once every 24 hours. Day turns to night and then back to day as Earth rotates. Because Earth rotates from west to east, objects in the sky rise in the east and set in the west.

Earth spins on its axis. Earth's axis is an imaginary line from the North Pole to the South Pole. The star Polaris is almost directly above the North Pole. As Earth spins, stars near Polaris appear to travel in a circle around Polaris. These stars never set when viewed from the northern hemisphere. They are always present in the night sky.

Naked-Eye Astronomy

You don't need expensive equipment to view the sky. *Naked-eye astronomy* means "gazing at the sky with just your eyes, without binoculars or a telescope." Long before the telescope was invented, people viewed the sky in this way.

Key Concepts

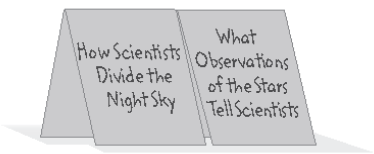
- How do astronomers divide the night sky?
- What can astronomers learn about stars from their light?
- How do scientists measure the distance and the brightness of objects in the sky?

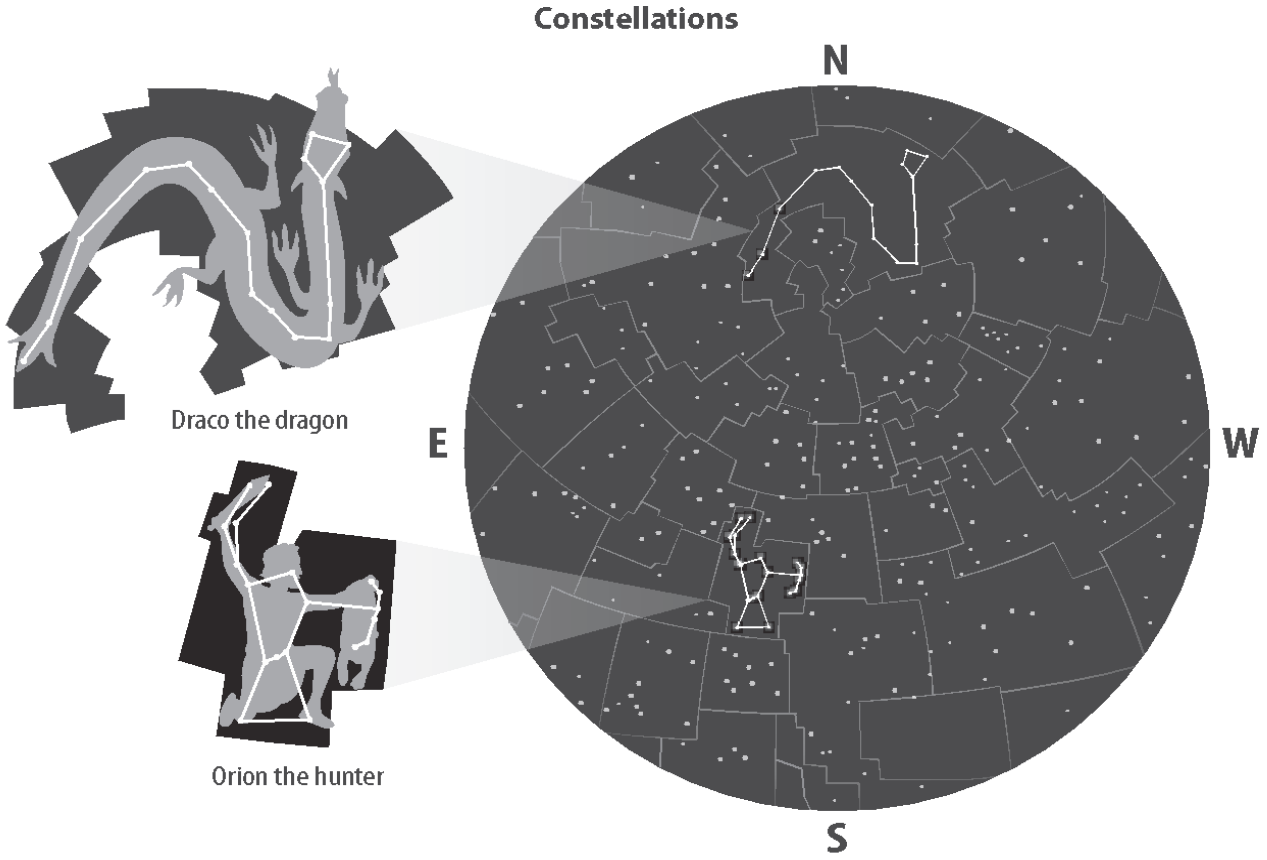
Study Coach

Create a Quiz Write five questions as you read this lesson. Exchange quizzes with a partner. After taking the quizzes, discuss your answers.

FOLDABLES®

Make a horizontal two-tab book to organize your notes on astronomy.





Visual Check

1. Analyze Why does east appear on the left and west appear on the right on the sky map? (Hint: Hold the map over your head, as you would view the sky. Position the map so that you are looking north.)

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Key Concept Check

2. Describe How do astronomers divide the night sky?

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People have observed stars to tell time and find directions since ancient times. They learned about planets, seasons, and astronomical events merely by watching the sky. As you practice naked-eye astronomy, remember never to look directly at the Sun. Ultraviolet radiation from the Sun could damage your eyes.

Constellations

As people in ancient cultures gazed at the night sky, they saw patterns. The patterns resembled people, animals, or objects, such as the hunter and the dragon shown in the figure above. The Greek astronomer Ptolemy (TAH luh mee) identified dozens of star patterns nearly 2,000 years ago. Today, these patterns and others like them are known as ancient constellations.

Present-day astronomers use many ancient constellations to divide the sky into 88 regions. The sky map in the figure above shows some of these regions, which are also called constellations. Dividing the sky helps scientists communicate to others what area of sky they are studying.

Telescopes

Telescopes were invented in the early 1600s. They can collect much more light than the human eye can detect. Visible light is just one part of the electromagnetic spectrum.

Look at the figure below. The electromagnetic spectrum is a continuous range of wavelengths. Longer wavelengths have low energy. Shorter wavelengths have high energy. Different objects in space emit different ranges of wavelengths. The range of wavelengths that a star emits is the star's spectrum (plural, spectra).

Visual Check

3. Interpret Which wavelength has the highest energy?

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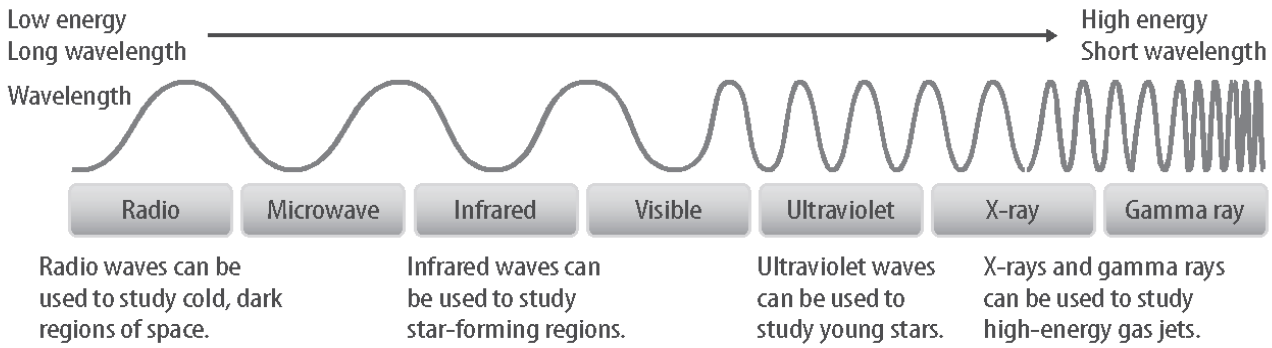
Electromagnetic Spectrum



Spectroscopes

Scientists study the spectra of stars using an instrument called a spectroscope. *A* **spectroscope** *spreads light into different wavelengths*. Using spectroscopes, astronomers can study stars' characteristics, including temperatures, compositions, and energies. For example, newly formed stars emit mostly radio and infrared waves, which have low energy. Exploding stars emit mostly high-energy ultraviolet waves and X-rays.

Key Concept Check

4. Assess What can astronomers learn from a star's spectrum?

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Measuring Distances

Extend your arm, and hold up your thumb. Close one eye, and look at your thumb. Now open that eye, and close the other eye. Did your thumb seem to jump? This is an example of parallax. Parallax is the apparent change in an object's position caused by looking at it from two different points.

Astronomers use angles created by parallax to measure how far objects are from Earth. Astronomers do not use the eyes as the two points of view. Instead, they use two points in Earth's orbit around the Sun.

Reading Check

5. Explain What is parallax?

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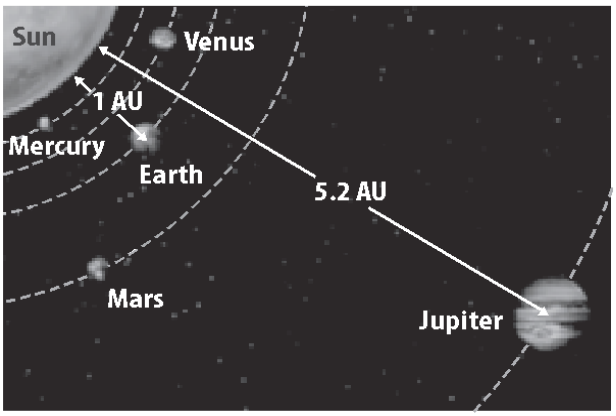
Distances Within the Solar System

The universe is too large to measure easily in meters or kilometers. Therefore, astronomers use other units of measurement. For distances within the solar system, they use astronomical units (AU). *An* **astronomical unit** *is the average distance between Earth and the Sun*, about 150 million km.

Astronomical units make it easy to compare distances between objects in the solar system and the distance between Earth and the Sun. The figure below shows that Jupiter is 5.2 AU from the Sun. This means that Jupiter is 5.2 times farther from the Sun than Earth is from the Sun. The most distant planet, Neptune, is 30 AU from the Sun.

Astronomical Units



Distances Beyond the Solar System

Astronomers measure distances to objects beyond the solar system using a larger distance unit—the light-year. Despite its name, a light-year measures distance, not time. *A* **light-year** *is the distance light travels in 1 year*. Light travels at a rate of about 300,000 km/s. That means 1 light-year is about 10 trillion km! Proxima Centauri, the nearest star to the Sun, is 4.2 light-years away.

Looking Back in Time

Because it takes time for light to travel, you see a star not as it is today but as it was when light left it. At 4.2 light-years away, Proxima Centauri appears as it was 4.2 years ago. The farther away an object is, the longer it takes for its light to reach Earth.

Visual Check

6. Apply About how many million kilometers is Jupiter from the Sun?

Math Skills

Proportions can be used to calculate distances to astronomical objects. Light can travel nearly 10 trillion km in 1 year (y). How many years would it take light to reach Earth from a star that is 100 trillion km away?

a. Set up a proportion.

$$\frac{10 \text{ trillion km}}{1 \text{ y}} = \frac{100 \text{ million km}}{x \text{ y}}$$

b. Cross multiply.

10 trillion km × (x)y = 100 trillion km × 1 y

c. Solve for x by dividing both sides by 10 trillion km.

$$x = \frac{100 \text{ trillion km}}{10 \text{ trillion km}} = 10 \text{ y}$$

7. Use Proportions How many years would it take light to reach Earth from a star 60 trillion km away?

Measuring Brightness

Some stars look dim and some look bright. Astronomers measure the brightness of stars in two ways: by how bright they appear from Earth and by how bright they actually are.

Apparent Magnitude

Scientists measure how bright stars appear using a scale developed by the ancient Greek astronomer Hipparchus (hi PAR kus). Hipparchus assigned a number to every star he saw based on the star's brightness. Astronomers today call these numbers magnitudes. *The* **apparent magnitude** *of an object is a measure of how bright it appears from Earth.*

As shown in the figure below, the fainter a star appears, the greater its apparent magnitude. Note that some objects have negative apparent magnitudes. That is because Hipparchus assigned a value of 1 to the brightest stars, but he did not assign values to the Sun, the Moon, or Venus. Astronomers later assigned negative numbers to the Sun, the Moon, Venus, and a few bright stars.

ACADEMIC VOCABULARY
apparent
(adjective) appearing to the eye or mind

Visual Check
8. Interpret What is the apparent magnitude of Sirius?

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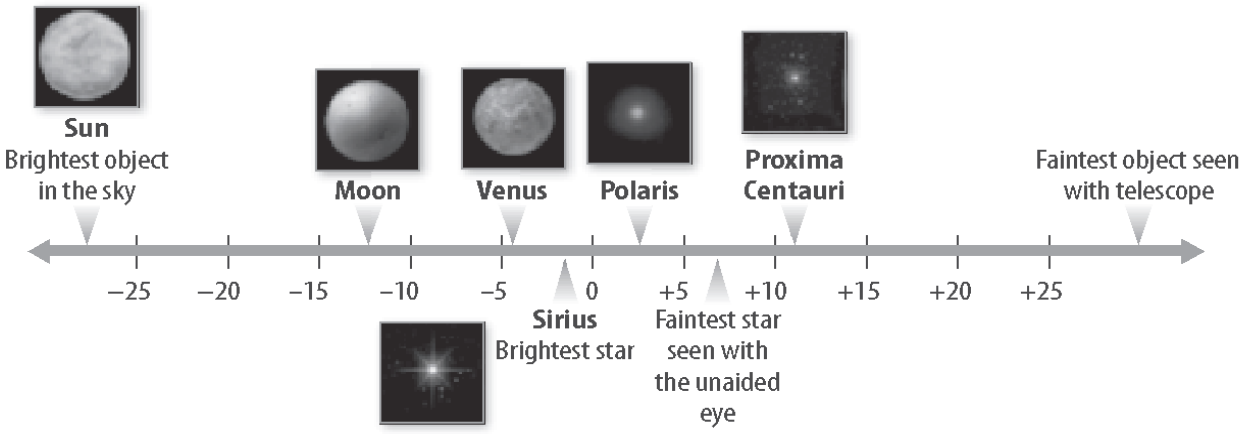
Apparent Magnitude



Absolute Magnitude

A star can appear bright or dim depending on its distance from Earth. But a star also has an actual, or absolute, magnitude. **Luminosity** (lew muh NAH sih tee) *is the true brightness of an object*. The luminosity of a star is measured on an absolute magnitude scale. A star's luminosity depends on the star's temperature and size, not on its distance from Earth. A star's luminosity, apparent magnitude, and distance from Earth are related. If scientists know two of these factors, they can determine the third using mathematical formulas.

Key Concept Check
9. Summarize How do scientists measure the brightness of stars?

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