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Science Readers: Content and Literacy in Science—Grade 5

This sample includes the following:

- **Teacher's Guide Cover** (1 page)
- **Table of Contents** (2 pages)
- **How to Use This Product** (5 pages)
- **Lesson Plan** (11 pages)
- **Reader** (17 pages)

To Create a World in which Children Love to Learn!

SCIENCE READERS

Content *and* Literacy *in* Science

Grade 5

Teacher's Guide

Teacher Created Materials
PUBLISHING

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INTRODUCTION

LIFE SCIENCE

PHYSICAL SCIENCE

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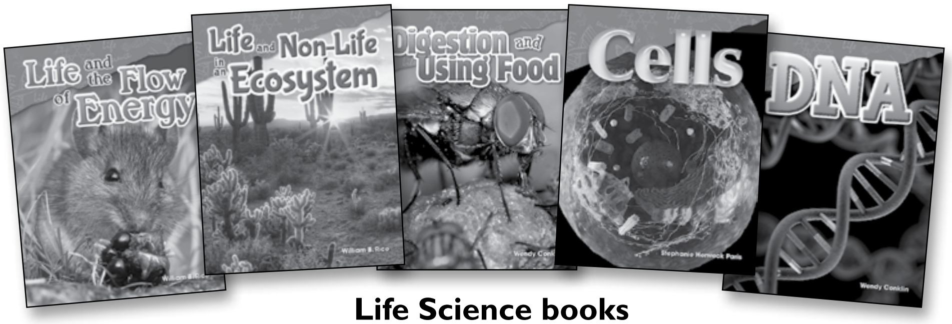
EARTH and SPACE SCIENCE

SCIENTIFIC PRACTICES

APPENDICES

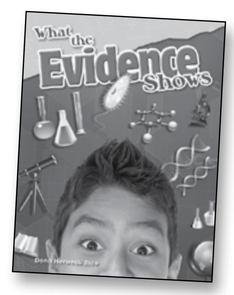
Kit Components



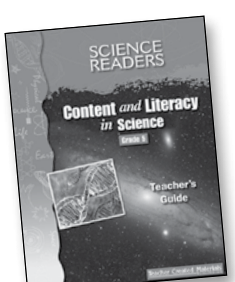
Life Science books

Physical Science books

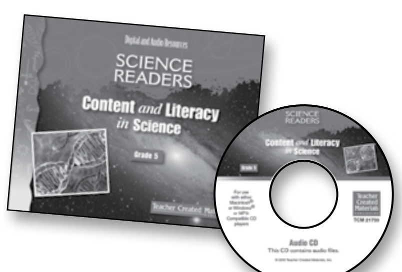
Earth and Space Science books



Scientific Practices book



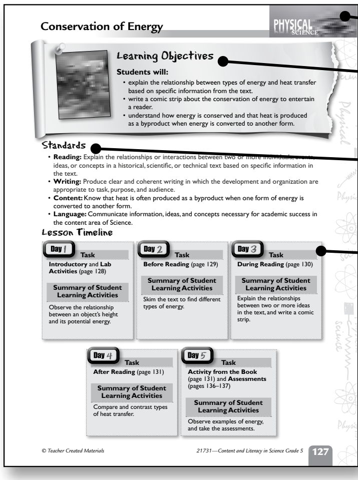
Teacher's Guide



Digital and Audio Resources

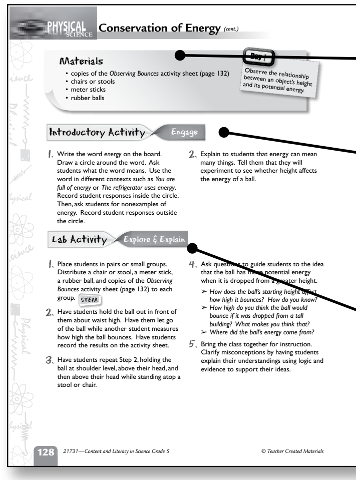
Unit Organization

Overview Page



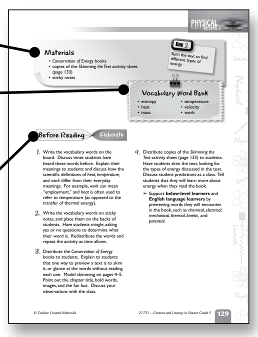
- Science strand
- Learning objectives
- Standards
- Suggested timeline for lesson

Introductory and Lab Activities



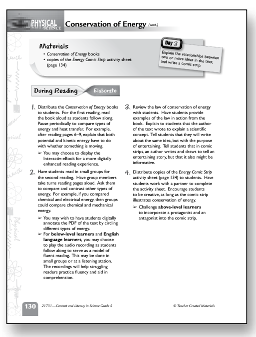
- Materials
- Engage students with the Introductory Activity
- Explore and Explain the new concept with the Lab Activity

Before Reading

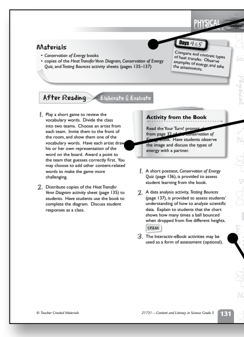


- Materials list
- Vocabulary Word Bank
- Elaborate on the concept with a vocabulary and a prereading activity

During Reading

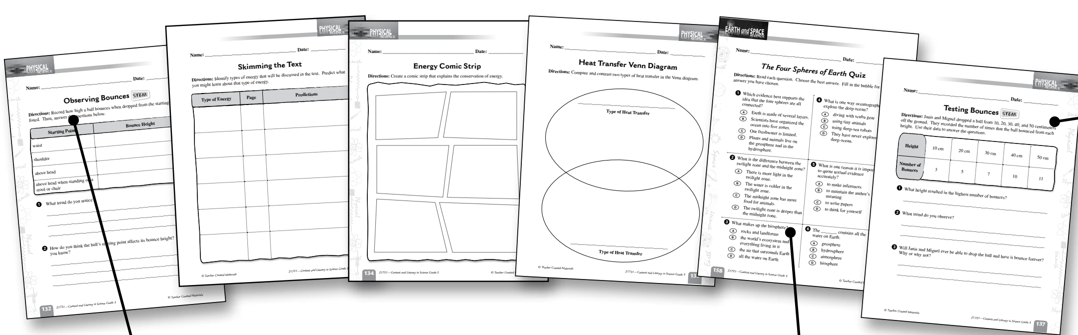


After Reading



- Materials list
- Elaborate with an After Reading activity on Day 4
- Evaluate with Assessments on Day 5

Student Reproducibles and Assessments



- Data Analysis activity
- Clear directions
- Multiple-choice quiz

Pacing Plan

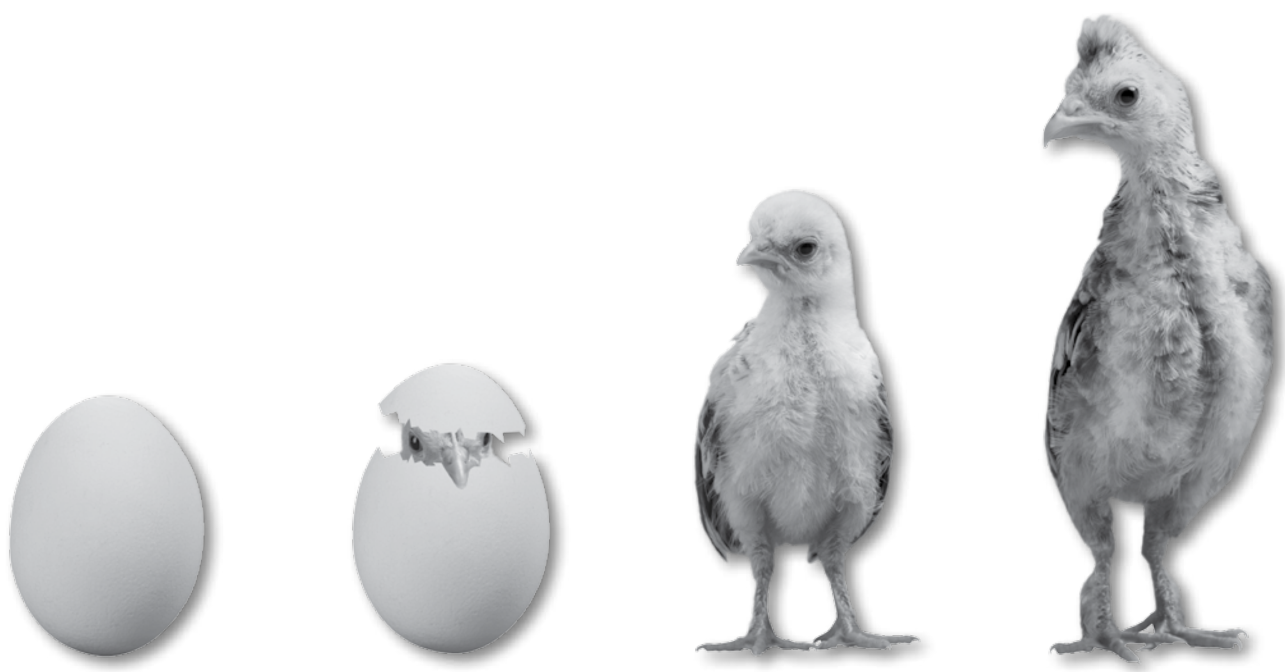
The following pacing plan shows an option for using this product. Teachers should customize this pacing plan according to their students' needs. One lesson has been included for each of the 16 books. Each day of the lesson requires 30 to 45 minutes of time and spans 5 instructional days, for a total of approximately 40–60 hours over the course of 80 days.

Instructional Time	Frequency	Setting
30–45 min/day	5 days/week	Whole-class, small-group, or one-on-one instruction

Day 1	Day 2	Day 3	Day 4	Day 5
Introductory and Lab Activities	Before Reading	During Reading	After Reading	Activity from the Book and Assessments

Lab Safety

To ensure safety in the science classroom, a Science Safety Contract has been provided in the Digital Resources (safety.pdf). Distribute copies of this contract to students prior to beginning any science instruction. Discuss with students how to be respectful and responsible during science activities. Ask students and their parents/guardians to sign and return the contract for your records.



Science Strands

The books and lessons in this kit cover the three strands of science which encompass the Disciplinary Core Ideas. The icons in the lessons and on the back of the books denote each strand. One book in this kit is devoted completely to scientific practices. This book describes how to think like a scientist and study the natural world.

Differentiation

Students learn best when material is scaffolded appropriately. If a student is confronted with material that is too difficult, he or she may become frustrated and give up. However, if a student is not challenged enough, he or she may become bored and lose interest in the subject. Differentiation is not about making the work easy for students. Instead, it is about challenging all students appropriately.

The books in this kit are leveled to target and support different groups of learners. The chart on page 26 contains specific information on the reading levels of the books included in this kit. The lesson plans for these books have **differentiation strategies** to help **above-**, **on-**, and **below-level learners** comprehend the material. These strategies will ensure that students are actively engaged in learning while receiving the support or enrichment that they need.

English language learners have different instructional needs. Although these students may struggle with reading, that is not always the case. English language learners need different support depending on their level of English proficiency. The lesson plans in this kit offer suggestions to differentiate instruction for the unique needs of English language learners.

SCIENCE READERS

Differentiation Tools in This Kit

- Audio recordings of texts model fluency and support auditory learners.
- An Interactiv-eBook for each book supports students through video, audio, and other digital functions.
- Graphic organizers support visual learners and language learning.
- Hands-on lab activities engage tactile learners.
- Leveled books support above-, on-, and below-level learners.
- Differentiation strategies embedded in each lesson support a variety of learners.

Assessment

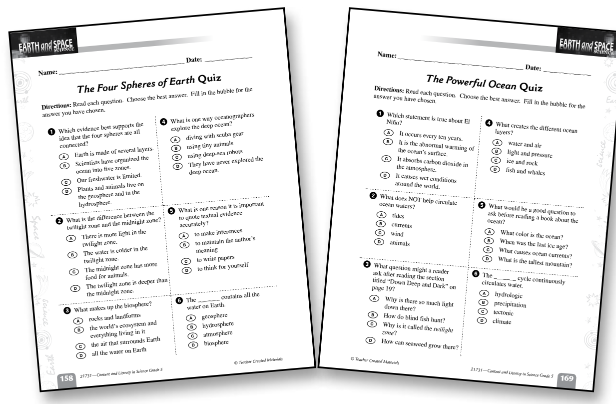
Assessment is an important part of this unit of study. The *Science Readers* series offers multiple assessment opportunities. You can gain insight into students' learning through multiple-choice quizzes, small-group observations, analysis of written assignments, and a culminating activity. These formal and informal assessments provide you with the data needed to make informed decisions about what to teach and how to teach it. This is the best way for you to know who is struggling with various concepts and how to address the difficulties that students are experiencing with the curriculum.

Multiple-Choice Quizzes—At the end of each book's lesson in this Teacher's Guide is a short quiz with multiple-choice questions. These short assessments may be used as open-book evaluations or as review quizzes in which students read and study the content prior to taking the quiz. Additionally, the quizzes may be used as a more formal assessment to provide evidence of learning.

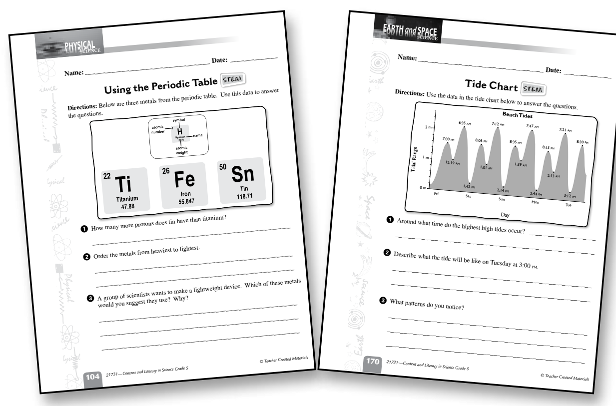
Data Analysis Activities—Each activity includes content-related data and text-dependent questions. These questions help students develop and strengthen critical thinking skills.

Culminating Activity—The culminating activity asks students to apply what they have learned throughout the units in an engaging and interactive way. Students use what they have learned to create new ideas in a real-life context.

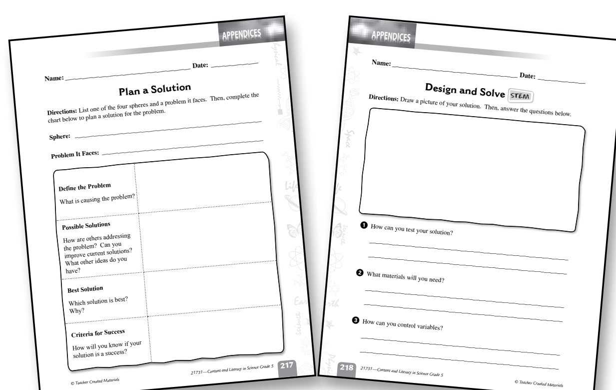
Progress Monitoring—There are several points throughout each lesson where useful evaluations can be made. These evaluations can be made based on group, paired, and individual discussions and activities.



Multiple-Choice Quizzes



Data Analysis Activity



Culminating Activity

Stars

Learning Objectives

Students will:

- identify cause-and-effect relationships in the text.
- write an opinion paragraph on whether we should do more space exploration.
- investigate how scientists compare light from different stars.

Standards

- **Reading:** Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.
- **Writing:** Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
- **Content:** Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
- **Language:** Communicate information, ideas, and concepts necessary for academic success in the content area of Science.

Lesson Timeline

Day 1

Task

Introductory and **Lab Activities** (page 183)

Summary of Student Learning Activities

Observe patterns from different light sources.

Day 2

Task

Before Reading (page 184)

Summary of Student Learning Activities

Find cause-and-effect signal words in the text.

Day 3

Task

During Reading (page 185)

Summary of Student Learning Activities

Identify cause-and-effect relationships in the text, and write an opinion paragraph.

Day 4

Task

After Reading (page 186)

Summary of Student Learning Activities

Identify a cause with multiple effects in the text.

Day 5

Task

Activity from the Book (page 186) and **Assessments** (pages 191–192)

Summary of Student Learning Activities

Observe and record the stars, and take the assessments.

Materials

- copies of the *Types of Light* activity sheet (page 187)
- 2 light sources, such as a lamp and a flashlight
- boxes (cube-shaped is best)
- cardboard tubes
- CDs
- duct tape
- paper
- thin cardboard
- transparent, milky, plastic film such as tape or a white grocery bag

Day 1

Observe patterns from different light sources.

Introductory Activity — Engage

1. Illuminate both light sources. Ask students to compare and contrast the light from each source.
2. Explain to students that light coming from different stars can also be compared and contrasted. Tell students that they will learn how scientists observe light from stars.

Lab Activity — Explore & Explain

1. Place students in small groups. Distribute a box, a cardboard tube, a CD, duct tape, paper, cardboard, plastic film, and copies of the *Types of Light* activity sheet (page 187) to each group. **Note:** You may wish to distribute precut boxes and have students reference the illustrated directions on page 29 of the *Stars* book. STEM
2. Have students tape paper over most of the CD, leaving a small section uncovered. Have students tape the CD inside the box so that the uncovered section is aligned with a corner of the box. Across from the uncovered section, have students cut a small hole about 5 centimeters (2 inches) in the box.
3. Have students tape two pieces of cardboard over the hole to create a small vertical slit about 1 millimeter (0.04 in.) wide. Have them tape the film over the slit.
4. On the side of the box adjacent to where the CD is exposed, have students cut a small hole and tape the cardboard tube around the hole to create an eyepiece.
5. Have students tape the box closed. Have them shine light from different sources through the slit, view them through the eyepiece, and record their observations.
6. Ask questions to guide students to the idea that light from different sources has different observable properties.
   - ➢ *How does the light from different sources differ?*
   - ➢ *What do you think makes them appear different?*
   - ➢ *How might this be useful to scientists?*
7. Bring the class together for instruction. Clarify misconceptions by having students explain their understandings using logic and evidence to support their ideas.

Day 2

Find cause-and-effect signal words in the text.

Materials

- *Stars* books
- copies of the *Signal Words* activity sheet (page 188)
- chart paper

Vocabulary Word Bank

- constellations
- latitude
- light years
- nuclear fusion
- satellites

Before Reading

1. Write the vocabulary words on the board, and discuss their meanings. Show students pictures related to the words (pictures from the book may be used), use gestures to represent the words, or use the words in sentences that provide context for the meanings of the words. Then, write the following related words on the board: *stars*, *distance*, *moon*, *shapes*, *gravity*, *Earth*, *fuel*, and *position*. Ask students which words relate to each vocabulary word. Accept any as solutions as long as students can provide a logical explanation.
2. Display the *Stars* book for students. Show students a few of the images and other text features in the book. Tell students that there are many cause-and-effect relationships in this book. Explain that identifying the relationships between ideas in the text can help a reader better understand the text.
3. Read the sidebar on page 6 aloud. Tell students that in this piece of text, the cause is that talking about large distances can be overwhelming, and the effect is that astronomers measure distances in light years.
4. Help students create a list of signal words that identify cause-and-effect relationships. Record the words on a sheet of chart paper. Include words such as *because, affect, since, so, if, when,* and *why*. **Note:** Save this list for later use.
5. Distribute copies of the *Signal Words* activity sheet (page 188) to students. Have students use the book to complete the activity sheet. Discuss the signal words that students found most often. If students identify additional signal words, record these on the list.
   - ➢ You may wish to have students digitally annotate the PDF of the text by circling cause-and-effect signal words.

Materials

- *Stars* books
- copies of the *Exploring Space* activity sheet (page 189)
- list of cause-and-effect signal words from the Before Reading activity

Day 3

Identify cause-and-effect relationships in the text, and write an opinion paragraph.

During Reading

1. Review the list of cause-and-effect signal words from the Before Reading activity. Distribute the *Stars* books to students. Read the book aloud as students follow along for the first reading. Pause periodically to point out cause-and-effect relationships and signal words in the text. For example, after reading page 7, explain to students that studying the sun is the cause, and astronomers learning things about stars is the effect.
   - ➢ You may choose to display the Interactiv-eBook for a more digitally enhanced reading experience.
2. Have students read in small groups for the second reading. Have group members take turns reading paragraphs aloud. Ask them to discuss additional cause-and-effect relationships in the text. Tell students that they can identify connections in diagrams, sidebars, captions, and body text.
   - ➢ For **below-level learners** and **English language learners**, you may choose to play the audio recording as students follow along to serve as a model of fluent reading. This may be done in small groups or at a listening station. The recordings will help struggling readers practice fluency and aid in comprehension.
3. As a class, discuss the connections students found. Add new signal words to the list, if needed.
4. Distribute copies of the *Exploring Space* activity sheet (page 189) to students. Discuss arguments for and against more space exploration, including potential discoveries and the cost of space exploration. Then, have students outline their paragraphs. Encourage students to reference the book, if needed. Have students use their outline to write a paragraph on a separate sheet of paper.
   - ➢ Help **below-level learners** and **English language learners** locate sections in the book that might support their opinions.
   - ➢ Have **above-level learners** include answers to possible objections in their paragraphs.

Materials

- *Stars* books
- copies of the *Many Effects, Stars Quiz,* and *Planet Days and Years* activity sheets (pages 190–192)
- empty tube

Days 4 & 5

Identify a cause with multiple effects in the text. Observe and record the stars, and take the assessments.

After Reading — Elaborate & Evaluate

1. Play a short game to review the vocabulary words. Divide the class into two teams. Choose an artist from each team. Invite them to the front of the room, and show them one of the vocabulary words. Have each artist draw his or her own representation of the word on the board. Award a point to the team that guesses correctly first. You may choose to add other context-related words to make the game more challenging.

2. As a class, discuss the cause-and-effect relationships in the *Stars* book. Explain to students that one cause can have multiple effects. Provide real-life examples, such as if a boy tripped over his shoelaces, he could drop what he was holding and bump into another person. Explain how the effects happened at the same time and were caused by one event.

3. Distribute the *Stars* books and copies of the *Many Effects* activity sheet (page 190) to students. Have students reread the sidebar and study the image on page 15 of the book. Then, have them complete the activity sheet. Have students share their ideas with the class.

Activity from the Book

Read the Your Turn! prompt aloud from page 32 of the *Stars* book. Have students look at the night sky through an empty tube and count the stars they see.

1. A short posttest, *Stars Quiz* (page 191), is provided to assess student learning from the book.

2. A data analysis activity, *Planet Days and Years* (page 192), is provided to assess students' understanding of how to analyze scientific data. Explain to students that the chart shows how long each day and year is on various planets compared to those on Earth. STEM

3. The Interactiv-eBook activities may be used as a form of assessment (optional).

Name: ______________________________ **Date:** ____________

Types of Light STEM

Directions: Record the light sources you test and your observations.

Light Source	Observations

Name: ______________________________ **Date:** ____________

Signal Words

Directions: Skim the text to find cause-and-effect signal words. Use the chart below to record words you find.

Word	Page

Name: ___________________________________ **Date:** _____________

Exploring Space

Directions: Write a paragraph explaining whether we should do more space exploration. Use the chart below to outline your paragraph.

Opinion

Reason

Reason

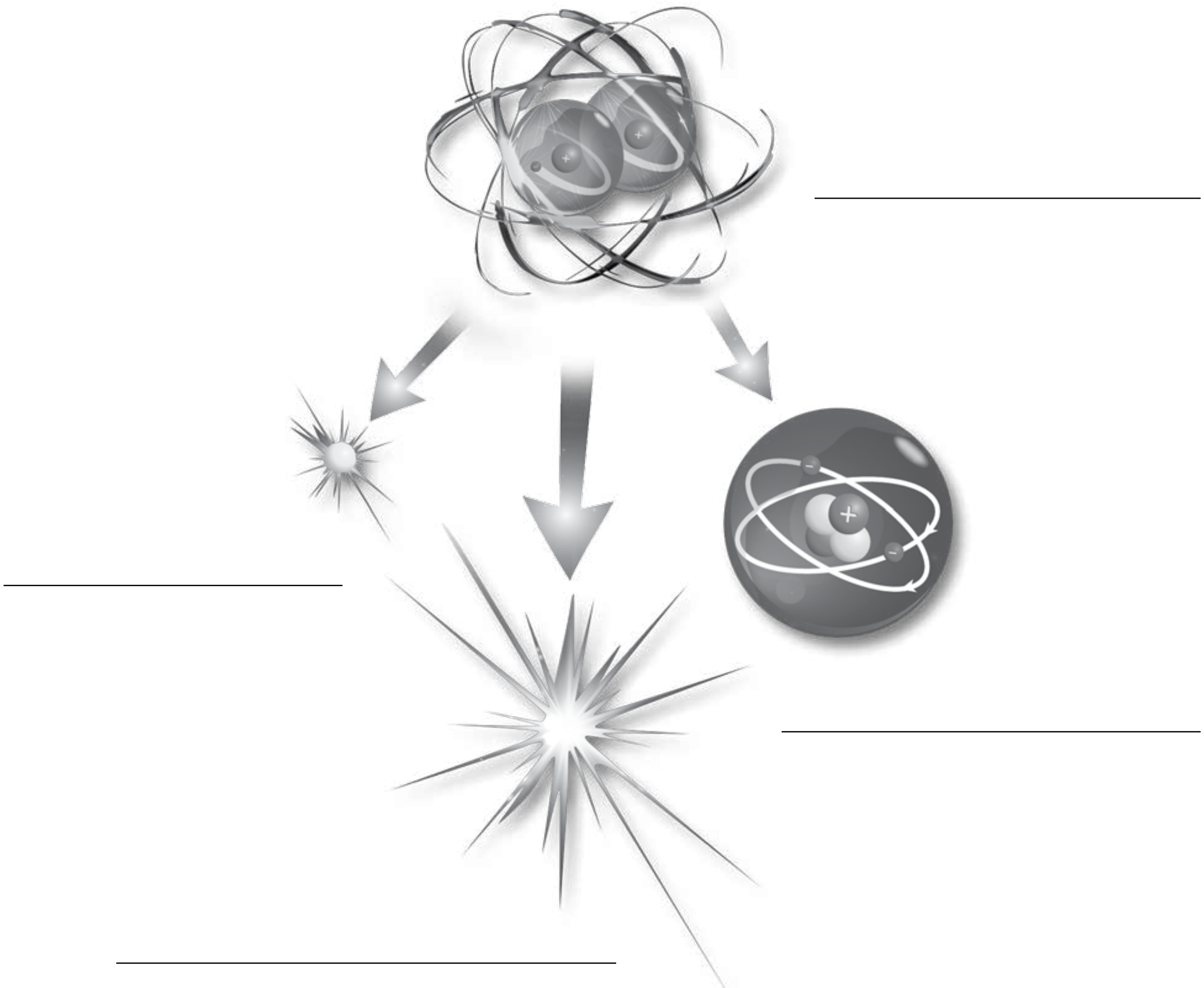
Evidence

Evidence

Name: ______________________________________ **Date:** ______________

Many Effects

Directions: Reread the sidebar and study the image on page 15 of the text. Label the cause and the effects. Then, describe how one cause had multiple effects.



____

____

____

____

Name: ___________________________________ **Date:** _____________

Stars Quiz

Directions: Read each question. Choose the best answer. Fill in the bubble for the answer you have chosen.

1. What causes a star to die?
   - (A) It evaporates.
   - (B) It is launched out of a black hole.
   - (C) Other stars get too close to it.
   - (D) It runs out of hydrogen, or fuel.

2. What is the effect of nuclear fusion in a main sequence star?
   - (A) The star burns out.
   - (B) It releases a massive amount of heat and energy.
   - (C) Hydrogen atoms explode.
   - (D) Hydrogen atoms move away from each other.

3. Why was it easy to see stars long ago?
   - (A) There were more stars.
   - (B) The stars were not so far away.
   - (C) There were no bright city lights.
   - (D) People used advanced telescopes.

4. What object has such strong gravity that even light cannot escape it?
   - (A) black hole
   - (B) supernova
   - (C) galaxy
   - (D) protostar

5. What works together to keep a star stable?
   - (A) heat and light
   - (B) nuclear fusion and light
   - (C) nuclear fusion and gravity
   - (D) magnetism and gravity

6. An object in space that orbits another object is a _______.
   - (A) constellation
   - (B) satellite
   - (C) dwarf
   - (D) supernova

Name: ________________________________ Date: ____________

Planet Days and Years STEM

Directions: The chart shows days (one full rotation) and years (one full revolution around the sun) on other planets in relation to Earth. It also shows their distances from the sun in kilometers and miles. Use the data to answer the questions.

Planet	Day	Year	Distance from Sun
Mercury	59 days	88 days	57 million km (35 million mi.)
Venus	243 days	225 days	108 million km (67 million mi.)
Earth	24 hours	365 days	150 million km (93 million mi.)
Mars	25 hours	687 days	228 million km (142 million mi.)
Jupiter	10 hours	12 years	779 million km (484 million mi.)
Saturn	11 hours	29.5 years	1.43 billion km (889 million mi.)
Uranus	17 hours	84 years	2.88 billion km (1.79 billion mi.)
Neptune	16 hours	165 years	4.50 billion km (2.8 billion mi.)

1. Which planet has the longest year? ____________________

2. Which planet has the longest day? ____________________

3. What planet has a rotation and revolution that are almost the same? How can you tell?

____

____

4. What is the connection between the distance from the sun and the length of the year on other planets?

____

____

Stars

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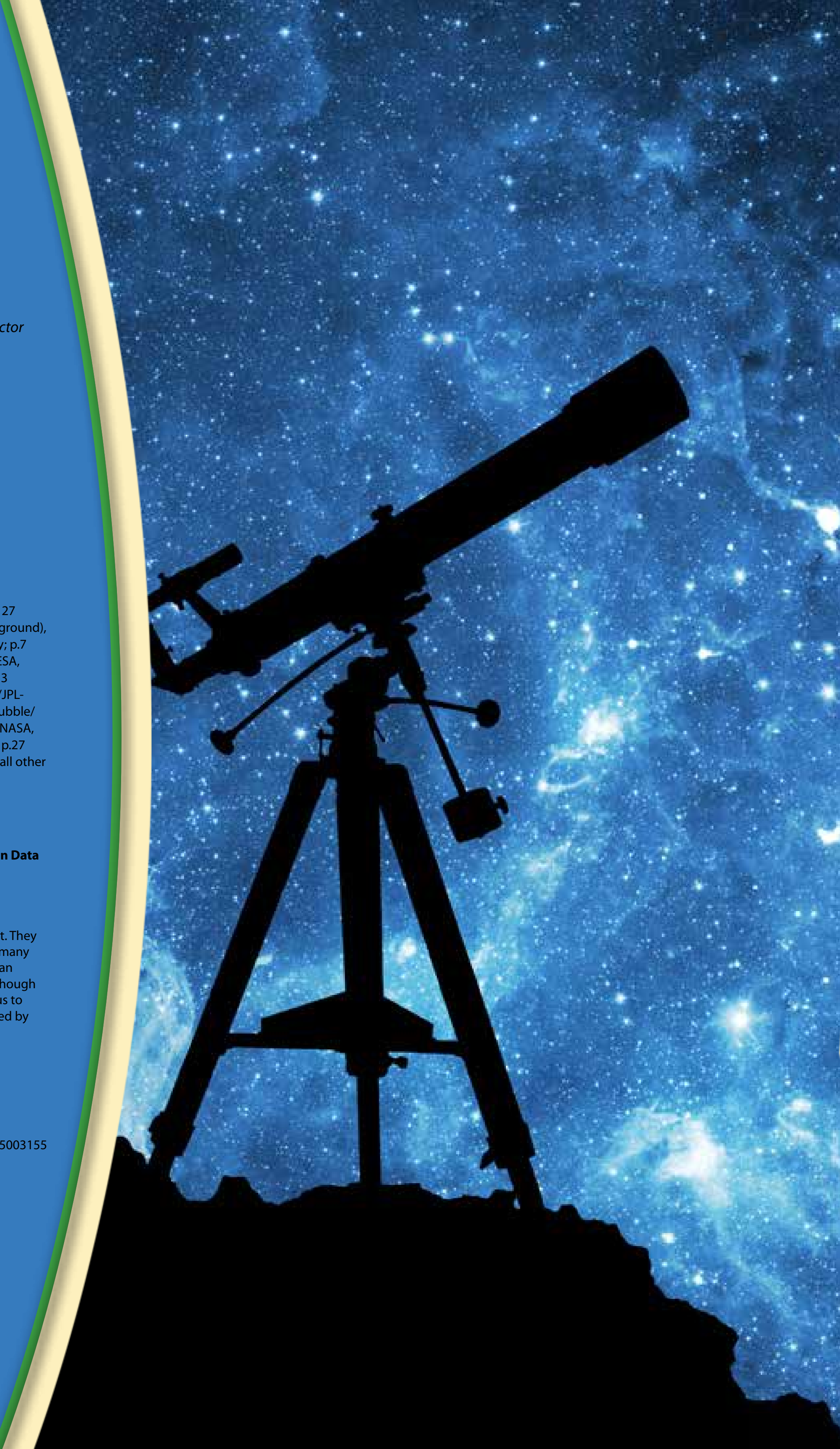


Table of Contents

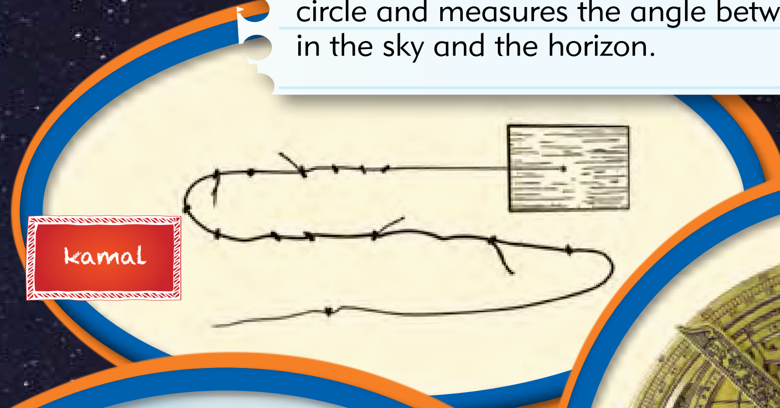
Starstruck

Have you ever looked up at the night sky and been amazed by the scattered twinkling lights? You are not alone! People have been captivated by the stars for thousands of years. Some were so starstruck that they studied their every move.

Early stargazers learned the stars could provide useful information. Ancient Egyptians planned their lives around Sirius, the Dog Star. Egyptian farmers knew they could plant crops in the moist soil after Sirius rose in the sky. The ancient Phoenicians (fi-NEE-shuhnz) navigated the seas using the night sky. They learned the annual patterns of the stars. At certain times of the year, the sun and the stars would be at fixed distances from the horizon. They used their fingers to measure the stars' positions. The Greeks named the stars after gods, heroes, and animals from their stories. The Chinese from the Han Dynasty grouped the **constellations** by the four directions—East (Dragon), West (Tiger), North (Tortoise), and South (Scarlet Bird). The Native American Tewa tribe named the Milky Way the "Endless Trail." They saw the constellation Orion as Long Sash, a hero who led his people away from their troubles on the Endless Trail.

Navigation

Ancient and modern navigators have used stars and fascinating tools to guide their travels at night. The kamal is an early device that measures **latitude**. The astrolabe (AS-truh-leyb) is used to locate and predict positions of the sun, moon, planets, and stars. The sextant is one-sixth of a circle and measures the angle between an object in the sky and the horizon.


kamal


astrolabe


sextant

Astronomy is the study of things in space. Many people get astronomy confused with astrology. Astronomy is based in science, while astrology is not.

Modern day **astronomers** use powerful telescopes to see stars. They also use **satellites**. Computers and other instruments help scientists learn what stars are made of, how far away they are, and much more.

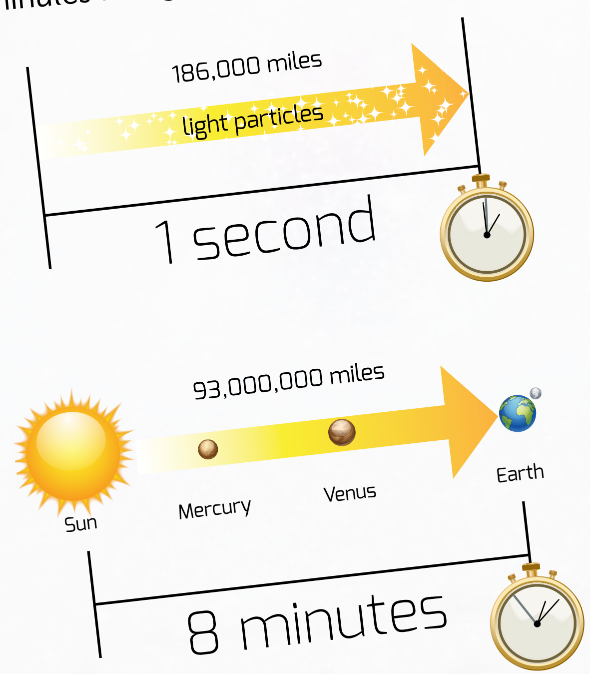
Astronomers have learned there are different kinds of stars. Some are hundreds of times larger than our sun, while others are much smaller. Stars come in a range of colors: blue, red, orange, yellow, and white. Their temperatures and distances from Earth range widely as well. Some stars are closer to Earth than others. The sun is our closest star.

By studying the sun, astronomers have learned many things about stars. The sun is about 150 million kilometers (93 million miles) away. Flying in a jet plane, it would take you 17 years to get to the sun! The next closest star is Proxima Centauri, at a whopping 40 trillion km (25 trillion mi.) away. Many other stars are even farther away than Proxima Centauri. Despite their vast distance from us, those twinkling stars continue to fascinate us.

Stars are old! Most stars are between 1 and 10 billion years old.

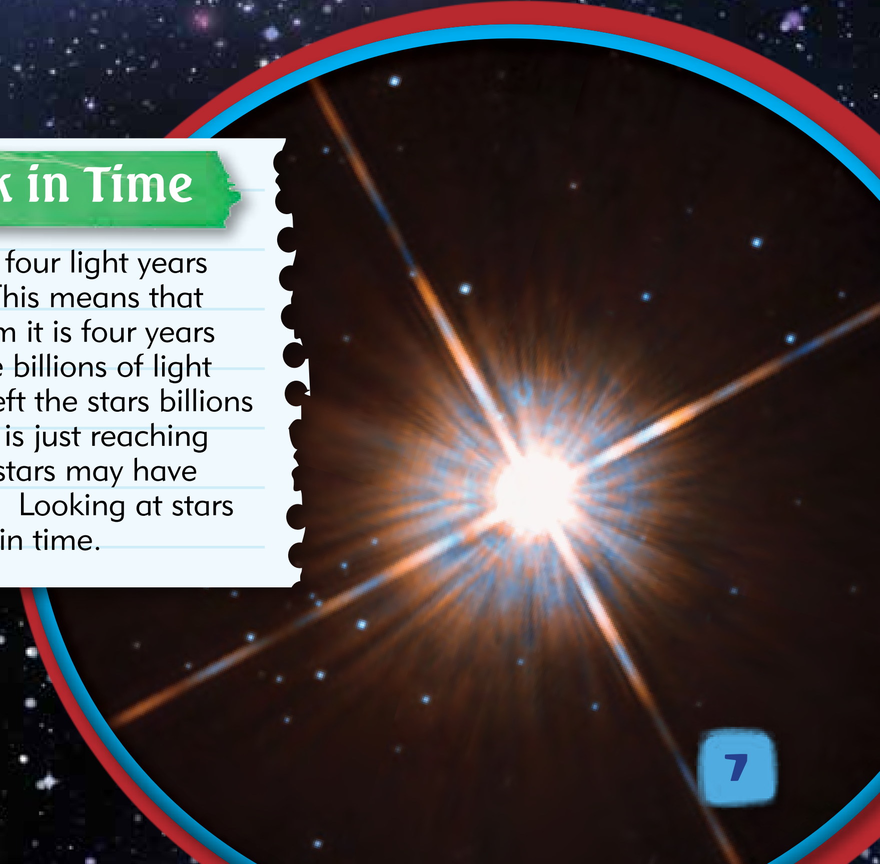
Light Years Away

Talking about trillions of kilometers can get a little overwhelming, so astronomers measure huge distances in **light years**. This is the distance light travels in one year. A single light year is about 9 trillion km (6 trillion mi.). The sun is less than a light year away. It only takes 8 minutes for light from the sun to reach Earth.



Step Back in Time

Proxima Centauri is four light years away from Earth. This means that the light we see from it is four years old. Other stars are billions of light years away. Light left the stars billions of years ago, and it is just reaching us. Some of these stars may have already burned out. Looking at stars is like looking back in time.



Science of Stars

Over the years, astronomers have been challenged to learn more about stars. Since stars are light years away, this is a difficult task. Research shows that stars are huge balls of burning hot gases. The main chemical elements that make up stars are hydrogen and helium. These elements form clouds and collapse into stars due to **gravity**. Astronomers are still learning about stars and are trying to figure out ways to organize their information.

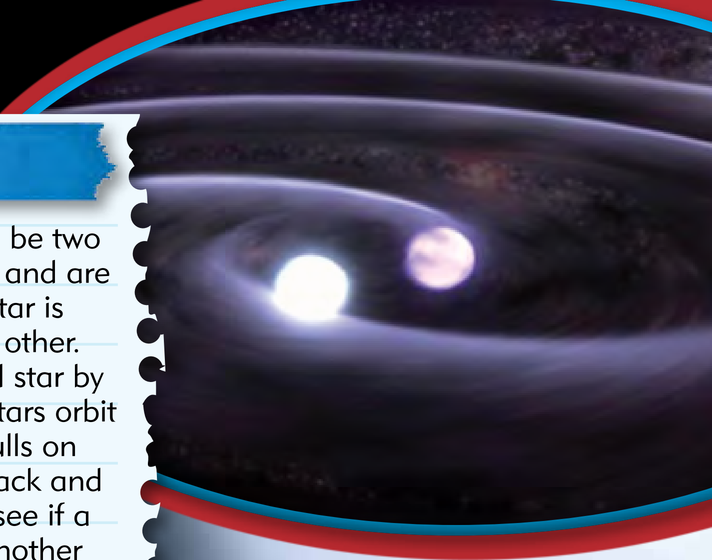
Classifying Stars

In order for people to understand and learn more about stars, astronomers define and classify them. They group stars by their size and by their temperature. Stars that are the size of the sun or smaller are called **dwarfs**. Stars that are 10 times the size of the sun are called *giants*. **Supergiants** are hundreds of times larger than the sun.

To your eye alone, stars may look completely white. But when seen through a telescope, we can see that stars come in many colors. The color is related to a star's temperature. The hottest stars appear blue, and the coolest are red. There are also white, yellow, and orange stars.

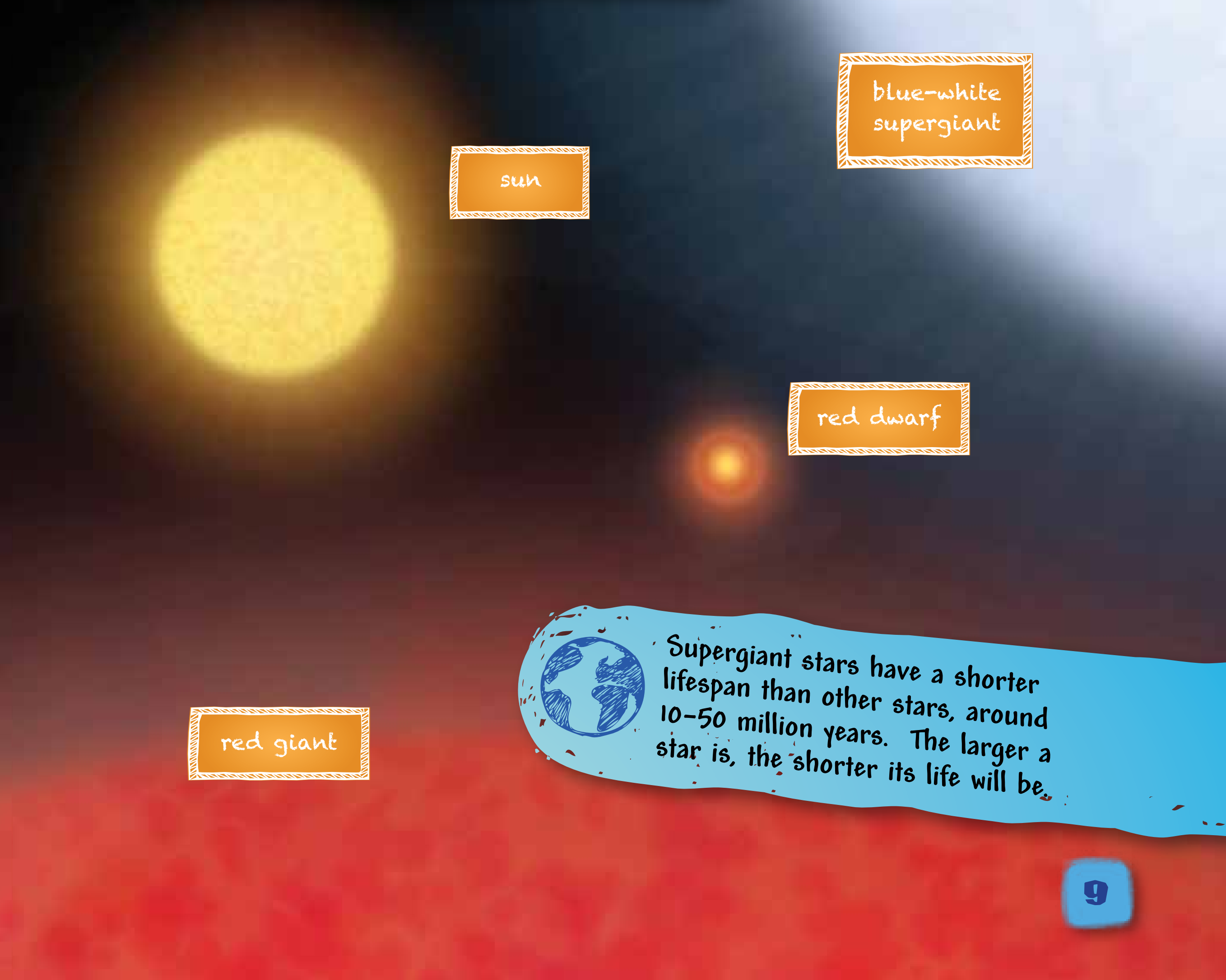
Always Shining

Stars are out all the time. We just can't see them during the day because the sun's light blocks them from view. Look at a star chart, a smartphone app, or the Internet to find out which stars we could see if we could turn off the sun's light.



Twins!

Sometimes, one star turns out to be two stars. The stars orbit each other and are called *binary stars*. Often, one star is much larger or brighter than the other. Astronomers can find the second star by observing its "wobble." As the stars orbit each other, each star's gravity pulls on the other, causing it to wobble back and forth. Astronomers also look to see if a star drifts from time to time as another star passes in front of it.



Supergiant stars have a shorter lifespan than other stars, around 10–50 million years. The larger a star is, the shorter its life will be.

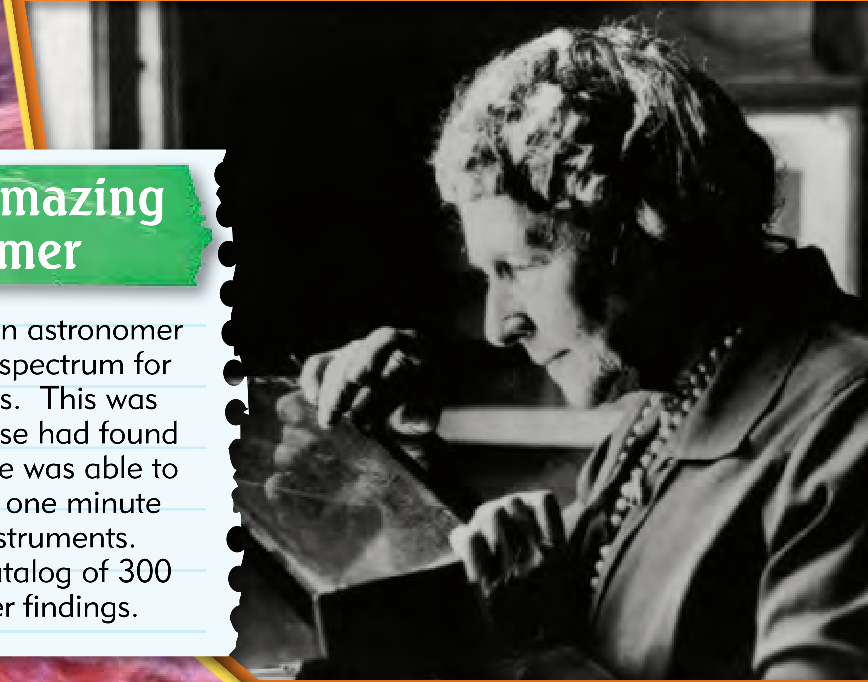
Astronomers have discovered a dead star 12 million light years away that burns 10 million times brighter than our sun.

Analyzing Stars

Astronomers also classify a star's **luminosity**. Luminosity rates the amount of light a star emits. This depends upon the star's size and temperature. It also depends upon its distance from Earth. They also classify a star's apparent brightness. This is how bright a star looks from Earth. An ancient Greek astronomer named Hipparchus (hi-PAHR-kuhs) developed this system. He named bright stars **magnitude** 1. The next brightest stars that can be seen through a telescope are magnitudes 2 through 6.

There are several factors that affect how bright a star appears: star's size, temperature, and distance from Earth. For example, the sun is much smaller than many other stars. But it is the brightest star when seen from Earth because it is the closest star to Earth.

Astronomers also use measurements to determine the chemical makeup of stars. Even though a star may be classified as having a certain color, when its light is shown through a **spectrograph**, it splits into a spectrum of colors. Each star has a different spectrum. Astronomers can read the spectrum to determine each star's makeup.



Annie the Amazing Astronomer

Annie Cannon was an astronomer who found the color spectrum for around 350,000 stars. This was more than anyone else had found during that time. She was able to classify three stars in one minute without the use of instruments. Cannon created a catalog of 300 stars to document her findings.

Technical Tools

Scientists don't just observe the visible light that stars emit. They also use X-rays, gamma rays, radio waves, and infrared radiation. Each type of radiation shows them more about a star.

Star Saga

Stars are not living things, but astronomers often talk about them as though they were. The story of a star is one of balance. Gravity and the energy a star creates play tug-of-war with the star. Eventually, one of these forces must win.

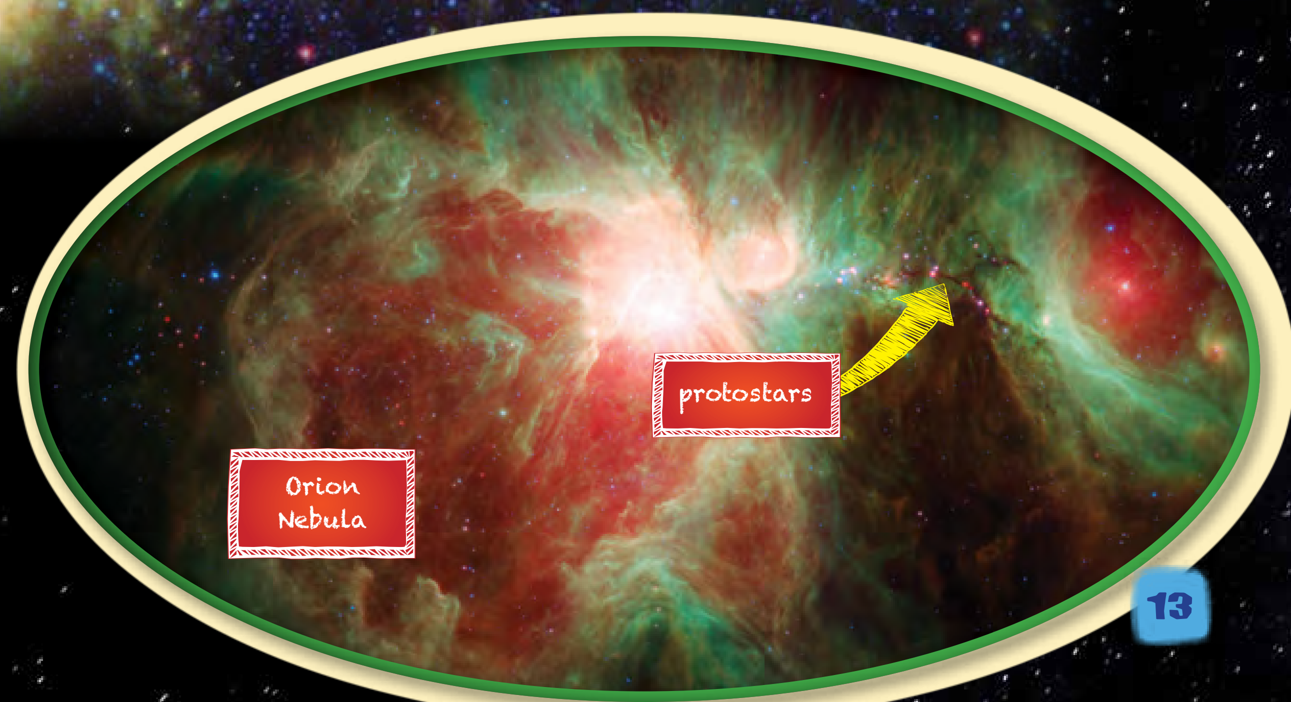
A Star Is Born

Stars begin as giant clouds of gas and dust called **nebulae**. They are mostly made of hydrogen gas. These huge clouds are like star nurseries. One nebula can produce hundreds sometimes even thousands of stars.

Slowly, gravity pulls gas and dust from the nebula together into clumps. As the clump gathers, its gravity grows stronger. This draws in more gas and dust, and the clump begins to spin. Over the course of about one hundred thousand years, the spinning cloud gets hotter and thicker. Finally, it gets so thick that it collapses into a ball, called a **protostar**. The dust and gas gather together as the center heats up. When the center reaches 15 million degrees Celsius (27 million degrees Fahrenheit), **nuclear fusion** begins. As the core of the protostar begins to burn, a star is born!

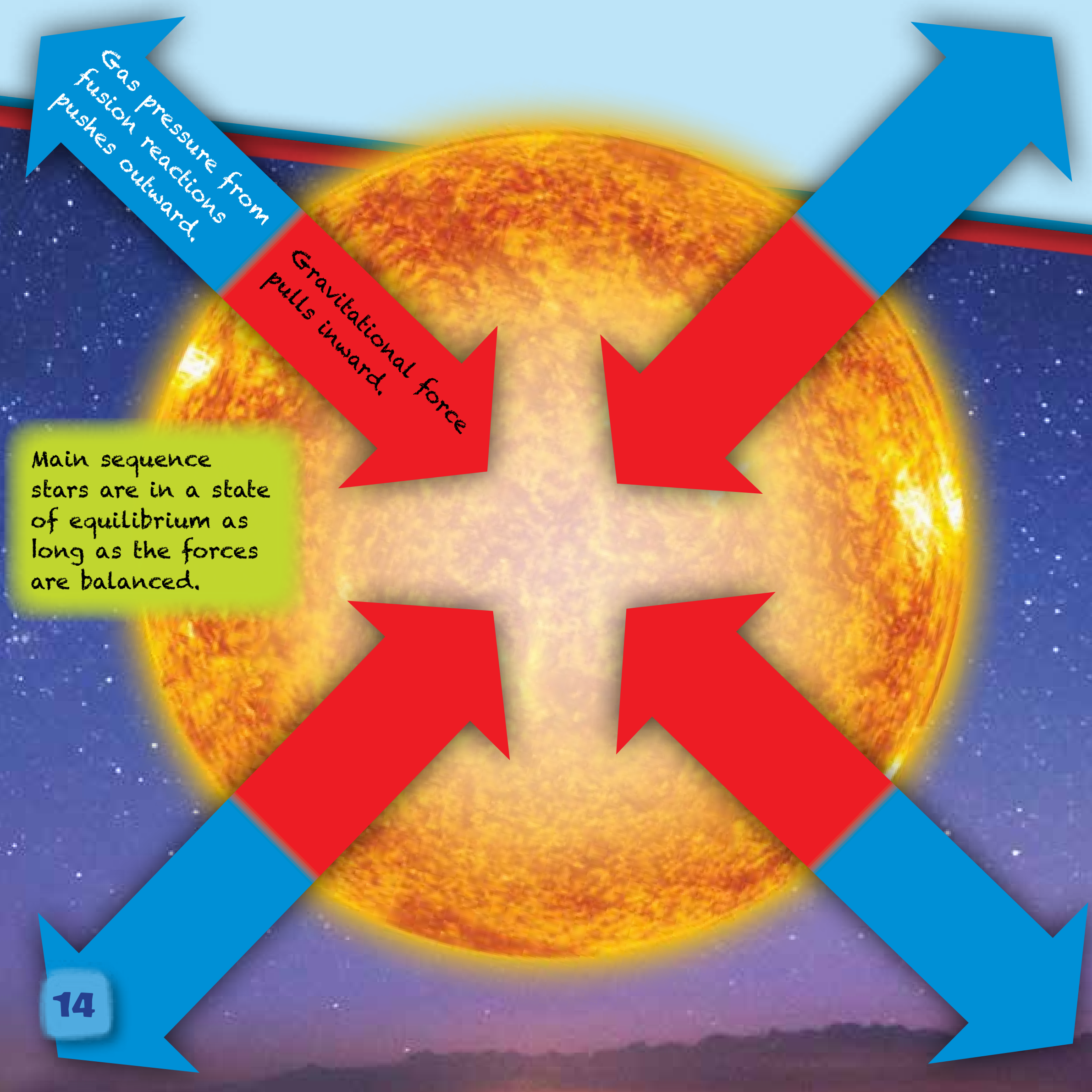
The word *nebula* originates from a Latin word meaning "cloud."

Planets, comets, and asteroids are also formed from spinning clouds of gas and dust.



Balancing Act

Once nuclear fusion begins in a star's core, it is considered a *main sequence star*. This is the stage in which a star spends 80–90 percent of its life. The fusion in the core of a star generates a massive amount of heat and energy. This pushes the star outward and stops gravity from collapsing it any further. The star is now balanced between the outward pressure released by nuclear fusion and the inward pull of its own gravity. These balanced forces keep a star about the same size for the entire main sequence stage, making this stage of the star's life the most stable.

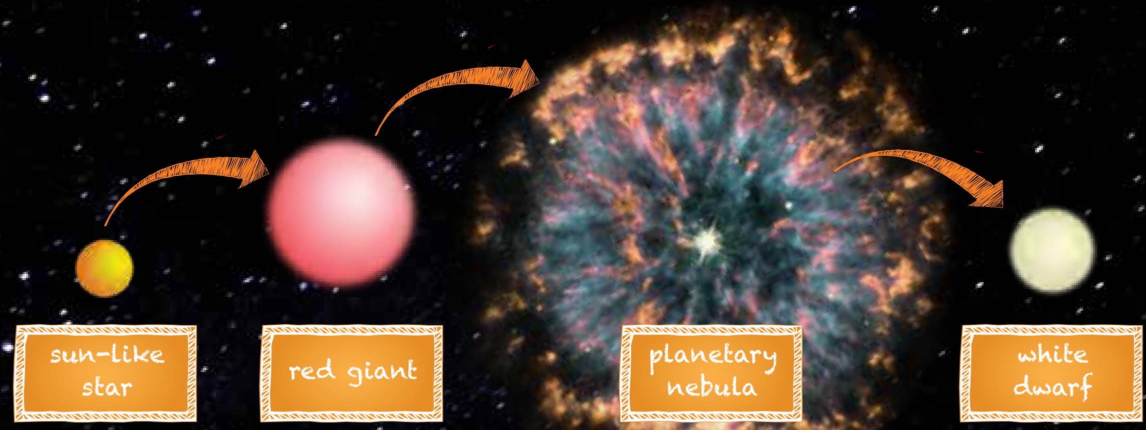


A star will remain in its main sequence stage for as long as it has hydrogen to fuse. This is different for different-size stars. Large stars have more hydrogen, but they burn through it much faster than smaller, more efficient stars. The largest stars actually have the shortest lives.

Eventually, their supply of hydrogen dwindles. All stars will run out of fuel. But their deaths can be even more spectacular than their lives.

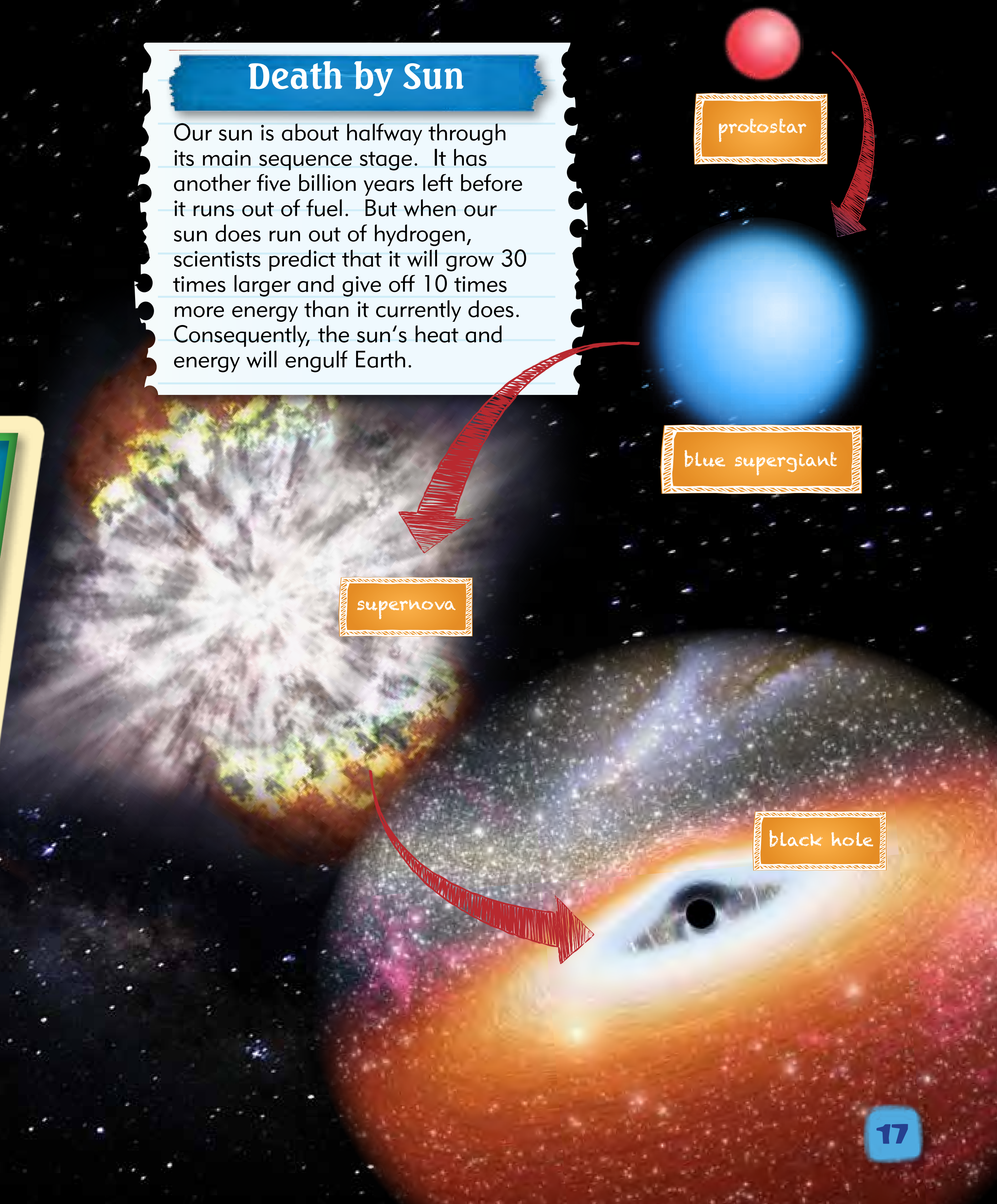
Nuclear Fusion

Nuclear fusion powers stars. Deep inside the core of a star, hydrogen atoms smash together with great force. They fuse to make helium atoms. This releases an enormous amount of energy and light. This is why we can see stars that are so far away.



Death by Sun

Our sun is about halfway through its main sequence stage. It has another five billion years left before it runs out of fuel. But when our sun does run out of hydrogen, scientists predict that it will grow 30 times larger and give off 10 times more energy than it currently does. Consequently, the sun's heat and energy will engulf Earth.



Violent Deaths

With no more fuel to burn, fusion in the core of a star stops, and gravity begins to win the stellar tug-of-war. But the death of a star depends on its size. Smaller stars collapse into themselves and become extremely dense white dwarfs. Medium-size stars, like our sun, expand to become red giants. After a few hundred thousand years, their outer layers expand outward, leaving behind their cores as white dwarfs.

The death of a large star comes with terrific force and makes for quite a show! When a star 30 times the **mass** of the sun dies, it explodes into a massive **supernova**. It flings dust and particles from the star's outer layers far into space. Eventually, these star fragments get recycled. They become the building blocks in nebulae and are reborn as stars and planets.

After a supernova blast, a star may collapse into a **neutron star**. A neutron star is only a few kilometers wide. It's so dense that one spoonful of it would weigh as much as a mountain! If the star is more than 30 times the mass of the sun, the supernova turns into a **black hole**. This super-dense object has so much gravity that not even light can escape it.

Galaxies

Stars collect together with other debris, gases, and dust to form **galaxies**. Gravity holds these objects together. Scientists can see far-off galaxies thanks to the light that shines from so many stars. The famous astronomer, Edwin Hubble, classified galaxies into three types—elliptical, irregular, and spiral.

Elliptical Galaxies

Elliptical galaxies are usually round in shape. They are made only of older stars. Elliptical galaxies are not nearly as bright as spiral galaxies, and most are smaller in size. They may contain just a few thousand stars, and it's common for the stars to be close together. This can sometimes make the galaxy look like one gigantic star.

Irregular Galaxies

Irregular galaxies are not round or spiral in shape. These galaxies are usually misshapen or formless. Scientists believe these galaxies may have once been elliptical or spiral galaxies but have lost their shape over time. They may have crashed into another galaxy, or they may be pulled out of shape by the gravity of nearby galaxies.

This Just In!

Scientists estimate that 80 percent of the mass in space cannot be seen! Astronomers call it *dark matter*, and they think it exists in huge spaces between the stars. They believe this matter holds stars and planets in their galaxies.

Edwin Hubble wanted to give astronomers "hope to find something we had not expected."

Billion, Trillion, Sextillion?

Galaxies hold hundreds of billions of stars. Scientists estimate that there are over 100 billion galaxies in the universe. Currently, NASA estimates that there are about 1,000,000,000,000,000,000,000, or 1 sextillion, stars in the universe!

Spiral Galaxies

Spiral galaxies are shaped like pinwheels. At the center is a flat disk shape made up of older stars. Twisting arms extend from this center. The spinning motion of the arms gives the galaxy its spiral shape. The waves of the arms create very large new stars. The great light of these large stars makes the nearby dust clouds glow brightly.

Our own galaxy, the Milky Way, is a spiral galaxy. It's home to us, our sun, and another hundred billion stars. It's one hundred thousand light years across and rotates once every two hundred million years. The center is loaded with stars that surround a very large black hole. These stars stretch for fifteen thousand light years. The Milky Way is so enormous that several smaller galaxies orbit it. Talk about huge!

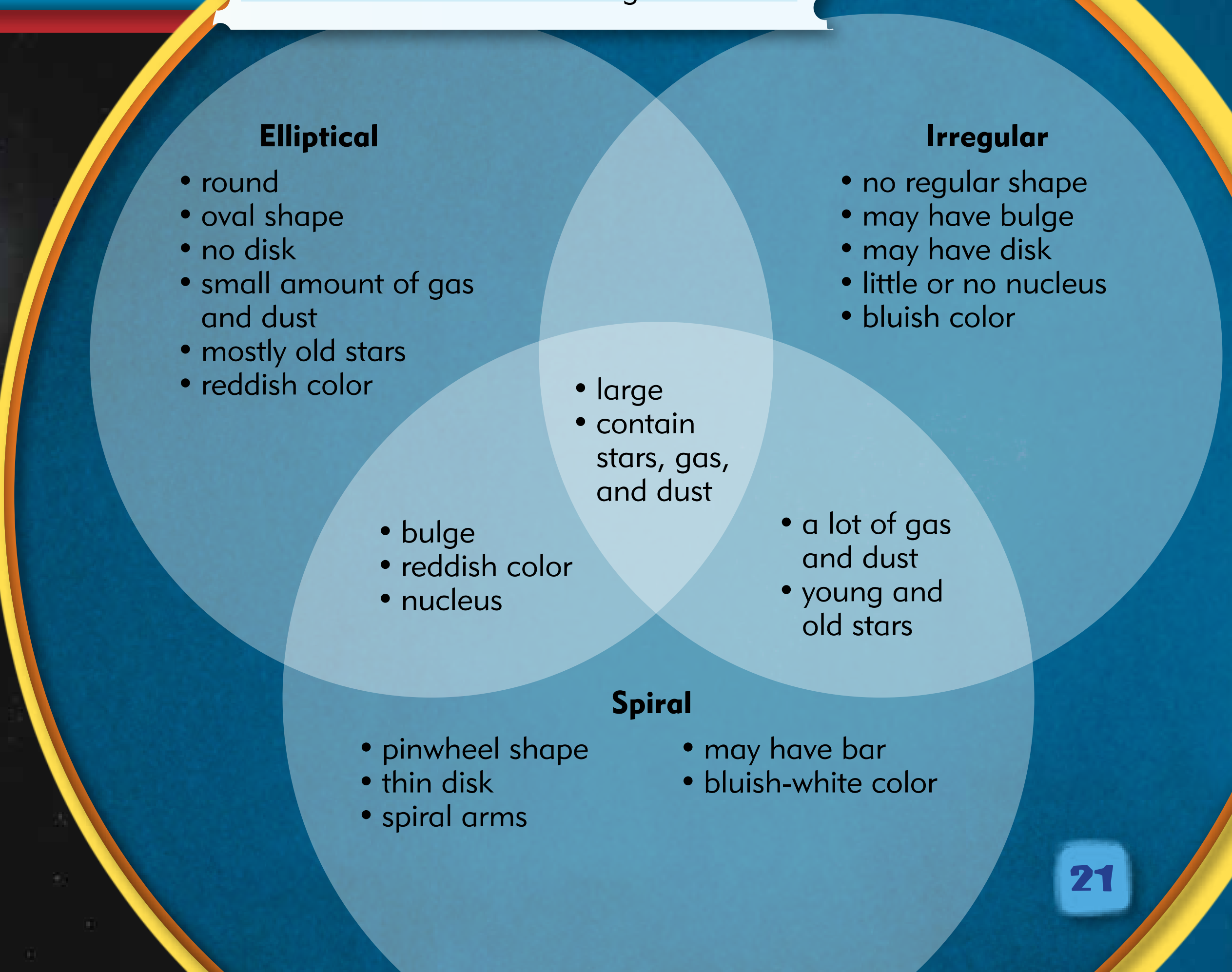
Galaxy Games

Galaxies may pull at one another or even crash and combine. Arp 273 is the name given to this group of interacting galaxies. The larger galaxy to the upper right has a distorted rose shape due to the gravitational pull of the galaxy below it.

The center of the Milky Way is hard for astronomers to see. This is because clouds of dust and gas block their view. Scientists believe there may be a very large black hole at the center of the Milky Way. This massive black hole has super-powerful gravity. It swallows anything that wanders into its territory. It's a good thing we're thousands of light years away!

Comparing Galaxies

Use the diagram below to compare and contrast the three different galaxies.



Our Solar System

Our solar system is one tiny part of the Milky Way. Our own star, the sun, lies at the center of the solar system. All other materials revolve around the sun. As the sun was born, gases, dust, and rocks swirled around it. They crashed together to create planets, moons, asteroids, comets, and meteors.

The sun is by far the largest object in our solar system. It contains 99 percent of all the material in our solar system. The sun's gravity keeps planets, moons, and other objects in orbit.

Each of the eight planets in the solar system is unique. They have different properties, colors, and sizes. The inner planets are much smaller than the outer planets. This is because of the location of the planet when it formed and its proximity, or distance, to the sun. Heat from the sun burned up the gases of the inner planets. The outer planets, however, were farther from the sun and did not lose their gases, making them larger.

The sun sings a long, slow song that we can't hear unless we use special instruments. It sounds like a deep humming.

Lucky for us, the sun was the exact right size and distance away from Earth to allow our planet to have liquid water. Scientists think that this is one of the main reasons life was able to develop on Earth. We still rely on the sun's energy to sustain us. Our solar neighbor in space makes life possible!

Our Planets

The chart to the right shows information for each planet in our solar system. The chart includes the length of a day and a year and the number of moons for each planet. Remember these measurements are according to our time on Earth.

Planet	Day	Year	Moons
Mercury	59 days	88 days	0
Venus	243 days	225 days	0
Earth	1 day	365 days	1
Mars	25 hours	687 days	2
Jupiter	10 hours	12 years	53
Saturn	11 hours	29.5 years	53
Uranus	17 hours	84 years	27
Neptune	16 hours	165 years	13

Star Studies

Long ago, the sky was clear. Stars were easy to see because there were no bright city lights. Thousands of stars sparkled against the velvety blackness of night. Stargazing was popular entertainment. Today, it is much harder to see stars. Pollution and electrical lighting dim the twinkling starlight. To see many stars, we must venture outside the cities most of us call home.

Astronomers have developed powerful telescopes and special devices to see stars. These instruments allow people to see stars not visible to the naked eye. Some of these huge telescopes are larger than a school gym. Many are built in remote mountain areas far from bright city lights, where the air is clean and the night is dark. These stellar lookouts are the best places for studying stars.

Other powerful telescopes float in space. Without Earth's atmosphere, these machines are able to peer deeper into space than Earth-bound telescopes. These telescopes collect photos and other kinds of data. They help astronomers learn about thousands of distant stars and galaxies.

Helpful Hubble

A well-known and exciting tool for star study is the Hubble Space Telescope. It may look like little more than a tin can, but it has taken some of the most striking photos of deep space. With it, astronomers have studied the births and deaths of stars. They have looked billions of light years into space.

If you look closely, you will notice that stars are not all the same color. They can be white, blue, yellow, orange, or red.

Sun Shows

Using hi-tech equipment, we have learned much about the surface of the sun. Its surface is a fiery mass of hot gases that boil and splash. Fountains of super-heated gases shoot out and put on quite a show! Dark spots appear and disappear. Our sun, which seems so constant, is constantly changing.

Scientists are always looking for new ways to study and explore space. They hope to learn more about how the universe began and how it has changed since then. They want to piece together the history of the universe. They are also on a quest to see if there are forms of life on other planets or if we are alone in the universe. They have identified several planets that are similar to Earth, but they're too far away for us to reach.

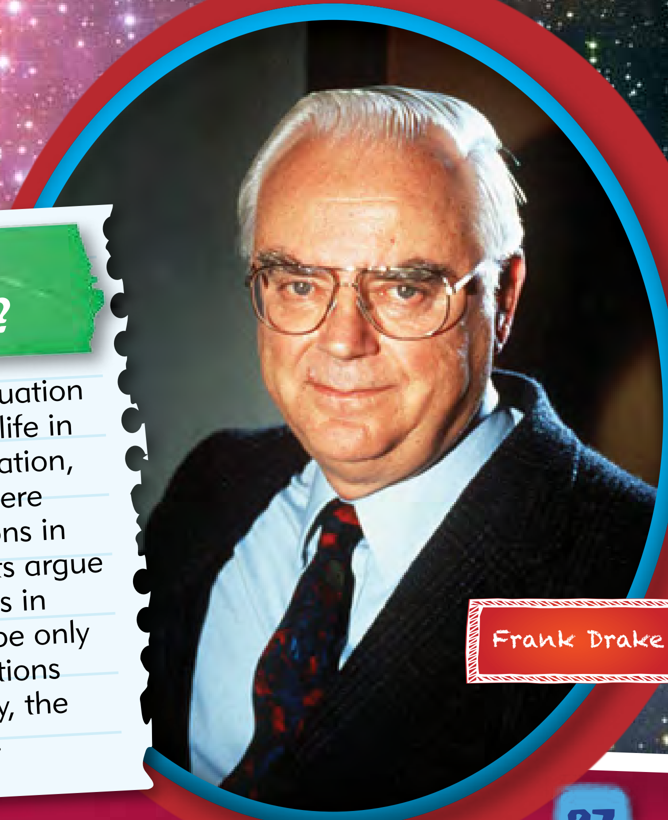
Astronomers and engineers are looking for new ways to power spacecraft. One idea is to use solar power. With an unlimited supply of energy from the sun, spacecrafts could travel much deeper into space.

In the meantime, you can learn about stars yourself. All you need is a clear, dark night away from city lights. Bring a star chart or use an app to help you locate stars, constellations, planets, and even galaxies. Keep studying the night sky, and maybe one day *you* will make the next great discovery.

The search for life outside of our planet is abbreviated to SETI, or Search for Extraterrestrial Intelligence.

Is There Life Beyond Ours?

Frank Drake created an equation to estimate the amount of life in our galaxy. Using this equation, scientists estimated that there might be 12,000 civilizations in our galaxy. Other scientists argue that with different numbers in the equaton, there could be only about two or three civilizations in each galaxy. Either way, the possibility exists out there.



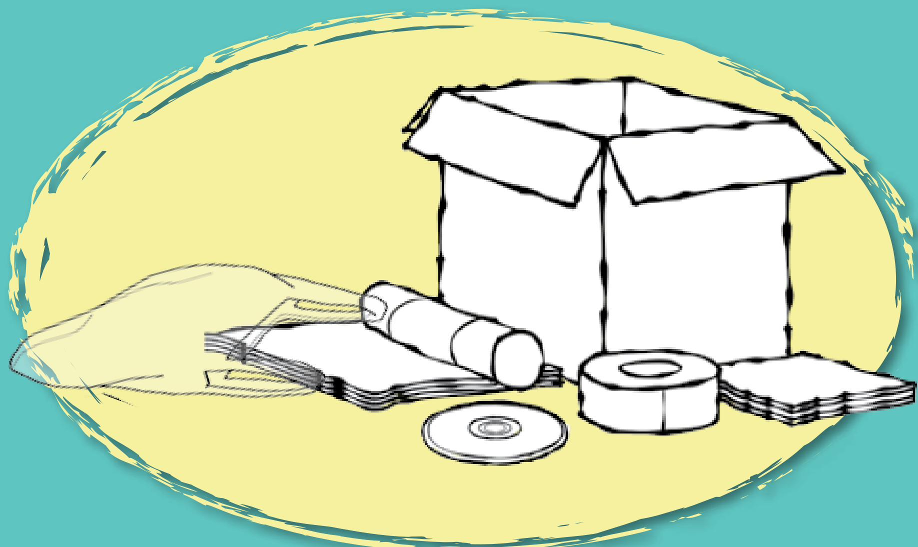
Frank Drake

Think Like a Scientist

How do scientists compare light from different stars? Experiment and find out!

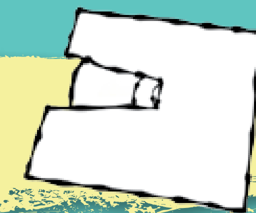
What to Get

- box (cube-shaped is best)
- cardboard tube
- CD
- duct tape
- paper
- thin cardboard
- transparent, milky plastic film such as tape or a white grocery bag

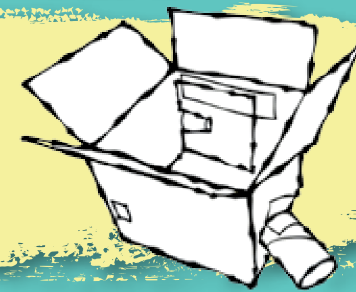


What to Do

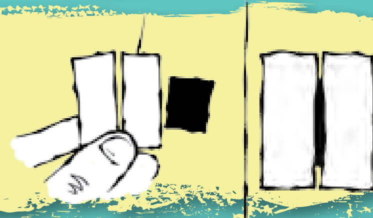
1. Tape paper over most of the CD, leaving a small section uncovered.



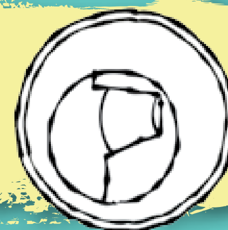
2. Tape the covered CD to the inside of the box. The uncovered section should be aligned with a corner of the box. Then, cut a small hole about 5 centimeters (2 inches) directly across from the uncovered section of the CD.



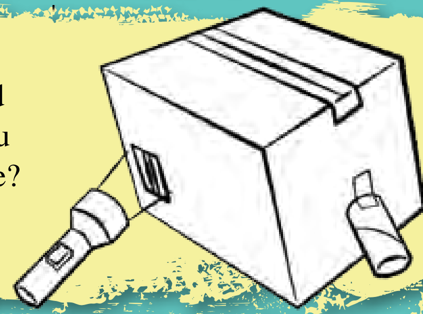
3. Tape two thin pieces of cardboard over the hole to create a small vertical slit about 1 mm (0.04 in.) wide. Tape transparent, milky film over the slit.



4. On the side of the box, adjacent to where the CD is exposed, cut another small hole. Tape a cardboard tube around this hole. This will be the eyepiece.



5. Close the box and tape it closed. Shine different kinds of light through the slit and view it through the eyepiece. What do you notice? How do the light sources compare? What do you think makes them appear different?



Glossary

astronomers—people who observe celestial phenomena

black hole—an area in space with gravity so strong that light cannot escape

constellations—groups of stars that form particular shapes in the sky and have been given names

dwarfs—stars of ordinary or low luminosity and relatively small mass and size

galaxies—systems of stars, gas, and dust held together by gravity

gravity—a force that acts between objects, pulling one toward the other

latitude—the position of a place measured in degrees north or south of the equator

light years—the distance light can travel in one year

luminosity—the quality or state of something producing light

magnitude—the size or power of something

mass—the amount of matter an object contains

nebulae—clouds of gas and dust in space

neutron star—a very small, dense star composed mostly of tightly packed neutrons

nuclear fusion—an atomic reaction in which two nuclei combine to make a larger one, releasing a large amount of energy

protostar—a cloud of gas and dust in space believed to develop into a star

satellites—objects in space that orbit other larger objects

spectrograph—instrument that splits light into different spectrums

supergiants—extremely large and luminous stars

supernova—explosion of a star that causes it to become extremely bright

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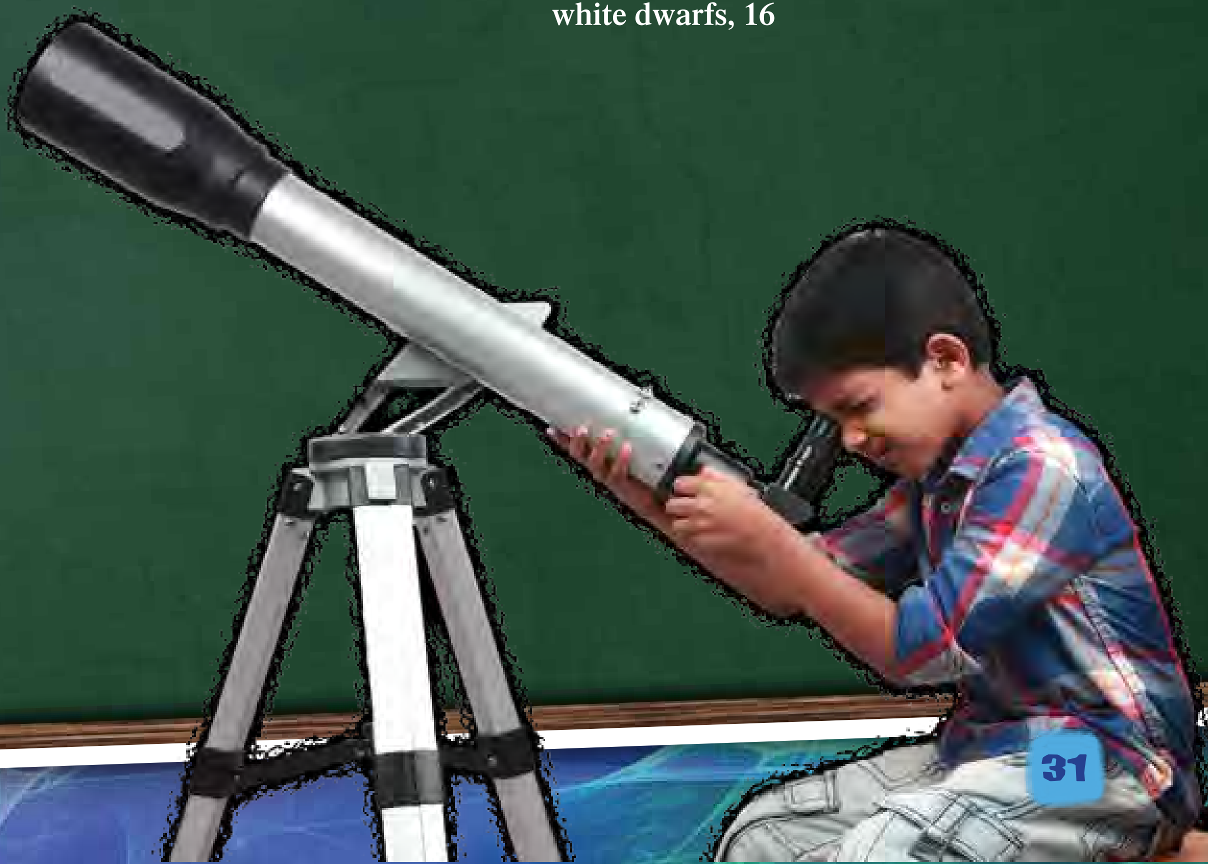

Your Turn!

A Night Out

Go outside on a clear night. Look at the sky through an empty toilet paper roll or paper towel roll. Count the number of stars you see. Record the number. Do this several times with different patches of sky. From which location do you see the most stars? From which location do you see the least? Why do you think it is different? Share your findings with your friends and family.