UNIT OVERVIEW

The universe is an incomprehensibly large space. It is filled with countless stars, galaxies, and other features. The Outside the Solar System unit helps students understand more about what lies beyond the reaches of our solar system, in deep space. The unit addresses the life cycle of stars, the existence of faraway planets and planetary systems, nebulas, supernovas, black holes, and galaxies. It also discusses the history of space exploration and theories about the origins of the universe.

Certain reading resources are provided at three reading levels within the unit to support differentiated instruction. Other resources are provided as a set, with different titles offered at each reading level. Dots on student resources indicate the reading level as follows:

- low reading level
- middle reading level
- high reading level

THE BIG IDEA

As long as humans have existed, we have looked into the night sky with curiosity and wonder. At this point in history, we are fortunate to benefit from technology that allows us to see and study parts of the universe that earlier cultures never could have. However, we are also limited by our current knowledge and technology. As time marches on, humankind will continue to pursue an understanding of the universe and its many amazing features. Someday—perhaps even in students' lifetimes—we may get answers to some key questions, including how the universe began and whether life exists anywhere beyond Earth.

Other topics

This unit also addresses topics such as: measuring great distances, exoplanets, telescopes, the Voyager program, and products developed as a result of space exploration.

SPARK

The spark is designed to get students thinking about the unit's topics and to generate curiosity and discussion.

Materials

- posters of deep-space features or computer with Internet connection
- projector or interactive whiteboard (optional)

Activity

Discuss students' prior knowledge of our solar system and then ask what exists beyond it. Explain to students that the images you are going to show are photos and/or illustrations of features found in deep space—the area beyond our solar system.

Display a variety of colorful images of features from deep space for the class. Viewing will be easiest if you obtain large posters or can display Web pages on a projector screen or interactive whiteboard. Many great space images can be found online.

While each image is displayed, invite students to describe what they see, including what they think the image shows, what makes the image interesting, how they think the subject of the image formed, how large they think the subject of the image might be, what else the image looks like, and any other observations they wish to share. You can have students respond to each image orally and/or in a science journal with a brief written response and an accompanying sketch.

Although you may want to share more information about each image after the discussion, the focus of this task does not have to be a deep understanding of what each picture shows. Instead, this spark is intended to simply get students excited to learn about the amazing features in the universe.

Below are questions to spark discussion.

Which features that you saw would you most want to see in person if you could travel into space? Why?

Which of the features that you saw can be seen with just your eyes, and which would require special tools? What kinds of tools?

Do you think you will ever be able to go into space during your lifetime? Why or why not?

If there were students in a classroom on some faraway planet, do you think they would be interested in seeing pictures from our solar system? Which parts?

Use this activity to begin an introductory discussion about the universe. Throughout the unit, students will learn more about space exploration and what lies outside the solar system.

Many of the unit's vocabulary terms are related to the spark activity and can be introduced during the spark. For vocabulary work, see the Vocabulary section in this *Unit Guide*.

PRIOR KNOWLEDGE

Invite students to explain their understanding of what our solar system consists of and what exists beyond it. Discuss what space looks like from Earth and what it might look like if people could travel into deep space.

Probing Questions to Think About

Use the following questions to have students begin thinking of what they know about what lies outside the solar system.

- What is inside our solar system? How do the different parts move in relation to one another?
- What is outer space made of?
- What is the difference between a planet and a star?
- Which is larger, a planet or a star? A solar system or a galaxy?
- Are the planets in our solar system the only planets in the universe?
- What else would you see in outer space besides stars and planets?
- How big is our solar system compared to the Milky Way Galaxy? How big is the Milky Way Galaxy compared to the whole universe?
- What dangers might you face if you traveled deep into space?
- Have people ever left Earth? Where have they gone?
- How do we know what exists far out in space if we've never been there?

Tell students they will learn more about these topics soon.

UNIT MATERIALS

Each unit provides a wide variety of resources related to the unit topic. Students may read books and other passages, work in groups to complete hands-on experiments and investigations, discuss science ideas as a class, watch videos, complete writing tasks, and take assessments.

Resources are available for printing or projecting, and many student resources are also available for students to access digitally on Kids A–Z.

Selected unit resources are available in more than one language.

For a complete list of materials provided with the unit, see the Outside the Solar System unit page on the Science A–Z website.

VOCABULARY

Use the terms below for vocabulary development throughout the unit. They can be found in boldface in the *Nonfiction Book*, the *Quick Reads*, and/or other unit resources. These terms and definitions are available on *Vocabulary Cards* for student practice. Additional vocabulary lists are provided in the teaching tips for *Investigation Packs* and *FOCUS Books*.

Core Science Terms

These terms are crucial to understanding the unit.

astronomer	a scientist who studies planets, stars, galaxies, and other objects in space
big bang theory	a theory that suggests that the universe began from a single, enormous explosion and is still expanding
black hole	a region of space with a gravitational field so intense that nothing can escape it
cluster	a close group of similar objects
cosmologist	a scientist who studies the origin and structure of the universe
deep space	the open areas between solid bodies in the universe beyond the solar system
exoplanet	any planet that exists outside the solar system
galaxy	a large collection of planets, gas, dust, and millions or billions of stars, bound together by gravity
light-year	a unit of distance in astronomy equal to the distance that light travels in one year
luminosity	a measure of the amount of radiating or reflected light coming off a star or other celestial object; brightness
nebula	a region or cloud of interstellar dust and gas appearing as a bright or dark patch
orbit	to revolve around another object
solar system	a star and the celestial bodies that revolve around it; a planetary system
star	a body in outer space, made of hot gases, that shines in the night sky
supernova	the death explosion of a massive star, resulting in a sharp increase in brightness followed by a gradual fading
telescope	an instrument used to make distant objects look closer

Other Key Science Terms

The following vocabulary is not essential for comprehending the unit but may enrich students' vocabulary.

astronaut	someone trained to travel and perform tasks in space
constellation	a group of stars that forms a shape and is named for that shape
cosmos	the whole universe
elliptical galaxy	an oval-shaped galaxy

gravity	the force that draws objects toward the center of Earth or any other large celestial body
irregular galaxy	a galaxy without a regular shape
life cycle	the stages of change that something goes through as time passes
mass	the measure of the amount of matter in an object
matter	anything that takes up space and has weight
Milky Way Galaxy	the galaxy that includes the Sun and our solar system
planet	a celestial body in orbit around a star
spacecraft	a vehicle used for traveling in space
spiral galaxy	a galaxy with curved arms that extend from a central axis
universe	all things that exist in space

Vocabulary Activities

You may choose to introduce all the terms that will be encountered in the unit before assigning any of the reading components. *Vocabulary Cards* with the key science terms and definitions are provided. Dots on the cards indicate the reading levels of the *Nonfiction Book* or the *Quick Reads* in which each term can be found. If all level dots appear, the term may come from another resource in the unit. Students can use these cards to review and practice the terms in small groups or pairs. The cards can also be used for center activity games such as Concentration.

The *Word Work* activity sheets offer fun puzzles and practice with key vocabulary terms from the unit. For further vocabulary practice and reinforcement, you can choose from the vocabulary *Graphic Organizers*. To build customized vocabulary lessons with terms related to the topic, see Vocabulary A-Z.

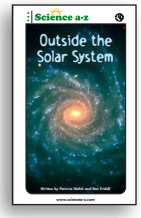
Students can use the *Word Smart* vocabulary *Graphic Organizer* to organize information on the science terms. You may want to assign each student one to three words to share his or her *Word Smart* knowledge with classmates. Students who have the same word should first compare their *Word Smart* sheets with each other and then report to the larger group.

The science terms can be used in oral practice. Have students use each term in a spoken sentence.

As students read, encourage them to create a science dictionary by recording new vocabulary terms and definitions in their *SAZ Journal*.

BACKGROUND AND MISCONCEPTIONS

Use this section as a resource for more background knowledge on unit content and to clarify the content for students if misconceptions arise. Refer to Using the Internet below for more ways to extend the learning.



Q: *Are stars really white, as they appear to be in the night sky?*

A: Actually, they are not. White light is a combination of all the other colors in the visible light spectrum. When looking through a telescope, it's evident that stars come in many colors. However, the unaided human eye tends to combine these colors into white light.

Q: *Should I be worried about the Sun dying? Will I need a warmer coat?*

A: As scientists have observed in other stars, the Sun goes through life cycle stages. Eventually it will die. But before we ever have to worry about its warmth fading out, we might have to be concerned with the Sun growing enormously and consuming Earth in its fiery gases. It may become a red giant long before it cools and becomes a nebula and finally a dwarf. However, and fortunately for us, these changes happen over millions or billions of years. The Sun should be roughly the same as it is now for the next billion years or so. Thus, in our lifetimes, there are not expected to be any changes to the Sun that would affect life on Earth.

Q: *Do stars twinkle because they give off light unevenly?*

A: While some stars, such as pulsars, give off light unevenly, most stars we see in the night sky give off fairly steady visible light. They appear to twinkle because their light passes through moving gases in our atmosphere. The refraction of the light as it passes through the moving medium makes the light waves bend in many directions, which causes the twinkling effect. The movement in the atmosphere can also make the light from stars change colors by the time it reaches Earth's surface.

Q: *Why don't planets twinkle?*

A: Actually, planets do twinkle. We generally don't see the twinkling because planets are so much closer to Earth than stars are. Any twinkle effect is overwhelmed by the sheer amount of light coming to our eyes. Stars send comparatively more light but over vastly greater distances. Thus, the smaller amount of light that reaches Earth from a star is more affected by atmospheric movement.

Q: *Would constellations look the same from other angles?*

A: No. Constellations are human-made inventions based on how stars appear in the sky from Earth. But in reality, the stars that make up a given constellation are very far from one another in space. From any vantage point except on or near Earth, the same group of stars would look completely different. (You can demonstrate this by placing objects in a group that produces a visual pattern, then having students observe the group from different vantage points.)

Q: *A year is a measurement of time, so doesn't a light-year also measure time?*

A: No. A light-year actually measures distance, despite having the word *year* in its name. One light-year is the distance that light can travel in one year. This is such a great distance that people sometimes use the term to refer to any great distance or large amount. For example, "Our dog is light-years ahead of where we expected she would be in her training by now."

Q: *If no humans have ever gone into deep space, how can we be sure what exists there?*

A: Some deep-space features can actually be seen and verified through modern telescopes. Other features can be proven to exist and can be described based on measurements of the electromagnetic energy they give off and by collecting other data. However, humans are quite far from understanding everything there is to know about the universe. Many theories exist about how the universe began, what the future holds for the universe, how space and time are related, types of matter, mysterious phenomena in space, and much more. As with other fields of study in science, the quest for understanding drives humanity's efforts to test theories and to build a greater understanding of the universe.

EXTENSION ACTIVITIES

Using the Internet

Most search engines will yield many results when a term such as *universe* or *deep space* is entered. You can also search for more on a specific deep-space feature, such as nebulas, supernovas, or galaxies. Be aware that some sites may not be educational or intended for the elementary classroom. More specific inquiries are recommended, such as:

- star life cycles
- Horseshoe Nebula
- timeline of space exploration
- convert light-years to miles/kilometers
- astronomy pictures
- closest stars to Earth
- famous astronauts
- cosmology for kids

Projects and Activities

- **Arts:** Cover a wall or door with black butcher paper and allow students to create a deep-space mural complete with colorful features they learned about in the unit.
- **Project:** Invite students to create board games or sports related to the exploration of deep space.
- **Project:** Encourage students to monitor newspapers and selected websites for current news related to space exploration. Then have groups of students each create a newscast of real and/or invented space news, including weather, sports, and human-interest stories.
- **Project/Home Connection/Guest:** Hold a star party on the school playground in which students and their families can look through telescopes on a clear night. Invite amateur astronomers to bring their equipment and share their astronomical expertise with students.
- **Field Trip:** Bring students to a planetarium or science center to learn about the tools of space exploration and to view displays on deep-space features.
- **Writing:** Have students write a science fiction narrative about a journey through space in which they demonstrate an understanding of the structure and systems of the universe. See Writing A-Z for extensive writing instruction.
- **Math:** Challenge students to invent a unit of measurement similar in scale to a light-year but that measures a large amount of something other than distance.
- **Research/ELL:** Compile a list of names of galaxies, stars, planets, and other space features with foreign word origins, such as Latin. Challenge students to identify similarities between these names and English words or names.

- **Research/Technology:** Assign specific deep-space features to individuals or groups to research in the library/media center or online. Have students create a class presentation on what they learned, complete with interesting details and appealing visuals.
- **Research/Home Connection:** Students can conduct research as a family/home project or in the library/media center to extend the learning about a topic in one of the *Quick Reads* or other unit resources.