

# Astronomy

## OUR SOLAR SYSTEM AND BEYOND

### Tell It Again!™ Read-Aloud Anthology

Core Knowledge Language Arts® • Listening & Learning™ Strand



Core Knowledge®

GRADE 3





# Astronomy

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Tell It Again!™ Read-Aloud Anthology

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GRADE 3

Core Knowledge Language Arts®



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# Alignment Chart for Astronomy: Our Solar System and Beyond

The following chart contains the core content objectives addressed in this domain. It also demonstrates alignment between the Common Core State Standards and corresponding Core Knowledge Language Arts (CKLA) goals.

## Alignment Chart for Astronomy: Our Solar System and Beyond

### Lesson

	1	2	3	4	5	6	7	8	9	10
<b>Core Content Objectives</b>										
Identify the sun as a constant source of heat and light energy	✓	✓	✓	✓						
Classify the sun as a star	✓	✓		✓	✓		✓			
Identify our planet Earth as the third planet from the sun and ideally suited for life	✓	✓	✓	✓	✓					
Demonstrate how day and night on Earth are caused by Earth's rotation	✓									
Explain why the sun seems to rise in the east and set in the west	✓									
Explain what happens during a solar eclipse and lunar eclipse	✓									
Explain the reasons for seasons	✓									
Describe the eight planets of our solar system and their sequence from the sun		✓	✓	✓	✓		✓			
Identify our solar system as the sun and all of the smaller bodies that orbit it, e.g., the planets, moons, asteroids, etc.		✓	✓	✓	✓					
Describe the characteristics of a planet	✓	✓								
Explain that Pluto has been reclassified as a dwarf planet		✓	✓						✓	
Describe the asteroid belt		✓	✓							
Compare and contrast asteroids, meteoroids, and comets		✓								
Describe stars as hot, distant, and made of gas	✓			✓			✓			
Describe the characteristics of stars						✓				
Compare and contrast our sun and other stars				✓		✓				
Describe a galaxy as a very large cluster of many stars				✓		✓	✓			
Identify the Milky Way as our own galaxy and Andromeda as the closest spiral galaxy in our universe				✓	✓	✓	✓			

**Alignment Chart for  
Astronomy: Our Solar System and Beyond**

**Lesson**

	1	2	3	4	5	6	7	8	9	10
Describe the universe as a vast space that extends beyond the imagination				✓			✓			
Describe gravity					✓					
Describe the effects gravity has on Earth, within the solar system, and in the universe					✓		✓	✓	✓	
Explain what constellations are and how they are useful						✓				
Recognize and name important constellations						✓				
Describe tools and methods used to study space and share information							✓	✓	✓	✓
Identify and use vocabulary important to the process of science							✓	✓		✓
Explain the Big Bang theory as an important scientific theory of the origin of the universe							✓	✓		
Describe the life and contributions of Copernicus								✓	✓	✓
Recall key details about the history of space exploration, e.g., Galileo's invention of the telescope, <i>Sputnik I</i> , Apollo 11, and the Hubble Space Telescope								✓	✓	✓
Describe the life and contributions of astronaut Mae Jemison										✓

**Reading Standards for Informational Text: Grade 3**

**Key Ideas and Details**

<b>STD RI.3.1</b>	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.									
<b>CKLA Goal(s)</b>	Ask and answer questions (e.g., <i>who</i> , <i>what</i> , <i>where</i> , <i>when</i> , <i>why</i> , <i>how</i> ), orally or in writing, requiring literal recall and understanding of the details and/or facts of a nonfiction/informational read-aloud						✓			
	Ask and answer questions, orally or in writing, that require making interpretations, judgments, or giving opinions about what is heard in a nonfiction/informational read-aloud, including asking and answering <i>why</i> questions that require recognizing or inferring cause/effect relationships						✓			
<b>STD RI.3.2</b>	Determine the main idea of a text; recount the key details and explain how they support the main idea.									
<b>CKLA Goal(s)</b>	Determine the main idea of a nonfiction/informational read-aloud; recount the key details and explain how they support the main idea						✓	✓		



**Alignment Chart for  
Astronomy: Our Solar System and Beyond**

**Lesson**

		1	2	3	4	5	6	7	8	9	10
<b>STD RI.3.3</b>	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.										
<b>CKLA Goal(s)</b>	With assistance, create and/or interpret timelines and lifelines related to content in a nonfiction/informational read-aloud									✓	✓
	Sequence four to six pictures or sentences illustrating/describing events from a nonfiction/informational read-aloud	✓	✓	✓		✓	✓	✓		✓	✓
	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a nonfiction/informational read-aloud, using language that pertains to time, sequence, and cause/effect	✓									
	Distinguish nonfiction/informational read-alouds that describe events that happened long ago from those that describe contemporary or current events								✓	✓	✓
<b>Craft and Structure</b>											
<b>STD RI.3.4</b>	Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a Grade 3 topic or subject area.										
<b>CKLA Goal(s)</b>	Determine the literal and nonliteral meanings of and appropriately use common sayings and phrases			✓	✓		✓				✓
	Determine the meaning of general academic and domain-specific words and phrases in a nonfiction/informational read-aloud relevant to a Grade 3 topic or subject area	✓									
<b>STD RI.3.6</b>	Distinguish their own point of view from that of the author of a text.										
<b>CKLA Goal(s)</b>	Distinguish their own point of view from that of the author of a text						✓		✓		

**Alignment Chart for  
Astronomy: Our Solar System and Beyond**

**Lesson**

		1	2	3	4	5	6	7	8	9	10
<b>Integration of Knowledge and Ideas</b>											
<b>STD RI.3.7</b>	Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).										
<b>CKLA Goal(s)</b>	Describe images, orally or in writing, and how they contribute to what is conveyed by the words in a nonfiction/informational read-aloud (e.g., where, when, why, and how key events occur)		✓		✓	✓	✓	✓	✓	✓	✓
	Use images (e.g., maps, photographs) accompanying a nonfiction/informational read-aloud to check and support understanding	✓									
	Interpret information from diagrams, charts, graphs, and/or graphic organizers	✓	✓			✓	✓	✓	✓	✓	✓
<b>STD RI.3.8</b>	Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).										
<b>CKLA Goal(s)</b>	Describe the logical connection between particular sentences and paragraphs in a nonfiction/informational read-aloud (e.g., comparison, cause/effect, first/second/third in a sequence)							✓			
	Sequence four to six pictures or sentences illustrating/describing events or processes from a nonfiction/informational read-aloud							✓			
<b>STD RI.3.9</b>	Compare and contrast the most important points and key details presented in two texts on the same topic.										
<b>CKLA Goal(s)</b>	Compare and contrast the most important points and key details presented in two nonfiction/informational read-alouds on the same topic		✓	✓	✓				✓		✓
<b>Writing Standards: Grade 3</b>											
<b>Text Types and Purposes: Narrative</b>											
<b>STD W.3.3</b>	Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.										
<b>STD W.3.3a</b>	Establish a situation and introduce a narrator and/or characters; organize an event sequence that unfolds naturally.										
<b>CKLA Goal(s)</b>	Identify and use parts of a paragraph, including a topic sentence, supporting details and a concluding statement, in a narrative piece								✓	✓	✓
	Establish a situation and introduce a narrator and/or characters; organize an event sequence that unfolds naturally								✓	✓	✓

**Alignment Chart for  
Astronomy: Our Solar System and Beyond**

**Lesson**

		1	2	3	4	5	6	7	8	9	10	
<b>STD W.3.3b</b>	Use dialogue and descriptions of actions, thoughts, and feelings to develop experiences and events or show the response of characters to situations.											
<b>CKLA Goal(s)</b>	Use dialogue and descriptions of actions, thoughts, and feelings to develop experiences and events or show the response of characters to situations									✓	✓	
<b>STD W.3.3c</b>	Use temporal words and phrases to signal event order.											
<b>CKLA Goal(s)</b>	Use temporal words and phrases to signal event order in a narrative piece								✓	✓	✓	
<b>STD W.3.3d</b>	Provide a sense of closure.											
<b>CKLA Goal(s)</b>	Provide a sense of closure in a narrative piece									✓	✓	
<b>Production and Distribution of Writing</b>												
<b>STD W.3.4</b>	With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose. (Grade-specific expectations for writing types are defined in Standards 1–3 above.)											
<b>CKLA Goal(s)</b>	With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose, i.e., ideas and paragraphs presented clearly and in a logical order										✓	
<b>STD W.3.5</b>	With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, and editing. (Editing for conventions should demonstrate command of Language Standards 1–3 up to and including Grade 3 on pages 28 and 29.)											
<b>CKLA Goal(s)</b>	With guidance and support from peers and adults, use the writing process of plan, draft, revise, edit, and publish to develop and strengthen writing									✓	✓	✓
<b>STD W.3.6</b>	With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others.											
<b>CKLA Goal(s)</b>	Share writing with others										✓	
	With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others**										✓	
<b>Research to Build and Present Knowledge</b>												
<b>STD W.3.7</b>	Conduct short research projects that build knowledge about a topic.											
<b>CKLA Goal(s)</b>	Conduct short research projects that build knowledge about a topic		✓	✓		✓		✓				

**Alignment Chart for  
Astronomy: Our Solar System and Beyond**

**Lesson**

		1	2	3	4	5	6	7	8	9	10
<b>STD W.3.8</b>	Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.										
<b>CKLA Goal(s)</b>	Make personal connections (orally or in writing) to events or experiences in a fiction or nonfiction/informational read-aloud, and/or make connections among several read-alouds						✓				
	Gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories		✓	✓					✓		
	Categorize and organize facts and information within a given domain	✓	✓	✓	✓		✓	✓	✓		
<b>STD W.3.10</b>	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.										
<b>CKLA Goal(s)</b>	Write responses to fiction and nonfiction/informational read-alouds that demonstrate understanding of the text and/or express/support opinion, using examples from a text and distinguishing own point of view from that of the author, narrator, or characters (short time frame)						✓				
	With guidance and support from peers and adults, use the writing process of plan, draft, revise, edit, and publish to develop and strengthen writing (extended time frame)								✓	✓	✓
	Write sentences to represent the main idea and details from a fiction or nonfiction/informational read-aloud (short time frame)						✓				

**Alignment Chart for  
Astronomy: Our Solar System and Beyond**

**Lesson**

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

**Speaking and Listening Standards: Grade 3**

**Comprehension and Collaboration**

<b>STD SL.3.1</b>	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 3 topics and texts, building on others' ideas and expressing their own clearly.																		
<b>STD SL.3.1a</b>	Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.																		
<b>CKLA Goal(s)</b>	Carry on and participate in a conversation with an adult or peer for at least six turns, staying on topic, building on others' ideas, and expressing their own ideas clearly																		
	Demonstrate preparedness for a discussion, having read or studied required material, explicitly drawing on preparation and other information known about the topic to explore content under discussion																		
	Prior to listening to a read-aloud, identify (orally or in writing) what they know and have learned that may be related to the specific read-aloud or topic																		
	Make predictions (orally or in writing) prior to and during a read-aloud, based on the title, images, and/or text heard thus far, and then compare the actual outcomes to predictions	✓				✓					✓								
<b>STD SL.3.1b</b>	Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).																		
<b>CKLA Goal(s)</b>	Use agreed-upon rules for group discussions, e.g., look at and listen to the speaker, raise hand to speak, take turns, say "excuse me" or "please," etc.																		
<b>STD SL.3.1c</b>	Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.																		
<b>CKLA Goal(s)</b>	Interpret information presented, and then ask questions to clarify information or the topic in a fiction or nonfiction/informational read-aloud																		
<b>STD SL.3.1d</b>	Explain their own ideas and understanding in light of the discussion.																		
<b>CKLA Goal(s)</b>	During a discussion, explain ideas and understanding in relation to the topic																		



**Alignment Chart for  
Astronomy: Our Solar System and Beyond**

**Lesson**

		1	2	3	4	5	6	7	8	9	10
<b>STD SL.3.2</b>	Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.										
<b>CKLA Goal(s)</b>	Determine the main ideas and supporting details of a read-aloud or information presented in diverse media and formats, including visually, quantitatively, and orally		✓	✓	✓	✓			✓	✓	✓
<b>STD SL.3.3</b>	Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.										
<b>CKLA Goal(s)</b>	Ask and answer questions to clarify directions, exercises, and/or classroom routines and/or what a speaker says about a topic to gather additional information or deepen understanding of a topic or issue						✓				
<b>Presentation of Knowledge and Ideas</b>											
<b>STD SL.3.4</b>	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.										
<b>CKLA Goal(s)</b>	Summarize (orally or in writing) read-aloud content and/or oral information presented by others			✓	✓				✓		✓
	Retell (orally or in writing) important facts and information from a fiction or nonfiction/informational read-aloud						✓				
<b>STD SL.3.6</b>	Speak in complete sentences when appropriate to task and situation in order to provide requested detail or clarification. (See Grade 3 Language Standards 1 and 3 on pages 28 and 29 for specific expectations.)										
<b>CKLA Goal(s)</b>	Speak in complete sentences when appropriate to task and situation in order to provide requested detail or clarification						✓				
<b>Language Standards: Grade 3</b>											
<b>Knowledge of Language</b>											
<b>STD L.3.3</b>	Use knowledge of language and its conventions when writing, speaking, reading, or listening.										
<b>STD L.3.3a</b>	Choose words and phrases for effect.*										
<b>CKLA Goal(s)</b>	Choose words and phrases for effect*						✓				
<b>Vocabulary Acquisition and Use</b>											
<b>STD L.3.4</b>	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on Grade 3 reading and content, choosing flexibly from a range of strategies.										
<b>STD L.3.4a</b>	Use sentence-level context as a clue to the meaning of a word or phrase.										
<b>CKLA Goal(s)</b>	Use sentence-level context as a clue to the meaning of a word or phrase						✓				


**Alignment Chart for  
Astronomy: Our Solar System and Beyond**


**Lesson**

		1	2	3	4	5	6	7	8	9	10
<b>STD L.3.4b</b>	Determine the meaning of the new word formed when a known affix is added to a known word (e.g., <i>agreeable/disagreeable, comfortable/uncomfortable, care/careless, heat/preheat</i> ).										
<b>CKLA Goal(s)</b>	Determine the meaning of the new word formed when a known affix is added to a known word (e.g., <i>agreeable/disagreeable, comfortable/uncomfortable, care/careless, heat/preheat</i> )				✓		✓	✓	✓	✓	✓
<b>STD L.3.4c</b>	Use a known root word as a clue to the meaning of an unknown word with the same root (e.g., <i>company, companion</i> ).										
<b>CKLA Goal(s)</b>	Use a known root word as a clue to the meaning of an unknown word with the same root (e.g., <i>company, companion</i> )	✓	✓		✓	✓	✓		✓	✓	✓
<b>STD L.3.5</b>	Demonstrate understanding of word relationships and nuances in word meanings.										
<b>STD L.3.5a</b>	Distinguish the literal and nonliteral meanings of words and phrases in context										
<b>CKLA Goal(s)</b>	Determine the literal and nonliteral meanings of and appropriately use common sayings and phrases			✓	✓		✓				✓
<b>STD L.3.5b</b>	Identify real-life connections between words and their use (e.g., describe people who are <i>friendly</i> or <i>helpful</i> ).										
<b>CKLA Goal(s)</b>	Provide and/or use synonyms and antonyms			✓				✓		✓	
	Identify real-life connections between words and their use (e.g., describe people who are <i>friendly</i> or <i>helpful</i> )										
<b>STD L.3.5c</b>	Distinguish shades of meaning among related words that describe states of mind or degrees of certainty (e.g., <i>knew, believed, suspected, heard, wondered</i> ).										
<b>CKLA Goal(s)</b>	Distinguish shades of meaning among related words that describe states of mind or degrees of certainty (e.g., <i>knew, believed, suspected, heard, wondered</i> )								✓	✓	✓
<b>STD L.3.6</b>	Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial and temporal relationships (e.g., <i>After dinner that night we went looking for them</i> ).										
<b>CKLA Goal(s)</b>	Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial and temporal relationships										

**Alignment Chart for  
Astronomy: Our Solar System and Beyond**

**Lesson**

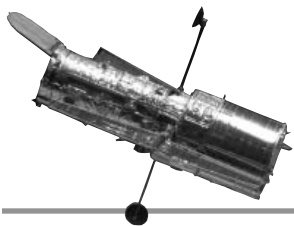
		1	2	3	4	5	6	7	8	9	10
<b>Additional CKLA Goals</b>											
<b>CKLA Goal(s)</b>	Listen to and understand a variety of texts, including informational texts and poems										
	Draw illustrations, diagrams, charts, and/or graphic organizers to represent the main idea and/or details from a fiction or informative/explanatory read-aloud, to depict a vocabulary word, or to enhance a piece of writing		✓	✓	✓	✓	✓	✓			

 These goals are addressed in all lessons in this domain. Rather than repeat these goals as lesson objectives throughout the domain, they are designated here as frequently occurring goals.

\* Skills marked with an asterisk (\*) in Language Standards 1–3 are particularly likely to require continued attention in higher grades as they are applied to increasingly sophisticated writing and speaking.

\*\* The editing and publishing steps of the narrative writing piece have been placed at the beginning of Pausing Point 2. It is highly recommended that this first section of Pausing Point 2 be regarded as *required* in order to most accurately align with the writing requirements of the Common Core State Standards.





# Introduction to Astronomy: Our Solar System and Beyond

This introduction includes the necessary background information to be used in teaching the *Astronomy: Our Solar System and Beyond* domain. The *Tell It Again! Read-Aloud Anthology for Astronomy: Our Solar System and Beyond* contains ten daily lessons, each of which is composed of two distinct parts—the Read-Aloud and the Extension—so that the lessons may be divided into smaller chunks of time and presented at different intervals during the day. Each entire lesson will require a total of seventy minutes.

In addition to these lessons, there are two Pausing Points in this domain: one after Lesson 5 for two days; and one after Lesson 10 for two days. These Pausing Points are designed to allow four total days for reviewing, reinforcing, or extending the material taught thus far. One day is included for the Domain Assessment. The remaining day may be devoted to review, reassessment as needed, and extension of the writing process. **You should spend no more than fifteen days total on this domain.**

## Domain Overview

Here is an overview of the domain schedule for *Astronomy: Our Solar System and Beyond*. Please see the Unit 7 Teacher Guide for the corresponding Skills schedule.

Week One										
Min.	Day 1	# 10	Day 2	# 10	Day 3	# 10	Day 4	# 10	Day 5	#
50	Lesson 1A: "Our Planet Earth"		Lesson 2A: "Our Solar System, Part I"		Lesson 3A: "Our Solar System, Part II"		Lesson 4A: "Galaxies"		Lesson 5A: "Gravity"	
20	Lesson 1B: Extensions		Lesson 2B: Extensions		Lesson 3B: Extensions		Lesson 4B: Extensions		Lesson 5B: Extensions	

Week Two										
Min.	Day 6	# 10	Day 7	# 10	Day 8	#	Day 9	# 10	Day 10	#
50	Pausing Point 1, Day 1		Pausing Point 1, Day 2		Lesson 6A: "Stars and Constellations"		Lesson 7A: "The Big Bang"		Lesson 8A: "Nicolaus Copernicus"	
20					Lesson 6B: Extensions		Lesson 7B: Extensions		Lesson 8B: Narrative Writing: Plan	

Week Three					
Min.	Day 11	Day 12	Day 13 † ⑩	Day 14 ⑩	Day 15 ⑩
50	Lesson 9: “Space Exploration”	Lesson 10: “Mae Jemison”	Pausing Point 2, Day 1	Pausing Point 2, Day 2	Domain Assessment/ Remediate/Reassess as needed
20	Lesson 9B: Narrative Writing: Draft	Lesson 10B: Sayings and Phrases; Narrative Writing: Draft/ Revise	Narrative Writing: Edit/ Final Copy	Narrative Writing: Publish	Remediate/Reassess as needed; Narrative Writing: Publish/ Independent Writing
30	Narrative Writing: Draft	Narrative Writing: Draft/ Revise	Narrative Writing: Edit/ Final Copy	Narrative Writing: Publish	Remediate/Reassess as needed; Narrative Writing: Publish/ Independent Writing

⑩ Lessons include Student Performance Task Assessments

# Lessons require advance preparation and/or additional materials; please plan ahead

† The editing and publishing steps of the narrative writing piece have been placed at the beginning of Pausing Point 2. It is highly recommended that this first section of Pausing Point 2 be regarded as *required* in order to most accurately align with the writing requirements of the Common Core State Standards.

Along with this anthology, you will need:

- *Tell It Again! Media Disk* or the *Tell It Again! Flip Book\** for *Astronomy: Our Solar System and Beyond*
- *Tell It Again! Image Cards* for *Astronomy: Our Solar System and Beyond*

\**Tell It Again! Posters* for *Astronomy: Our Solar System and Beyond* are located at the end of the *Tell It Again! Flip Book*.

You may wish to have one notebook/binder readily available for each student to be used for note-taking and other writing opportunities, such as “domain dictionaries.”

You will find the Instructional Objectives and Core Vocabulary for this domain in the sections that follow. The lessons that include Writing Opportunities, Student Choice/Domain-Related Trade Book Extensions, Instructional Masters, and Assessments are also listed in this Introduction.

## ***Why Astronomy: Our Solar System and Beyond Is Important***

This domain reviews what students have already learned about astronomy and introduces them to new information about this science. Students who used the Core Knowledge Language Arts program in Grades 1 and 2 will be familiar with some of the information concerning our solar system, sun, and planet Earth, especially the reason for seasons. Students will hear even more about the seven other planets in our solar system, as well as objects like asteroids, meteoroids, and

comets that also orbit the sun. Additionally, students will be exposed to new topics like galaxies, stars, and the Big Bang theory of how the universe may have originated. Students will also hear about key people and events involved in the study and exploration of outer space.

The content students learn in this grade will serve as the basis for more in-depth study in the later grades of topics such as gravity, matter, light-years, and black holes.

## **What Students Have Already Learned in Core Knowledge Language Arts During Kindergarten, Grade 1, and Grade 2**

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The following domains, and the specific core content that was targeted in those domains, are particularly relevant to the read-alouds students will hear in *Astronomy: Our Solar System and Beyond*. This background knowledge will greatly enhance your students' understanding of the read-alouds they are about to enjoy:

### ***Astronomy (Grade 1)***

- Recognize the sun in the sky
- Explain that the sun, moon, and stars are located in outer space
- Explain that the sun is a source of energy, light, and heat
- Classify the sun as a star
- Identify Earth as a planet and our home
- Identify the Earth's rotation or spin as the cause of day and night
- Explain that other parts of the world experience nighttime while we have daytime
- Explain sunrise and sunset
- Explain that Earth orbits the sun
- Explain that stars are large, although they appear small in the night sky
- Describe stars as hot, distant, and made of gas
- Explain that astronomers study the moon and stars using telescopes
- Describe how people sometimes tell stories about the moon and stars
- Explain what a constellation is
- Identify the Big Dipper and the North Star
- Identify the four phases of the moon—new, crescent, half, full
- State that the moon orbits the earth


- Explain that astronauts travel to outer space
- Describe the landing on the moon by American astronauts
- Explain the importance of the first trip to the moon
- Explain that our solar system includes the sun and the planets that orbit around it
- Identify that there are eight planets in our solar system (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune)
- Classify Pluto as a dwarf planet

### ***Cycles in Nature (Grade 2)***

- Recognize that Earth orbits the sun
- Explain that it takes one year for Earth to orbit the sun
- Explain that a cycle is a sequence of events that repeats itself again and again
- Describe the seasonal cycle: spring, summer, autumn (fall), winter
- Identify that the tilt of Earth’s axis in relation to the sun causes the seasons
- Recognize that most of Earth’s surface is covered by water
- Identify the three states of matter in which water exists: solid, liquid, and gas

## **Core Vocabulary for Astronomy: Our Solar System and Beyond**

The following list contains all of the core vocabulary words in *Astronomy: Our Solar System and Beyond* in the forms in which they appear in the text. The vocabulary words used in the Word Work activities are boldfaced. The multiple-meaning vocabulary words that are used as activities in the Pausing Points are marked with a + sign. The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure throughout the lessons, they should acquire a good understanding of most of these words and begin to use some of them in conversation.

 **Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may choose to have students write these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

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**Lesson 1**

atmosphere\*  
axis\*  
eclipse\*  
hemisphere  
orbit\*  
rotate\*  
**universe**

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**Lesson 2**

asteroids\*  
celestial bodies  
comets\*  
**core**  
debris+  
meteoroids\*  
satellites\*  
solar system\*  
terrain

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**Lesson 3**

dense  
**frigid**  
greenhouse  
NASA\*  
polar

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**Lesson 4**

astronomical  
atoms  
cluster  
fuse  
galaxy\*  
**irregular**  
light-years  
spiral

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**Lesson 5**

attraction\*  
black hole  
force  
gravitational pull  
**gravity\***  
matter\*  
tides

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**Lesson 6**

**constellations\***  
ladle  
magnetic  
navigate  
orient  
orienteering  
Polaris

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**Lesson 7**

Big Bang\*  
compressed  
data  
elements  
evidence  
**expanding**  
phenomenon  
theories\*

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**Lesson 8**

calculations  
diurnal  
**geocentric**  
**heliocentric**  
hypothesis  
logical  
opposed

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**Lesson 9**

module  
observatory\*  
probes\*  
reusable\*  
spacecraft  
space shuttle\*  
**triumph**

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**Lesson 10**

aeronautics  
applications  
conducted+  
engineering\*  
international\*  
**mission**  
pursue  
refugees  
tragedy

\*The words or variations of the words marked with an asterisk (\*) are included in the Skills Reader and Vocabulary Cards.

## Comprehension Questions

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In the *Tell It Again! Read-Aloud Anthology for Astronomy: Our Solar System and Beyond*, there are three types of comprehension questions: literal questions to assess students' recall of the core content; inferential questions to guide students to infer information from the text and think critically; and evaluative questions to guide students to build upon what they have learned from the text to use their creative, analytical, and application skills. Many of these questions are also labeled as writing prompts and are discussed in more detail in the Writing Opportunities section in this introduction.

The last comprehension question in each lesson prompts students to ask, answer, and/or research any remaining questions they may have about the content; this question may also be expanded upon as an “Above and Beyond” research and/or writing activity. Many of these comprehension questions may also serve as meaningful take-home topics to discuss with family members.



It is highly recommended that students answer all comprehension questions in complete sentences—whether orally or in writing—using domain vocabulary whenever possible. You may wish to have students collect written responses in their Space Notes notebook or folder.

## Writing Opportunities

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In the *Tell It Again! Read-Aloud Anthology for Astronomy: Our Solar System and Beyond*, the content is reinforced through a biographical narrative piece, which students complete as a class in Lessons 8–10, Pausing Point 2, and the Domain Genre Writing time using the steps of the formal writing process: plan, draft, revise, edit, and publish.

Everyday writing opportunities are included in the Comprehension Questions and Extensions in Lessons 1–10, as well as in both Pausing Points. Students will collect information learned in their Space Notes notebook or folder.

In the Comprehension Questions, shorter writing prompts that assess students' literal recall of the core content and provide practice for the short-answer writing section of the Student Performance Task Assessment are indicated by this icon: . Longer writing prompts that encourage students to think critically and expand creatively upon the content are indicated by this icon: . Some of these prompts may serve

both purposes and may also be collected in students' Space Notes notebook or folder to provide source information for them to reference when writing their formal writing piece, as well as when writing a research paper in the Skills strand.

For these writing sessions, it is highly recommended that students take 5–10 minutes of Discussing the Read-Aloud time to write a half to a full page in response to one or more of the prompts, during which time you are encouraged to circulate and provide over-the-shoulder conferencing for a group of students each day. During these daily writing sessions, you may also choose to reinforce what students are learning in the Skills strand by having them practice these skills in their writing. The goal of these extended writing sessions is to provide students with daily “low-stakes” writing practice and to have them receive immediate feedback on the content, featured skill(s), and clarity and depth of their written expression. You may also choose to publish select pieces of students' writing to reinforce a particular concept or skill. It is highly recommended that students share their writing on a daily basis as time permits.

## ***Student Choice and Domain-Related Trade Book Extensions***

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In the *Tell It Again! Read-Aloud Anthology for Astronomy: Our Solar System and Beyond*, Student Choice and Domain-Related Trade Book activities are suggested in both Pausing Points. A list of recommended titles is included at the end of this introduction, or you may select another title of your choice.

## ***Astronomy: Our Solar System and Beyond Image Cards***

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There are thirty Image Cards for the *Astronomy: Our Solar System and Beyond* domain. These Image Cards include pictures of planets and other celestial bodies in our solar system, space exploration, galaxies, stars, and historical figures such as Nicolaus Copernicus and Neil Armstrong. In the *Tell It Again! Read-Aloud Anthology for Astronomy: Our Solar System and Beyond*, Image Cards are referenced in both Pausing Points and in Lessons 1–10.

## ***Astronomy: Our Solar System and Beyond Posters***

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There are four Posters for *Astronomy: Our Solar System and Beyond*. These Posters depict our solar system, a galaxy like the Milky Way, galaxy shapes, and a view of distant galaxies taken by the Hubble Telescope. Posters are referenced in both Pausing Points and in Lessons 2, 4, 6, and 9.

## ***Instructional Masters and Family Take-Home Letters***

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Blackline Instructional Masters and Family Take-Home Letters are located at the back of the *Tell It Again! Read-Aloud Anthology for Astronomy: Our Solar System and Beyond*. Instructional Masters are referenced in the Domain Assessment, in both Pausing Points, and in Lessons 1B–4B, and 7B–10B. The Family Letters are referenced in Lessons 1B and 6B.

## ***Above and Beyond Opportunities***

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In the *Tell It Again! Read-Aloud Anthology for Astronomy: Our Solar System and Beyond*, there are numerous opportunities in the lessons and the Pausing Point to challenge students who are ready to attempt activities that are above grade-level. These activities are identified with this icon: ↗.

These opportunities may be found in the following: Comprehension Questions, Extensions, Pausing Point activities, research activities, and writing exercises.


You may also wish to assign some of these and other activities as homework for students who are ready for a challenge outside of the classroom. Many of the comprehension questions also serve as meaningful take-home topics to discuss with family members.

Additionally, you may choose to coordinate with your school's science and/or social studies teacher(s) to further reinforce the content covered in this language arts block.



## Student Performance Task Assessments

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In the *Tell It Again! Read-Aloud Anthology for Astronomy: Our Solar System and Beyond*, there are numerous opportunities to assess students' learning. These assessment opportunities range from informal observation opportunities to more formal written assessments and are indicated by this icon: . There is also a cumulative Domain Assessment. Instructional Masters DA-1, DA-2, and DA-3 are used for this purpose. You may wish to make a copy of the *Answer Keys* to send home to family members. Use the Tens Conversion Chart located in the Appendix to convert a raw score on each assessment into a Tens score. On the same page, you will also find the rubric for recording observational Tens scores.

## Recommended Resources for *Astronomy: Our Solar System and Beyond*

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It is highly recommended that students spend a minimum of twenty minutes each night reading independently or aloud to family members, or listening as family members read to them. You may suggest that they choose titles from this trade book list. These titles may also be put into the classroom book tub for various reading levels.

### Trade Book List

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1. *13 Planets: The Latest View of the Solar System*, by David Aguilar (National Geographic Children's Books, 2011) ISBN 978-1426307706
2. *Astronaut Handbook*, by Meghan McCarthy (Alfred A. Knopf, 2008) ISBN 978-0375844591
3. *Astronomy (Amazing Science Discoveries)*, by Dr. Bryson Gore (Stargazer Books, 2009) ISBN 978-1596041998
4. *Astronomy (DK Eyewitness Books)*, by Kristen Lippincott (Dorling Kindersley Limited, 2009) ISBN 978-0756637675
5. *Basher Science: Astronomy: Out of this World!*, by Dan Green (Kingfisher, 2010) ISBN 978-0753466179
6. *The Best Book of Spaceships*, by Ian Graham (Kingfisher, 1998) ISBN 978-0753461679
7. *Big and Busy Space*, by Roger Priddy (St. Martin's Press, 2008) ISBN 978-0312506872

8. *The Big Dipper*, by Franklyn M. Branley (HarperCollins Publishers, 1991) ISBN 978-0064451000
9. *Black Holes*, by Dana Meachen Rau (Compass Point Books, 2007) ISBN 978-0756510954
10. *Black Holes (True Books)*, by Ker Than (Children's Press, 2010) ISBN 978-0531228012
11. *Born With a Bang: The Universe Tells Our Cosmic Story*, by Jennifer Morgan (Dawn Publications, 2002) ISBN 978-1584690320
12. *Boy, Were We Wrong About the Solar System*, by Kathleen Kudiniski (Dutton Juvenile, 2008) ISBN 978-0525469797
13. *Comets*, by Melanie Chrismer (Scholastic, Inc., 2008) ISBN 978-0531146941
14. *Comets, Meteors, and Asteroids*, by Seymour Simon (Mulberry Books, 1998) ISBN 978-0688158439
15. *Comets, Stars, the Moon, and Mars*, by Douglas Florian (Harcourt, Inc., 2007) ISBN 978-0152053727
16. *Constellations (True Books)*, by F.S. Kim (Children's Press, 2010) ISBN 978-0531228029
17. *Destination: Space*, by Seymour Simon (HarperCollins, 2006) ISBN 978-0060877231
18. *Discover Space*, by Cynthia Pratt Nicolson (Kids Can Press, Ltd., 2005) ISBN 978-1553378242
19. *Discover Space Rocks (Kids Can Read)*, by Cynthia Pratt Nicolson (Kids Can Press, 2006) ISBN 978-1553379010
20. *DK First Space Encyclopedia*, by Caroline Bingham (Dorling Kindersley Limited, 2008) ISBN 978-0756633660
21. *First Space Encyclopedia*, by DK Publishing (DK Children, 2008) ISBN 978-0756633660
22. *Floating in Space*, by Franklyn M. Branley (HarperCollins, 1998) ISBN 978-0064451420
23. *Forces Make Things Move*, by Kimberly Brubaker Bradley (HarperCollins, 2005) ISBN 978-0064452144
24. *Galaxies*, by Seymour Simon (HarperCollins, 1991) ISBN 978-0688109929

25. *Galaxies (True Books)*, by Howard K. Trammel (Children's Press, 2010) ISBN 978-0531228036
26. *Galaxies, Galaxies!*, by Gail Gibbons (Holiday House, 2007) ISBN 978-0823421923
27. *Galileo's Leaning Tower Experiment*, by Wendy Macdonald (Charlesbridge, 2009) ISBN 978-1570918704
28. *Glow in the Dark Constellations: A Field Guide for Young Stargazers*, by C.E. Thompson (Grosset & Dunlap, 1999) ISBN 978-0448412535
29. *Gravity is a Mystery*, by Franklyn M. Branley (HarperCollins Publishers, 2007) ISBN 978-0064452014
30. *The Hubble Space Telescope: Understanding and Representing Numbers in the Billions*, by Greg Roza (Rosen Publishing Group, 2005) ISBN 978-1404251298
31. *I Fall Down*, by Vicki Cobb (HarperCollins Publishers, 2004) ISBN 978-0688178420
32. *If You Decide to Go to the Moon*, by Faith McNulty (Scholastic Inc., 2005) ISBN 978-0590483599
33. *The International Space Station (Let's-Read-And-Find-Out Science: Stage 2)*, by Franklyn M. Branley (Perfection Learning, 2000) ISBN 978-0756901752
34. *Mae Jemison: Out of this World*, by Corinne J. Naden and Rose Blue (The Millbrook Press, Inc., 2003) ISBN 978-0761325703
35. *The Magic School Bus Blasts into Space (Scholastic Reader, Level 2)*, by Kristin Earhart (Scholastic, 2009) ISBN 978-0545086028
36. *The Magic School Bus Lost in the Solar System*, by Joanna Cole (Scholastic Audio Books, 2010) ISBN 978-054522337
37. *The Magic School Bus Sees Stars: A Book About Stars*, by Nancy White (Scholastic Inc., 1999) ISBN 978-0590187329
38. *The Magic School Bus Takes a Moonwalk (Scholastic Reader, Level 2)*, by Joanna Cole (Scholastic, 2007) ISBN 978-0439684002
39. *Messages from Mars*, by Andrew Schuerger and Loreen Leedy (Holiday House, 2006) ISBN 978-0823419548
40. *The Mighty Mars Rovers: The Incredible Adventures of Spirit and Opportunity*, by Elizabeth Rusch (Houghton Mifflin Books for Children, 2012) ISBN 978-0547478814

41. *The Milky Way*, by Gregory L. Vogt (Lerner Publications Company, 2010) ISBN 978-0761338758
42. *The Moon*, by Seymour Simon (Simon and Schuster Books for Young Readers, 2003) ISBN 978-0689835636
43. *Moonshot: The Flight of Apollo 11*, by Brian Floca (Atheneum Books for Young Readers, 2009) ISBN 978-1416950462
44. *Night Light (A Book About the Moon)*, by Dana Meachen Rau (Picture Window Books, 2006) ISBN 978-1404817319
45. *NightWatch: A Practical Guide to Viewing the Universe*, by Terence Dickinson (Firefly Books, 2006) ISBN 978-1554071470
46. *On Earth*, by G. Brian Karas (Puffin Books, 2005) ISBN 978-0142410639
47. *On the Moon*, by Anna Milbourne (Usborne Publishing Ltd., 2006) ISBN 978-0794506179
48. *Once Upon a Starry Night: A Book of Constellations*, by Jacqueline Mitton (National Geographic Society, 2009) ISBN 978-1426303913
49. *Our Solar System*, by Seymour Simon (HarperCollins, 2007) ISBN 978-0061140082
50. *The Planet Gods: Myths and Facts about the Solar System*, by Jacqueline Mitton (National Geographic Society, 2008) ISBN 978-1426304484
51. *Pluto: A Dwarf Planet*, by Ralph Winrich (Capstone Press, 2010) ISBN 978-1429645850
52. *Pluto: Dwarf Planet*, by Christine Taylor-Butler (Children's Press, 2008) ISBN 978-0531147665
53. *Roaring Rockets*, by Tony Mitton (Kingfisher, 2000) ISBN 978-0753453056
54. *Seven Wonders of the Rocky Planets and Their Moons*, by Ron Miller (Twenty First Century Books, 2011) ISBN 978-0761354482
55. *The Sky is Full of Stars*, by Franklyn M. Branley (HarperCollins, 1983) ISBN 978-0064450027
56. *Space Exploration*, by Carole Stott (DK Children, 2009) ISBN 978-0756658281

57. *Space, Stars, and the Beginning of Time: What the Hubble Telescope Saw*, by Elaine Scott (Clarion Books, 2011) ISBN 978-0547241890
58. *Stargazers*, by Gail Gibbons (Holiday House, 1999) ISBN 978-0823415076
59. *Stars*, by Seymour Simon (HarperCollins Publishers, 2006) ISBN 978-0060890018
60. *Stars (True Books)*, by Ker Than (Scholastic Inc., 2010) ISBN 978-0531228067
61. *(Jump Into Science: Stars )*, by Steve Tomecek (National Geographic Society, 2003) ISBN 978-0792255819
62. *The Sun (True Books)*, by Elaine Landau (Children's Press, 2008) ISBN 978-0531147962
63. *The Sun*, by Seymour Simon (Perfection Learning, 2001) ISBN 978-0688092368
64. *Sun, Moon and Stars*, by Stephanie Turnbull (Usborne Publishing Ltd., 2007) ISBN 978-0794513993
65. *The Sun is My Favorite Star*, by Frank Asch (Sandpiper, 2008) ISBN 978-0152063979
66. *Sun Up, Sun Down: The Story of Day and Night*, by Jacqui Bailey (Picture Window Books, 2006) ISBN 978-1404811287
67. *There's No Place Like Space!*, by Tish Rabe (Random House, Inc., 2009) ISBN 978-0679891154
68. *The Universe*, by Seymour Simon (HarperCollins, 2006) ISBN 978-0060877255
69. *Up, Down, All Around: A Story of Gravity*, by Jacqui Bailey (Picture Window Books, 2006) ISBN 978-1404819993
70. *What Makes Day and Night (Let's-Read-and-Find-Out Science 2)*, by Franklyn Branley (HarperCollins, 1999) ISBN 978-0064450508
71. *What the Moon Is Like*, by Franklyn M. Branley (HarperCollins Publishers, 2000) ISBN 978-0064451857
72. *When Is a Planet Not a Planet?: The Story of Pluto*, by Elaine Scott (Clarion Books, 2007) ISBN 978-0618898329

73. *Why Can't I Jump Very High?: A Book About Gravity*, by Kamal S. Prasad (Science Square Publishing, 2004) ISBN 978-0974086156
74. *Why Isn't Pluto a Planet?*, by Michael Portman (Gareth Stevens Publishing, 2013) ISBN 978-1433982835
75. *You Are the First Kid on Mars*, by Patrick O'Brien (G. P. Putnam's Sons, 2009) ISBN 978-0399246340
76. *Zoo in the Sky: A Book of Animal Constellations*, by Jacqueline Mitton (National Geographic Society, 2006) ISBN 978-0792259350

### Teacher Resources

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1. *A Black Hole Is Not a Hole*, by Carolyn DeCristofano (Charlesbridge Publishing, 2012) ISBN 978-1570917837
2. *The Coolest Job in the Universe: Working Aboard the International Space Station*, by Henry Holden (Enslow Publishers Inc., 2012) ISBN 978-1464400776
3. *Eye on the Universe: The Incredible Hubble Space Telescope*, by Michael Cole (Enslow Publishers Inc., 2012) ISBN 978-0766040779
4. *The Great Voyager Adventure*, by Alan Harris and Paul Weissman (Julian Messner, 1990) ISBN 978-0671725396
5. *Solar System: A Visual Exploration of All the Planets, Moons and Other Heavenly Bodies that Orbit Our Sun*, by Marcus Chown (Black Dog and Leventhal Publishers, 2011) ISBN 978-1579128852

### Teacher Websites

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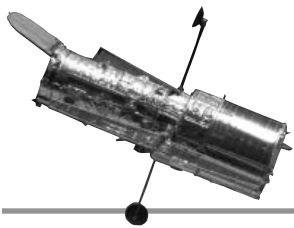
1. Amazing Space: Capture the Cosmos  
<http://amazing-space.stsci.edu/capture>
2. The Hubble Telescope Picture Gallery  
<http://hubblesite.org/gallery>
3. The Hubble's Telescope Discoveries: Amazing Space  
<http://amazing-space.stsci.edu>
4. Information, Sky Maps, Puzzles, and Post Cards  
<http://www.dustbunny.com/afk>
5. NASA: Home  
<http://www.nasa.gov/home/index.html>
6. NASA: Mars Exploration Program  
<http://mars.jpl.nasa.gov>

7. **NASA's The Space Place**  
<http://spaceplace.nasa.gov>
8. **Space.com—Astronomy News**  
<http://www.space.com/science-astronomy>

### **Student Websites**

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1. **The European Space Agency for Kids**  
<http://www.esa.int/esaKIDSen/index.html>
2. **Games, Activities, Facts, and Resources**  
<http://www.kidsastronomy.com/index.htm>
3. **Kids NASA: Mars for Kids**  
<http://mars.jpl.nasa.gov/participate/funzone>
4. **The Natural History Museum: Meteorites**  
<http://www.nhm.ac.uk/kids-only/earth-space/meteorites>



# Our Planet Earth

# 1

## ☑ **Lesson Objectives**

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### **Core Content Objectives**

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Students will:

- ✓ Identify the sun as a constant source of heat and light energy
- ✓ Classify the sun as a star
- ✓ Identify our planet Earth as the third planet from the sun and ideally suited for life
- ✓ Demonstrate how day and night on Earth are caused by Earth's rotation
- ✓ Explain why the sun seems to rise in the east and set in the west
- ✓ Explain what happens during a solar eclipse and lunar eclipse
- ✓ Explain the reasons for seasons
- ✓ Describe the characteristics of a planet
- ✓ Describe stars as hot, distant, and made of gas

### **Language Arts Objectives**

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The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ Sequence four to six sentences describing the events of a solar eclipse and a lunar eclipse as illustrated and described in “Our Planet Earth” (RI.3.3)
- ✓ Interpret information from teacher demonstrations and diagrams in “Our Planet Earth” about the movements of the earth and moon in relation to the sun, such as solar and lunar eclipses, daytime and nighttime, and the seasons (RI.3.7)



- ✓ Make personal connections to concepts related to the students' position in space presented in "Our Planet Earth" through the creation of a "space address" for the school (W.3.8)
- ✓ Make personal connections to concepts presented in "Our Planet Earth" through engagement with a class KWL chart (W.3.8)
- ✓ Categorize and organize statements and questions about space through engagement with the KWL chart used in "Our Planet Earth" (W.3.8)
- ✓ Categorize the sun as a star and Earth as a planet (W.3.8)
- ✓ Make predictions about what would be included in the school's "space address" prior to hearing "Our Planet Earth" and then add the next lines to the "space address" as gleaned from the read-aloud (SL.3.1a)
- ✓ Choose words and phrases to describe the motions of the earth and moon in relation to the sun to effectively explain daytime and nighttime and the seasons (L.3.3a)
- ✓ Use the known root *astro-* as a clue to the meaning of unknown words, such as *astronomy* and *astronomer* (L.3.4c)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial relationships, to describe the school's space address, such as *street, city or town, state, ZIP code, country, and planet* (L.3.6)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial relationships, such as *orbit, rotate, axis, tilted, and eclipse* (L.3.6)

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**atmosphere, n.** A blanket of gas surrounding a planet

*Example:* The atmosphere around Earth helps hold the sun’s heat and keeps our planet at a steadier temperature.

*Variation(s):* atmospheres

**axis, n.** A real or imaginary line through the center of an object

*Example:* Deidre watched the toy top as it spun around its axis on the floor.

*Variation(s):* axes

**eclipse, n.** An event that occurs when one object in outer space blocks the sunlight reaching another object

*Example:* Sometimes astronomers are able to observe an eclipse occurring on another planet in our solar system, as when one of Jupiter’s moons recently passed between Jupiter and the sun and cast a shadow on Jupiter.

*Variation(s):* eclipses

**hemisphere, n.** Half of the sphere of Earth

*Example:* The Northern Hemisphere of planet Earth lies north of the equator.

*Variation(s):* hemispheres

**orbit, n.** The curved path a planet, spacecraft, or heavenly body takes around another object in space

*Example:* The moon appears to change shape in its orbit around Earth.

*Variation(s):* orbits

**rotate, v.** To turn around an axis or a center


*Example:* The spokes on a bicycle wheel rotate around the center hub of the wheel.

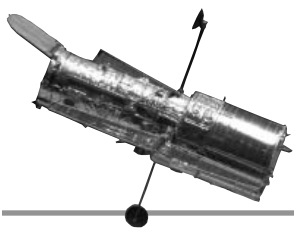
*Variation(s):* rotates, rotated, rotating

**universe, n.** All objects and matter in space including Earth and beyond

*Example:* Our planet Earth is very, very small compared to the vastness of the universe.

*Variation(s):* universes

<b><i>At a Glance</i></b>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>Domain Introduction</b>		10
	<b>KWL Chart</b>	chart paper, chalkboard, or whiteboard [This activity requires advance preparation.]	
	<b>Essential Background Information or Terms</b>	Image Card 1; globe	
	<b>Purpose for Listening</b>		
<b><i>Presenting the Read-Aloud</i></b>	<b>Our Planet Earth</b>	Image Card 2; U.S. or world map; large envelope; dark permanent marker; globe; small ball; light source; current year's calendar; chart paper, chalkboard, or whiteboard	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>	Image Cards 2, 3; globe; small ball; light source	15
	<b>Word Work: Universe</b>		5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>KWL Chart</b>		20
	<b>Why Do We Have Eclipses?</b>	Instructional Masters 1B-1, 1B-2	
	<b>Why Do We Have Daytime and Nighttime?</b>	drawing paper, drawing tools	
<b><i>Take-Home Material</i></b>	<b>Family Letter</b>	Instructional Masters 1B-3, 1B-4	



# Our Planet Earth

1A

## Introducing the Read-Aloud

10 minutes

### Domain Introduction

Ask students what they see when they look up at the sky during the day. (Answers may vary, but may include the sun, clouds, occasionally the moon, etc.) Ask students what they see when they look up at the sky at night. (Answers may vary, but may include stars, planets, the moon, etc.) Tell students that when they look up at the sky and past the clouds, they are really looking into outer space.

Tell students that over the next few weeks they will be learning about outer space and the study of outer space called astronomy, and that they will be gathering information that they learn in a Space Notes notebook or folder.

Ask students to repeat the word *astronomy* with you. Explain that *astro-* is a word part that means “star,” and that astronomy includes the study of stars. Tell students that astronomy also includes the study of all objects in space and that these are sometimes referred to as heavenly or celestial bodies, which are fancy ways of saying natural objects in the sky. Ask students, “If astronomy is the study of the stars and other objects in outer space, what do you think a person who studies astronomy is called?” Tell students that astronomers are scientists who study all of the objects in outer space and that most of what we know about outer space we have learned from the observations, measurements, and thinking of astronomers.

**Note:** Earth is located in space. When we use the term *outer space*, we are referring to areas beyond the earth’s immediate atmosphere. If students name objects that they can see in the sky, such as airplanes, birds, or clouds, you may wish to remind them that these objects are located in Earth’s atmosphere and are not considered to be in outer space.

Tell students that during this domain they will often hear the word *solar* used. Ask students to repeat the word *solar* with you. Explain that *sol* is Latin for “the sun” and that *solar* means “related to the sun.” Ask

students what phrases that include the word *solar* are familiar to them. Tell students that they will learn more about the solar system and solar eclipses during this domain. Tell students that they will also be hearing the word *lunar*. Ask students if they remember from Grade 1 *Astronomy* what the word *lunar* means. (related to the moon) Tell students that they will also learn what causes a lunar eclipse.

## KWL Chart

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On chart paper, a chalkboard, or a whiteboard, create a KWL (What I **K**now, **W**onder, and **L**earn) chart. This chart will be used throughout Lessons 1–6 to determine what your students may already know (K), what they wonder (W), and what they have learned (L) about our solar system. Make three columns labeled ‘K,’ ‘W,’ and ‘L.’ Give students the opportunity to share anything they already know about astronomy and outer space.

**Note:** Students who participated in the Core Knowledge Language Arts program in Grades 1 and 2 should be familiar with basic concepts about astronomy and outer space from the domains *Astronomy* and *Cycles in Nature*. From this previous exposure, answers may include the following: classifying the sun as a star; the sun, moon, and stars are located in outer space; the phases of the moon; the reason for seasons; etc.

As students respond and share their ideas, repeat and expand upon each of the student’s responses using richer and more complex language, including, if possible any read-aloud vocabulary. Record students’ responses under the ‘K’ of the KWL chart. If a student’s response includes inaccurate factual information, record it nonetheless and acknowledge the response. Tell students that they will revisit these items later to see if they are correct.

In the second column, ‘W,’ have students share what they wonder about outer space. Tell students that throughout the domain they will add facts they have learned about outer space to the third column, ‘L.’

**Note:** Keep this chart to reference throughout the next several lessons. You may wish to add to the ‘W’ column throughout the domain. You may also choose to maintain this chart to use for review at the end of the domain.

## Essential Background Information or Terms

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Remind students that they learned the word *atmosphere* in the *Classic Tales: The Wind in the Willows* domain. Ask students to recall the definition of *atmosphere* they learned in that domain. (the distinct quality of a place) Explain that when they heard the word *atmosphere* in *The Wind in the Willows*, it referred to how a place felt or seemed. For example, they heard that Water Rat felt uncomfortable in the underground atmosphere, unlike Mole, because it was very enclosed. He preferred an atmosphere that was more open and free, like the riverbank.

Tell students that scientists also use the word *atmosphere*. When scientists talk about the atmosphere, they are referring to the nearly invisible blanket of air or gas that surrounds Earth and other bodies in outer space. Point to the globe, and explain to students that the globe doesn't show the atmosphere surrounding Earth. Remind students that a gas is a thin substance that objects can pass through like air, smoke, or steam. Explain that from our location here on Earth it is hard to see the atmosphere. Show students Image Card 1 (Earth's Atmosphere), and have a student volunteer point to the atmosphere in this image. From the distance of space, the thin layer of the atmosphere becomes more visible.

Remind students that they also heard the word *atmosphere* in the *Light and Sound* domain. They learned that light energy from the sun must travel through Earth's atmosphere to reach us on Earth. They may remember that some sunlight is absorbed by the atmosphere and some of it is diffused, or scattered, by the particles in the atmosphere so that it does not reach the earth.

So, whereas the word *atmosphere* in *The Wind in the Willows* refers to how a place feels, the word *atmosphere* in astronomy refers to the area of gas surrounding Earth or another planet. Point out to students that *atmosphere* is an example of one word that has multiple meanings depending on how it is being used.

## Purpose for Listening

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Tell students to listen to learn about our planet Earth and its home in outer space and to predict what they might include if they needed to address an envelope to their school using a "space address."

**Note:** Explain to students that astronomy is the study of things that are very, very far away. Even though the tools and methods of

science allow astronomers to know things are there in space, we are not always able to take photographs of them. Whereas a number of images in this domain are actual photographs, many are not. Some are diagrams created from real photographs. Others are models or digital recreations that have been completely or partially rendered based on measurements and observations made by scientists using scientific equipment.



## Our Planet Earth

### ← Show image 1A-1: Aerial view of a place on Earth

If you traveled to another country and someone asked, “Where in the world is your school located?” you might answer by giving the school’s address. Its address explains where your school is located on planet Earth.<sup>1</sup>

*Our school’s name:* \_\_\_\_\_

*Our school’s number and street:* \_\_\_\_\_

*Our town or city:* \_\_\_\_\_

*Our state and ZIP code:* \_\_\_\_\_

*Our country:* \_\_\_\_\_<sup>2</sup>

A mail carrier could find our school and deliver this envelope from anywhere in the world!

### ← Show image 1A-2: View of Earth

But let’s pretend you traveled far, far away to a distant place in outer space, and an extraterrestrial being asked, “Where in the **universe** is your school located?” How would you answer that question? You would need to give someone who lives far away from Earth more information as part of your school’s address—a “space address” that explains where your school is located on a map of the universe.

The first part of your space address that you would add to the envelope is your planet: Earth.<sup>3</sup> You might think you already know everything there is to know about Earth—after all, you’ve lived here your entire life! But what do we really mean when we say we live on a planet? The word *planet* means “wanderer,” a name ancient Romans gave to objects in the sky that appeared to wander on a different path than the stars did. As astronomers have continued to observe and study space with more powerful tools and learn more, they kept thinking about and discussing the exact definition of a

1 [Read the following phrases aloud. Ask students to help you in identifying the following information as you write your school’s address on a large envelope.]

2 [Read aloud the address you have written on the envelope. You may wish to point, or have a volunteer point, to your city or town, state, and country on a globe or map as you read your school address.]



3 [Add *Planet Earth* to the envelope after the country. Put the envelope in a visible place, and tell students you will add more to the address over the next couple of days.]



planet. Scientists today classify a planet as having five important qualities:

- A planet is a sphere or nearly round object in space that has a large mass.
- A planet travels (or wanders) in a path—called an **orbit**—around a star.
- A planet has cleared out most other objects from its path as it orbits around the sun.
- A planet is mostly made of rock or gas or a combination of both.
- A planet does not make its own light, but shines in the sky because it reflects the light of the star it orbits.



← **Show image 1A-3: Earth with the sun beyond**

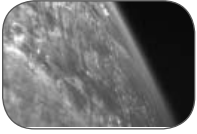
Planet Earth is made of rock and orbits a star you already know by name. Can you guess it? Earth’s star is the sun! The sun (like all stars) is an enormous mass of incredibly hot gas.<sup>4</sup> It creates a huge amount of energy in the form of light and heat. Earth is one of eight planets that orbit the sun.

Actually, Earth is the third planet away from the sun—ninety-three million miles away, to be exact! That’s a long way! If you drove from Earth to the sun in a car going sixty miles an hour—or about the speed you might travel on a highway—it would take you almost 177 years to get there (and that’s without stopping to stretch!).

Most living things on Earth need heat and light from the sun to survive. Ninety-three million miles may seem far from the sun, but it’s actually the perfect distance for human, animal, and plant life on Earth to exist. You can think of the sun’s energy as being like the temperature of Goldilocks’s porridge: If the sun were closer to Earth, it would be too hot—so hot that Earth’s water would boil away. If the sun were farther away, it would be too cold—so cold that all Earth’s water would freeze completely. As it is, Earth’s position in our planetary system is just right for life.<sup>5</sup> In fact, Earth is the only place in our sun’s system of planets—or in the entire universe—where we know life exists.

4 [Show Image Card 2 (Sun).]

5 Astronomers have discovered other stars that have planetary systems similar to ours, but we still know very little about them.



← **Show image 1A-4: Earth's atmosphere as seen from space**

Another reason life can exist on Earth is because of Earth's **atmosphere**. An atmosphere is a covering or “envelope” of gases that surrounds a planet. Earth's atmosphere traps the sun's heat, keeping it near the surface of Earth. This keeps Earth from getting too cold.

Earth's atmosphere is all around us. Take a deep breath and hold it. You have just breathed in some of the atmosphere! Now breathe out. Your breath has just added something to the atmosphere! Besides providing the air we breathe, the atmosphere also protects Earth. Have you ever slathered on sunscreen to keep from getting sunburned when you go outside? Earth's atmosphere is like sunscreen for Earth, blocking some of the sun's harmful light rays from reaching Earth's surface. Earth's atmosphere also diffuses<sup>6</sup> some of the sun's light. This is what makes the sky look blue.

6 or scatters

In images of Earth as seen from space, it's easy to see the blue of Earth's oceans. Water covers about seventy percent of planet Earth—that's a lot more than half the surface of the earth! Earth's water is essential to support plant and animal life as we know it.



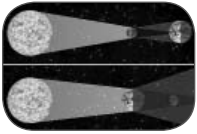
← **Show image 1A-5: View of Earth from the moon**

One moon orbits Earth many miles beyond Earth's atmosphere. Earth's moon is by far our closest neighbor in space, but it is still far away. Do you remember this classic Mother Goose rhyme?

*Hey, diddle, diddle,  
The cat and the fiddle,  
The cow jumped over the moon;  
The little dog laughed  
To see such sport,  
And the dish ran away with the spoon.*

Well, that was one high-jumping cow! The moon is about 239,000 miles away from Earth. So if the cow “jumped” from Earth to the moon going sixty miles per hour, it would get there in about 166 days! That would be one mighty jump for a cow!<sup>7</sup>

7 At the same speed, who remembers how long it would take to get to the sun from Earth? (177 years)

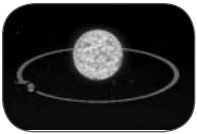


← **Show image 1A-6: Solar eclipse; lunar eclipse**

You have seen the different phases of the moon as its shape changes during a month’s time. As the moon orbits Earth we see different amounts of sunlight reflected from the moon’s surface.

Sometimes the moon, Earth, and sun line up so that one of them is hidden from view. This is known as an **eclipse**. A solar eclipse happens when the moon comes between the sun and Earth, hiding the sun so some people on Earth can’t see it. A lunar eclipse is when Earth comes between the sun and the moon. When this happens, people on Earth see Earth’s shadow on the moon, making the moon appear dark or even seem to disappear. But the moon doesn’t really disappear—it’s just hidden for a short time in Earth’s shadow.<sup>8</sup>

8 Think back to the *Light and Sound* domain. Who can explain why there is a shadow behind Earth? (The earth blocks the sun’s light, which is not able to bend around Earth.)



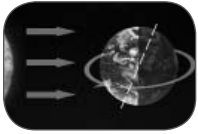
← **Show image 1A-7: Earth’s elliptical orbit around the sun**

Planet Earth moves in two ways. The first we’ve already talked about: it travels in a nearly circular path—or orbit—around the sun. The actual path of Earth’s orbit is not a perfect circle. It is just a little longer in one direction than in the other. The name for this type of nearly circular path is an *ellipse*.<sup>9</sup> An orbit that is shaped like an ellipse is described as an elliptical orbit. It takes Earth 365 and  $\frac{1}{4}$  days to orbit the sun one time—so Earth’s year is 365 days. The amount of time it takes a planet to orbit the sun one time is called its planetary year. But what about that extra  $\frac{1}{4}$  day? Why don’t we count it? Actually, we do count it; we just don’t count it every year. Instead, we add up this extra  $\frac{1}{4}$  day for four years in a row to make one full day.<sup>10</sup> Then in the fourth year we add that extra day to the end of February, so once every four years it has twenty-nine days instead of its usual twenty-eight. We call this year with the extra day a “Leap Year” because everything “leaps” ahead by one day.<sup>11</sup>

9 [You may wish to draw an ellipse on chart paper, a chalkboard, or a whiteboard.]

10 [Write the following on chart paper, a chalkboard, or a whiteboard as you say aloud:  $\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} = 1$  day.]

11 [Show students the month of February on a current calendar.] Is this year a Leap Year? How do you know? [Pause for students to share.]



## ← Show image 1A-8: Daytime and nighttime on Earth

12 [Ask students to stand up and slowly spin in place.]

13 [Pause for students to share.]

14 [Use a globe to demonstrate the rotation of Earth on its axis as you read about how this causes daytime and nighttime. Be sure to spin the globe “toward the east” as you turn it during that same time and point out that Earth’s axis is tilted.]

The second way planets in our solar system move is by spinning as they orbit the sun. Have you ever spread your arms wide and twirled yourself around until you were so dizzy you could hardly stand up?<sup>12</sup> Can you feel the **axis** or center line of your body around which you spin? What parts of your body **rotate** or spin around your axis?<sup>13</sup> Maybe you have played with a spinning top or have seen an ice-skater spin quickly around and around on one foot. This is what it means to rotate. But when a planet rotates, it doesn’t twirl around on feet like you do—it spins around an imaginary line that goes from its north pole to its south pole, right through its center.<sup>14</sup> This imaginary line is called the planet’s axis.

One day is the amount of time it takes for a planet to rotate one time around its axis. A day on Earth is twenty-four hours. These twenty-four hours are divided into daytime and nighttime. As Earth rotates, half of Earth faces the sun and receives the sun’s light. It is daytime on this side of Earth. But at that same moment, the opposite half of Earth is facing away from the sun. This side of Earth is not receiving any of the sun’s light, so it is dark there. It is in the Earth’s shadow. It is nighttime.

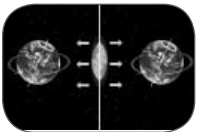
We don’t feel Earth spinning. From our viewpoint it looks like the sun is moving and the Earth is not. After all, doesn’t the sun appear to “rise” every morning in the east and “set” every evening in the west? This daily motion of the sun from east to west might make it seem like the sun is moving around the Earth, but it’s not. You are moving around the sun! Or really, Earth is. In the morning, the part of Earth you are standing on is turning away from darkness and rotating to face the sun.

When the sun is up at its highest point in the sky, Earth has rotated so you are fully facing the sun. In the evening, Earth turns away from the sun and it becomes dark again. Why is it dark? Because you are in the shadow of Earth!<sup>15</sup> It is night and you go to bed. But as you sleep, Earth keeps rotating on its axis, and before you know it, your side of the world will have turned to face

15 [If you have a light source available, demonstrate day and night on the globe. Show how your location on the globe is in Earth’s shadow at night.]

the sun again. You and the part of Earth on which you live will have once again moved out of Earth’s shadow. And you’ll know that one rotation of Earth—one day—will have ended. And another one will be just beginning!

Days turn into months, and months turn into seasons. What is your favorite season of the year? Fall? Winter? Spring? Summer? You might know what your favorite season is, but do you know what causes the seasons? It’s the combination of the two motions of Earth that we’ve been talking about: Earth’s orbit around the sun, and Earth’s rotation on its tilted axis.



← **Show image 1A-9: Summer and winter seasons and the tilt of Planet Earth**<sup>16</sup>

16 [You may wish to use the globe and a light source to demonstrate as you read the next four paragraphs.]

17 You can see this tilt of Earth on a globe and in this image. The arrows in this image represent the light from the sun. [The image on the left shows summer in the Northern Hemisphere; the right-hand image shows winter in the Northern Hemisphere.]

18 [You may wish to observe the midday sun with your class and discuss its highest position in the sky relative to the current season.]

19 [Ask a volunteer to show which part of the globe is the Southern Hemisphere.]

Remember, an axis is the imaginary line that goes through the center of a planet from its north pole to its south pole and then points out into space in both directions. But a planet’s axis doesn’t always point straight “up and down” like the axis of a spinning top. Many planets—including Earth—have an axis that is tilted a little to the side. This tilt is the key to understanding Earth’s seasons.<sup>17</sup>

Because Earth is tilted, there is a time of year during Earth’s orbit around the sun that the North Pole—and therefore, the whole Northern **Hemisphere**—is tilted a little bit toward the sun. This tilt gives the Northern Hemisphere longer periods of daylight, and shorter periods of nighttime darkness. Longer periods of daylight give the sun more time to warm Earth, so it gets hotter. The tilt of Earth’s axis also makes the sun in the Northern Hemisphere appear higher in the sky at noon. When the sun is higher in the sky, its rays hit Earth more directly, at less of an angle. The more directly the sun hits the Northern Hemisphere, the better job it does of heating that part of Earth. So it is the tilt of Earth—which causes longer periods of daylight—and a high noontime sun—that makes summer happen.<sup>18</sup>

While it is summer in the Northern Hemisphere, let’s see what is happening in the Southern Hemisphere. Why is it winter on this part of Earth?<sup>19</sup> The reason is, again, the tilt of Earth. When

the Northern Hemisphere is tilted toward the sun, the Southern Hemisphere is tilted away from the sun. This causes the Southern Hemisphere to have shorter periods of daylight and the sun to appear lower in the sky at noon. Shorter periods of daylight give the sun less time to warm Earth, so it is cooler. And when the sun is lower in the sky, its rays hit Earth at more of an angle, or a slant. This angle makes the sun have to heat a larger area of Earth with the same amount of energy—and this means the sun does not feel as warm. The rays of sunlight are less direct and less intense. It is colder. It is winter.

As Earth continues its orbit around the sun, the axis of Earth always stays pointed in the same direction. So when Earth reaches the opposite side of the sun, the South Pole (instead of the North Pole) is now tilted toward the sun. This means that the Southern Hemisphere has summer and the Northern Hemisphere has winter. The seasons in the Northern and Southern Hemispheres are always opposite each other. This is because only one of them at a time is tilted toward the sun.



← **Show image 1A-10: Aerial view; Planet Earth**

So now you know the first part of your “space address”—your school is on planet Earth, and planet Earth is part of your space address.<sup>20</sup> So now you have more information that you would need to answer an extraterrestrial being that might ask where your school is located in the universe!<sup>21</sup>

*Our school’s name:* \_\_\_\_\_

*Our school’s number and street:* \_\_\_\_\_

*Our town or city:* \_\_\_\_\_

*Our state and ZIP code:* \_\_\_\_\_

*Our country:* \_\_\_\_\_

*Our planet:* Planet Earth

In the next lesson you will learn more about the next line of your “space address.”




20 [Point to this part of the address written on the envelope.]

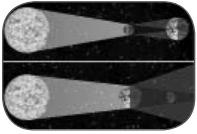
21 We would say: [Read the address on the envelope together.]

### Comprehension Questions

15 minutes

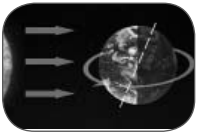
If students have difficulty responding to questions, reread pertinent passages of the read-aloud and/or refer to specific images. If students give one-word answers and/or fail to use read-aloud or domain vocabulary in their responses, acknowledge correct responses by expanding the students' responses using richer and more complex language. Have students answer in complete sentences by having them restate the question in their responses. **It is highly recommended that students answer at least one question in writing and that some students share their writing as time allows.** You may wish to have students collect their written responses in their Space Notes notebooks or folders to reference throughout the domain as source material for longer writing pieces and as preparation for written responses in the Domain Assessment.

1.  *Inferential* [Show Image Card 2 (Sun).] What kind of space object is our sun? (a star) Why is the sun classified this way? (Our sun is a huge, distant mass of fiery gas that gives off constant light and heat.)
2. *Inferential* What kind of space object is Earth? (a planet) Why is Earth classified this way? (Earth is a sphere in space with a large mass; it orbits around a star, our sun; it has cleared most other objects from its path around the sun; it is made mostly of rock and gas; it does not make its own light.)
3.  *Inferential* Describe the ways in which Earth moves in space. (Earth travels around the sun in an elliptical orbit; Earth rotates or spins on its axis.)
4.  *Inferential* [Show Image Card 3 (Earth).] What characteristics of Earth did you hear about in this read-aloud that make it a good place for life? (Earth is the third planet from the sun and gets just the right amount of heat and light; Earth is just the right temperature; it has an atmosphere that protects life from harmful sunlight and helps hold heat to maintain a steady temperature; it has water.)



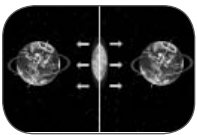
← **Show image 1A–6: Solar eclipse; lunar eclipse**

5. *Evaluative* [Ask students to point to the image or demonstrate using a globe, a small ball, and a light source as they explain.] You heard about a solar eclipse in today’s read-aloud. What happens during a solar eclipse? (Sunlight is blocked from Earth because the moon passes directly between the sun and Earth.) What is another type of eclipse? (lunar eclipse) What happens during this type of eclipse? (Earth passes directly between the sun and the moon, blocking the sun’s light from reaching the moon and casting Earth’s shadow on the moon.)



← **Show image 1A–8: Daytime and nighttime on Earth**

6. *Evaluative* [Ask students to point to the image or demonstrate using a globe and a light source as they explain.] How does the rotation of Earth cause daylight and the darkness of night? (The constant rotation of Earth changes the part of Earth facing the sun and receiving its light. When a portion of Earth is facing the sun, it experiences daylight; when that portion is facing away from the sun, it is in the darkness of nighttime.)
7. *Evaluative* [Ask students to demonstrate using a globe and a light source as they explain.] Why does it seem like the sun rises and sets? (The sun appears to rise and set because Earth is spinning on its axis as it orbits the sun.) In which direction does the sun appear to rise? (east) In which direction does the sun appear to set? (west)



← **Show image 1A–9: Summer and winter seasons and the tilt of Planet Earth**

8. *Evaluative* [Ask students to point to the image or demonstrate using a globe and a light source as they explain.] What causes Earth to have seasons as it orbits around the sun? (Earth is tilted in a fixed position, and as it travels around the sun, one side or hemisphere is tilted toward the sun and the other side or hemisphere is tilted away from the sun. The hemisphere that is tilted toward the sun gets more direct sunlight and experiences summer; the hemisphere that is tilted away from the sun gets less direct sunlight and experiences winter.)

I am going to ask a question. I will give you a minute to think about the question, and then I will ask you to turn to your neighbor and discuss the question. Finally, I will call on several of you to share what you discussed with your partner.



9. *Evaluative Think Pair Share:* Imagine you are traveling through the universe and you meet an imaginary extraterrestrial life form that asks you where your school is located. Describe the parts of your space address that would be important to share. (It would include the school's location, the name of the closest town or city, your state, your country, and Planet Earth.) What other parts of your space address do you predict would be important to include as well? (Answers may vary.)
  10. After hearing today's read-aloud and comprehension questions and answers, do you have any remaining questions?
- ✈️ You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.

### Word Work: Universe

5 minutes

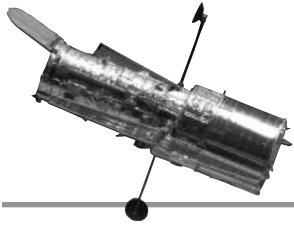
1. In the read-aloud you heard, "Where in the *universe* is your school?"
2. Say the word *universe* with me.
3. The universe is everything in space including Earth, our solar system, and all of the stars and other space objects that exist.
4. Scientists have only explored a very small part of the universe; they do not know how big the universe is, but they know there is a great deal more to explore.
5. You know that planets, moons, and stars exist in the universe. What other objects do you think exist in the universe? Be sure to use the word *universe* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students' responses to make complete sentences: "\_\_\_\_\_ exist in our universe" or "I heard that our universe contains . . ."]
6. What's the word we've been talking about? What part of speech is *universe*?

Use a *Sharing* activity for follow-up. Directions: Turn to your partner and take turns sharing a question you have about our universe. Then, I will call on one or two of you to share your partner's question with the class. Be sure to use the word *universe* in a complete sentence as you share.

**Note:** You may wish to add the questions generated by the students to the KWL chart.



## Complete Remainder of the Lesson Later in the Day



# Our Planet Earth

1B

## Extensions

20 minutes

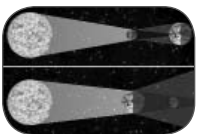
### KWL Chart

Using the KWL chart you created earlier in the lesson, review briefly with students what they said they knew about outer space and astronomy. Ask students if after hearing today's read-aloud, there is anything they'd like to change in the 'K' (Know) column.

**Note:** If there are any factual inaccuracies in the 'K' column that were addressed in today's read-aloud, prompt students to recognize and correct them.

Then, remind students of the 'W' (Wonder) column to see if they can find answers to some of their questions from today's read-aloud. Ask students if there is anything from today's read-aloud that they would like to add to this column. Finally, point to the 'L' (Learn) column. Ask students if there is anything from today's read-aloud that they would like to add to this column.

✈ You may wish to have some students create their own KWL charts and keep them in their Space Notes notebooks or folders.

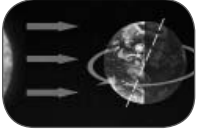


### 10 Why Do We Have Eclipses? (Instructional Masters 1B-1 and 1B-2)

#### ← Show image 1A-6: Solar eclipse; lunar eclipse

Using the image, review solar and lunar eclipses with students. Use Instructional Masters 1B-1 and 1B-2 to have students sequence the steps that explain a solar eclipse and a lunar eclipse. Write the number "1" next to the first step, "2" next to the second, and so on. You may wish to have students complete this activity individually, in small groups, or as a class. You may also wish to have students keep their worksheets in their Space Notes notebook or folder.

Encourage students to identify words and phrases that signal order as they explain their choices. Guide students to use domain vocabulary and spatial words such as *orbit*, *eclipse*, *lunar*, *solar*, and *shadow* in their explanations.



## Why Do We Have Daytime and Nighttime?

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### ← Show image 1A-8: Daytime and nighttime on Earth

Ask students to use the diagram to explain orally why we have daytime and nighttime on the earth. Encourage students to use domain vocabulary as they explain the main ideas shown in the diagram, such as the rotation of the earth around its axis and that only half the earth receives the sun's light at a time while the other half of the earth is in shadow. Remind students that a day on Planet Earth is the time it takes the planet to rotate one time around its axis. Explain that one Earth day includes both daytime and nighttime for places and living things on Earth.

As time allows, have students draw a diagram that shows why Earth has daytime and nighttime. Have students add labels to the diagram and write one or two sentences below the diagram that explain the main idea of the diagram.

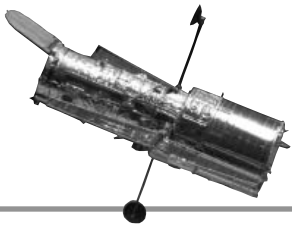
## ***Take-Home Material***

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### **Family Letter**

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Send home Instructional Masters 1B-3 and 1B-4.



# Our Solar System, Part I

## 2

### ☑ **Lesson Objectives**

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#### **Core Content Objectives**

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Students will:

- ✓ Identify the sun as a constant source of heat and light energy
- ✓ Classify the sun as a star
- ✓ Identify our planet Earth as the third planet from the sun and ideally suited for life
- ✓ Describe the eight planets of our solar system and their sequence from the sun
- ✓ Identify our solar system as the sun and all of the smaller bodies that orbit it, e.g., the planets, moons, asteroids, etc.
- ✓ Describe the characteristics of a planet
- ✓ Explain that Pluto has been reclassified as a dwarf planet
- ✓ Describe the asteroid belt
- ✓ Compare and contrast asteroids, meteoroids, and comets

#### **Language Arts Objectives**

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The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ Using the mnemonic **Many Very Energetic Mermaids Just Swam Under Neptune**, sequence the names of the eight planets in their position from the sun (RI.3.3)
- ✓ Describe the sequence of the planets, the asteroid belt, and dwarf planets Ceres and Pluto as presented in “Solar System, Part I” using language that pertains to sequence and their positions in the solar system (RI.3.3)

- ✓ Describe how a bar graph further explains what is conveyed by the text and the image of the planets' orbits (RI.3.7)
- ✓ Interpret information about planets' day length and year length as shown in the images (RI.3.7)
- ✓ Compare and contrast the characteristics of an asteroid and a comet as shown in the images and described in "Our Solar System, Part I" (RI.3.9)
- ✓ Compare and contrast the characteristics of a meteoroid, a meteorite, and a meteor as shown in the images and described in "Our Solar System, Part I" (RI.3.9)
- ✓ Conduct a short research project that builds knowledge about a particular planet (W.3.7)
- ✓ Gather information about one of the planets in our solar system from trade books and available digital sources; take brief notes using the graphic organizer provided (W.3.8)
- ✓ Make personal connections to concepts related to their own position in space presented in "Our Solar System, Part I" through the addition of *Our Solar System* to the school's "space address" on the envelope (W.3.8)
- ✓ Make personal connections to concepts presented in "Our Solar System, Part I" through engagement with a class KWL chart (W.3.8)
- ✓ Categorize and organize statements and questions about space using a KWL chart in "Our Solar System, Part I" (W.3.8)
- ✓ Categorize the sun as a star and Earth as a planet (W.3.8)
- ✓ Categorize the planets as inner rocky planets or outer gas giants (W.3.8)
- ✓ Determine the main ideas and supporting details about a chosen research planet as presented in diverse media and formats, including from the read-alouds, discussions, images, trade books and media sources (SL.3.2)
- ✓ Choose words and phrases to effectively describe the celestial bodies of our solar system (L.3.3a)
- ✓ Use the newly defined word *terrain* and the familiar word *extraterrestrial* to determine the meaning and application of the root *terra* (L.3.4c)

- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial relationships, to describe the school’s space address, such as *street, city or town, state, ZIP code, country, planet,* and *solar system* (L.3.6)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial and temporal relationships, to describe the celestial bodies in our solar system, such as *orbit, rotate, ellipse, not to scale, atmosphere, left over, and birth* (L.3.6)
- ✓ Create drawings and/or diagrams to illustrate and share information learned through research about a planet

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**asteroids, n.** Small rocky bodies that orbit the sun and that are smaller in size than a planet

*Example:* Most asteroids orbit the sun in a band between Mars and Jupiter.

*Variation(s):* asteroid

**celestial bodies, n.** Any objects, including planets, moons, stars, comets, or meteors, which can be found in outer space

*Example:* Nalini likes learning about all of the celestial bodies in our solar system, and she especially loves hearing about the new discoveries on the planet Mars.

*Variation(s):* celestial body

**comets, n.** Frozen balls of dust and ice whose orbits take them far out in the solar system

*Example:* Comets, like many objects in space, are often named after the people who discover them.

*Variation(s):* comet

**core, n.** The central inside part of a celestial body, other objects, or ideas

*Example:* Mr. Rodriguez told us that the inner core of the earth is made from the metals iron and nickel.

*Variation(s):* cores

**debris, n.** Bits and pieces of leftover dust and rocks

*Example:* There is a lot of space debris left over from collisions and explosions in space.

*Variation(s):* none

**meteoroids, n.** Small pieces of metal or rock that travel through the solar system and that are much smaller than an asteroid

*Example:* Scientists think most meteoroids are small pieces from asteroids.

*Variation(s):* meteoroid

**satellites, n.** Natural or human-made objects that orbit around a planet or other celestial objects

*Example:* Mars has two natural satellites in orbit around it.

*Variation(s):* satellite

**solar system, n.** Our sun and all the planets and other objects that move around it


*Example:* Earth is the third planet from the sun in our solar system.

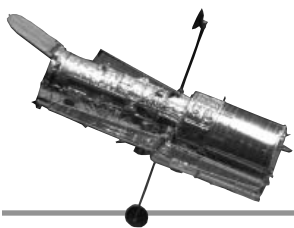
*Variation(s):* solar systems

**terrain, n.** The surface of the land and its features

*Example:* Earth’s terrain has a lot of variety—rocky and mountainous in some places, and flat and covered with plants in others!

*Variation(s):* terrains

<i>At a Glance</i>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>What Have We Already Learned?</b>	Image Cards 2, 3	10
	<b>Essential Background Information or Terms</b>	Poster 1 (Our Solar System); yardstick; a lemon-sized sphere; small marble	
	<b>Purpose for Listening</b>		
<b><i>Presenting the Read-Aloud</i></b>	<b>Our Solar System, Part I</b>	Poster 1 (optional); Image Cards 4, 5; envelope with space address; globe; chart paper, chalkboard, or whiteboard	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>	Poster 1; Image Cards 5–7	15
	<b>Word Work: Core</b>		5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>KWL Chart</b>		20
	<b>Planet Research</b>	Instructional Master 2B-1; drawing tools; trade books; online resources	



# Our Solar System, Part I

2<sub>A</sub>

## Introducing the Read-Aloud

10 minutes

### What Have We Already Learned?

Remind students that for the next several days they will be learning about outer space and astronomy. Ask students if they remember what *astro-* means. (stars) Ask students what other words they know that have the word part *astro-* and ask if they know what those words mean. (Answers may vary, but may include *astronomer*, *astrology*, *astrolabe*, etc.)

Remind students that they have heard about five characteristics that determine whether or not a celestial body or object in space is classified as a planet. Ask students to name and explain the five characteristics that astronomers consider to be true of all planets. Prompt students as needed.

A planet:

- . . . is a sphere in shape and has a large mass.
- . . . orbits around a star in an elliptical path.
- . . . has cleared most other objects from its path.
- . . . is made mostly of rock or gas, or a combination.
- . . . does not make its own light.

Show Image Card 2 (Sun) and Image Card 3 (Earth). Ask students to explain why the sun is not classified as a planet. (The sun does not orbit around a star; the sun makes its own light.) Ask students to explain why Earth is classified as a planet. (It meets all of the criteria listed above. The Earth is a sphere with a large mass; it orbits a star, our sun; it has cleared most objects from its path; it is made of rock and gas; it does not make its own light.)

### Essential Background Information or Terms

Show students Poster 1 (Our Solar System). Tell students that in today's read-aloud they will be learning more about the planets in our solar system. Ask students what kind of celestial body is at the center of



our solar system (a star) and what we call it. (the sun) Ask for a student volunteer to point to the Earth on Poster 1. Ask students, “Who can describe Earth’s position in the solar system?” (Earth is the third planet from the sun.)

Guide students in understanding that neither the relative sizes of the sun and the planets nor their distances from each other is accurately represented in the Posters, Flip Book images, and Image Cards that they will see during this domain. Explain that the extremely large sizes of the sun and the outer planets, as well as the vast distances between the largest planets, are too difficult to show accurately in a paper-sized graphic.

For example, use the yardstick to show that if the sun was one yard across, then Neptune would be about the size of a small lemon and there would be nearly a two-mile distance between them. Guide students to understand that walking eight times around a running track that circles a standard football field is a distance of two miles. Ask students how big they think Earth would be in a model that size. Tell them it would be about the size of a small marble. If we shrank that distance down to fit on a piece of paper, Earth and even Neptune would be so small that we couldn’t even see them!

Point to Poster 1 and tell students that we describe this kind of diagram as being “not-to-scale.” Tell students that they will see other diagrams that have been drawn to show or demonstrate an idea but are not-to-scale in showing size and distance. Tell students that, in comparison to the sun, the planets are so small and the distances between them so great, that it is basically impossible to draw them accurately—or “to scale”—on a regular sheet of paper.

### **Purpose for Listening**

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Tell students to listen carefully to learn more about our solar system and the different kinds of celestial bodies we have as planetary neighbors.



## Our Solar System, Part I

### ← Show image 2A-1: Aerial view; Planet Earth

Imagine traveling to a far-away world and encountering an extraterrestrial being that asked, “Where in the universe is your school?” Who remembers how you would describe your school’s “space address”? You could confidently state part of your space address as the following:<sup>1</sup>

*Our school’s name:* \_\_\_\_\_

*Our school’s number and street:* \_\_\_\_\_

*Our town or city:* \_\_\_\_\_

*Our state and ZIP code:* \_\_\_\_\_

*Our country:* \_\_\_\_\_

*Our planet:* Planet Earth

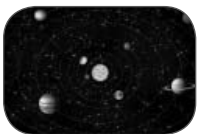
You already know a lot about your planet, Earth. But if the extraterrestrial life form went on to ask, “So where, exactly, is planet Earth?” you would need to be able to include the next part of your “space address”—your planetary system.

### ← Show image 2A-2: Our solar system

A planetary system is a group of objects in space that have come together to form a neighborhood—a very big, “spacious” neighborhood! (Get it, *space-ious*? A little interplanetary humor there!) All planetary systems have a star at the center and a collection of planets and other smaller objects that orbit around it. We call the planetary system that we are part of our **solar system**.<sup>2</sup> The shape of Earth’s solar system looks a lot like a “bull’s-eye” target. The sun is the “bull’s-eye” at the center, and the orbits of the eight planets are similar to the rings around it.

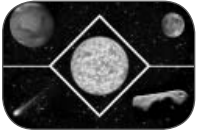
Astronomers know for certain about several hundred other planetary systems, but most astronomers believe there may be billions of other planetary systems in the universe besides our own. It is believed that our solar system formed a very long time

1 [Ask students to respond chorally to each prompt to fill in the blank.]



2 [Add *Our Solar System* to the envelope under *Our Planet*.] If *solar* means related to the sun, what do you think a solar system is? (Our solar system is what we call the planetary system associated with our sun.)

ago from a huge cloud of gas and dust. Just how long ago did it form? A *really* long time ago! Many scientists think our solar system is about four and a half billion years old! That’s older than your great-great-great-grandfather! Actually, it’s older than all of human existence, older than the dinosaurs, older than all the oceans and landmasses—older than Earth itself.

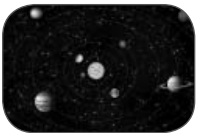


← **Show image 2A-3: The sun and objects found in our solar system**

But what exactly is our solar system? You can think of our solar system as a gigantic neighborhood in space. But instead of being made up of houses or apartments like the neighborhood you might live in, our solar system is made up of the sun and the **celestial bodies** that orbit around it. Besides the sun, it includes other interesting things like planets and their moons, dwarf planets, **satellites, asteroids, meteoroids, and comets**. Our solar system is huge—so huge that some of the objects in it are billions of miles away from each other! In fact, the largest part of our solar system is the vast amount of space between all the celestial bodies that are in it!

3 [Point to the sun, and ask how this is an example of an image that is “not to scale.”] (The sun is much larger in relation to many other space objects than it is depicted here.)

As you have heard, the sun is the center of this neighborhood we call our solar system. Our sun is a star.<sup>3</sup> That’s right—it’s a gigantic, unbelievably hot mass of gas that makes light and heat for everything that orbits around it. The sun is so gigantic that Earth could easily fit inside it—more than one million times!



← **Show image 2A-4: Our solar system**

There are eight planets in our solar system. The planet Mercury is the closest to the sun, followed by Venus, Earth, Mars, Jupiter, Saturn, Uranus [*YUR-in-us*], and Neptune. One easy way to remember the order of the planets is to remember this sentence or mnemonic device: **Many Very Energetic Mermaids Just Swam Under Neptune**.<sup>4</sup>

4 [You may wish to write this sentence on chart paper, a chalkboard, or a whiteboard. Reread the sentence, and ask students to recite the names of the planets as you point to each word in the mnemonic. You may wish to ask students if they have heard of other variations of this mnemonic. (“My Very Educated Mother Just Served Us Noodles” is a common one.)]

Besides these eight major planets, there are also a number of smaller planet-like objects in our solar system, classified as dwarf planets. Pluto is the most famous dwarf planet, because it was considered to be a major planet until 2006, when astronomers discovered other small, planet-like objects in our solar system.

Many astronomers from all over the world met to discuss a new definition of what makes a planet. Why did Pluto get demoted, or reduced in rank, from planet to dwarf planet? Astronomers have agreed that a planet has to be able to clear its orbit of most other objects such as asteroids and other space **debris** [da-BREE]. Because it is so small, Pluto hasn't cleared these leftover pieces of rock and dust from its orbit yet. Pluto is now classified as a dwarf planet.

Planets don't make their own light like stars do. When you look up and see a planet shining steadily in the night sky, it is shining because the planet is reflecting the sun's light—not because it's making its own.<sup>5</sup> If the light you see appears to be twinkling, this is a star, not a planet.

5 What other celestial body did you learn about in *Light and Sound* that reflects the sun's light? (the moon)

Each of the eight planets in our solar system receives light and heat from the sun as it travels in its own special path—or orbit—around the sun. The orbits of the eight planets get larger and larger the farther away from the sun they are. Mercury's orbit is the smallest because it is closest to the sun; Neptune's orbit is the largest, because that planet is the farthest away.

Many, but not all, of the planets have their own natural satellites, or moons, that orbit around them. Like Earth's moon, these moons travel around a planet at the same time that the planet orbits the sun. It is the light from our sun shining out into the solar system and being reflected back to us that allows astronomers to be able to see a planet and its moons. Even though Earth has only one moon, some of the planets have many. In fact, one of Jupiter's moons, Ganymede [gan-UH-meed], is larger than the planet Mercury!



← **Show image 2A-5: Orbits of Mercury, Earth, and Neptune**

- 6 How long is Earth's planetary year? (365 and  $\frac{1}{4}$  days)
- 7 [Point to Mercury's orbit.]
- 8 [Point to Neptune's orbit.] Since Neptune's discovery in 1846, Neptune has made just over one trip around the sun!
- 9 [Show Image Card 4 (Planetary Years).] Who can describe what this bar graph of Mercury, Earth, and Neptune conveys?

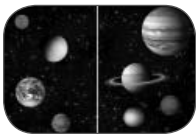
The amount of time it takes a planet to travel once completely around the sun in its orbit is called a planetary year.<sup>6</sup> Planets closer to the sun have shorter planetary years than planets that are farther away. Mercury's orbit is the fastest of all eight planets, taking only eighty-eight Earth days to complete its planetary year.<sup>7</sup> But Neptune takes 165 Earth years to go once around the sun!<sup>8</sup> So a one hundred year-old grandmother on Earth wouldn't even be one planetary year old if she lived on Neptune!<sup>9</sup>



← **Show image 2A-6: Day length on Mercury, Earth, and Jupiter**

- 10 How long does it take Earth to rotate once on its axis? (twenty-four hours)

Besides orbiting the sun, each of the eight planets in our solar system also rotates on its own axis. Remember, an axis is the imaginary line that goes from a planet's north pole through its south pole, right through its center. One day on a planet is the time it takes the planet to rotate one full time on its axis.<sup>10</sup> Other planets have shorter and longer days than Earth. One day on Mercury takes about fifty-eight Earth days, because Mercury rotates on its axis very slowly. Jupiter's rotation is much faster, clocking in at about one Jupiter day for every ten Earth hours.



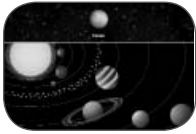
← **Show image 2A-7: The inner rocky planets; the outer gas giants**<sup>11</sup>

- 11 What words can you use to describe these planets? [You may wish to show Poster 1 as a reference for the planets' relative sizes and locations.]
- 12 What word part do *terrain* and *extraterrestrial* have in common? What do you think *terra* means? (earth or land) How would this help you explain the meaning of *extraterrestrial*? (beyond Earth)

Although the eight planets in our solar system have a lot in common, they are also very different, too. Many astronomers believe that all eight planets have a solid **core**, or rocky center. But the first four planets, those closest to the sun—Mercury, Venus, Earth, and Mars—are small in comparison to the other four and have a solid rocky **terrain**, or land surface, that you could walk on if you visited them.<sup>12</sup>

The four planets farthest away from the sun—Jupiter, Saturn, Uranus, and Neptune—are called “gas giants.” Why? Because they are mostly made of gas, so you couldn't walk on their surfaces if you visited because there is no solid surface, or terrain, to walk on.

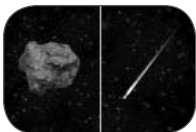
13 The moon is a natural satellite. Humans have created artificial satellites that have been placed in orbit around Earth to aid in communication and research. Perhaps some of you receive television, phone, or computer signals from a man-made satellite.



14 Who can describe what an atmosphere is?

15 [Have a volunteer point to Montana on a U.S. map or globe.] It would take about eight hours to drive across the state of Montana from east to west, or all the way around Ceres!

16 Birthstones are special rocks linked to the month in which a person is born. For example, emeralds are the birthstone for May birthdays, and the birthstone for a person born in July is the ruby.



The gas giants are also *huge*! Jupiter is so huge that more than 1,300 Earths could fit inside of it!

Most of the eight planets have moons. Mercury and Venus are the only two planets in our solar system that do not have any moons. Moons are satellites, or smaller objects that orbit around a larger planet. Earth's one moon is considered to be a satellite because it orbits around Earth.<sup>13</sup>

← **Show image 2A-8: Ceres and the asteroid belt**

Besides the sun, the eight major planets, their moons, and dwarf planets, there are also other “neighbors” that help make up the neighborhood we call our solar system. These include asteroids, meteoroids, and comets. An asteroid is a space rock that does not have an atmosphere.<sup>14</sup> An asteroid is too small to be classified as a planet because it does not have enough mass or substance to clear other objects and debris from its orbit around the sun, and it is not round. Most asteroids in our solar system—thousands of them—are located in orbit between Mars and Jupiter in a ring called “the asteroid belt.” The largest known object in the asteroid belt is Ceres [SEER-eez], which is about as large around as the state of Montana is wide!<sup>15</sup> Ceres, once classified as an asteroid, is now classified as a dwarf planet because it is spherical in shape. Because it has not cleared most other objects from its orbit, Ceres is not classified as a planet. Most asteroids are much smaller than Ceres. Many scientists believe that asteroids are material that was left over from the birth of our solar system. You might call them “birthstones.”<sup>16</sup> Do you think a dwarf planet would *really* have a birthstone? Just a little more planetary humor!

← **Show image 2A-9: A meteoroid and a shooting star**

One of our neighbors in our solar system has three different names: meteoroid, meteor, and meteorite, depending on where you find it. Meteoroids are space debris made of rock or metal that range in size from tiny pebbles to large boulders. Many scientists believe they may have broken off from other objects in our solar system, such as asteroids. They are called meteoroids when

17 Which object in the image is a meteoroid? (left) Which is a meteor? (right)

18 [Show Image Card 5 (Meteorite Crater).] Notice how small the buildings along the rim of this meteorite crater in Arizona appear compared to the size of the crater.



19 Who remembers the name for a stretched-out circle? (an ellipse)

20 You might wish to ask some of your adult relatives and friends if they can remember seeing Halley's comet in 1986. [You may wish to calculate with students the year that Halley's comet will return to Earth's skies.] (2062)



they are orbiting the sun in space, but once they enter Earth's atmosphere they are called meteors. Meteors are also known as “shooting stars” because they leave a bright streak or line of light that “shoots” through the sky. This streak of light is caused when the meteor burns up on its downward journey through Earth's atmosphere.<sup>17</sup>

Most meteors are small enough that they burn up completely before reaching Earth, but sometimes the larger ones make it to the surface. Meteors that reach the surface of Earth are called meteorites. Sometimes very large meteorites leave large craters, or pits, on the surface of Earth.<sup>18</sup>

← **Show image 2A-10: Comet in night sky as seen from Earth**

Did you know there are snowballs in space? It's true! They are called comets. Actually, a comet is a chunk of ice, dust, and gas that orbits the sun in a long, stretched-out circle.<sup>19</sup> A comet begins in the outer reaches of the solar system, and occasionally its orbit brings it in close to the sun. As a comet approaches the sun, part of its ice evaporates, making it glow and form a bright "tail" that trails behind it—sometimes for millions of miles! Comets shine like this because sunlight reflects off tiny particles of dust that are in the comet's tail. Halley's [*HAL-eez* or *HAIL-eez*] comet is a very famous comet that was discovered by English astronomer Edmund Halley. He was the first to realize that it was the same celestial body that returned to Earth's skies every seventy-six years. In the year 1705, he correctly predicted that the comet would return in the year 1758. The comet was then named Halley's comet in his honor. It was last seen from the Earth in 1986.<sup>20</sup>




← **Show image 2A-11: Aerial view; Planet Earth; and our solar system**

So, you now know that you can describe our solar system as a very large neighborhood in space. It's made up of many interesting neighbors, including the sun, eight planets, their moons, dwarf planets, asteroids, meteors, and comets. Our solar system is only one of many planetary systems in the universe. And it's a great place in the universe to live!

### Comprehension Questions

15 minutes


If students have difficulty responding to questions, reread pertinent passages of the read-aloud and/or refer to specific images. If students give one-word answers and/or fail to use read-aloud or domain vocabulary in their responses, acknowledge correct responses by expanding the students' responses using richer and more complex language. Ask students to answer in complete sentences by having them restate the question in their responses. **It is highly recommended that students answer at least one question in writing and that some students share their writing as time allows.** You may wish to have students collect their written responses in their Space Notes notebooks or folders to reference throughout the domain as source material for longer writing pieces and as preparation for written responses in the Domain Assessment.

1.  *Inferential* [Show Poster 1.] What is our solar system? (It is the sun and all of the objects that are in orbit around our sun.) What kinds of celestial bodies can be found in our solar system? (It includes the planets, their moons, dwarf planets, asteroids, comets, meteoroids, and other space debris.)
2. *Literal* [Show Poster 1 and the mnemonic written on the chart paper, chalkboard, or whiteboard.] What is the order of all eight planets from the sun? (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune)
3.  *Inferential* [Show Poster 1.] Which four planets form a group closest to the sun? (Mercury, Venus, Earth, and Mars) What characteristics do these four planets share? (They all have a core, a rocky terrain, and are much smaller than the other four planets.)
4. *Literal* [Show Poster 1.] Describe the asteroid belt and tell where it is found. (It is a ring of large and small asteroids orbiting the sun between Mars and Jupiter; it contains the dwarf planet Ceres.)
5.  *Inferential* [Show Poster 1.] Which planets are next in sequence after Mars and the asteroid belt? (Jupiter, Saturn, Uranus, and Neptune) What characteristics do these four planets share? (They are very large, have an inner core, are far from the sun, and are called "gas giants.")








← **Show image 2A–10: Comet in night sky as seen from Earth**

6.  *Evaluative* How is a comet like Halley’s comet different from an asteroid? (An asteroid is made of rocky or metallic material, like a small planet. Many are found in the asteroid belt. A comet is a lump of ice, dust, and gas. A comet’s ice melts as it nears the sun.) How are they similar? (They are both part of our solar system, and they both orbit the sun. Some are similar in size.)



← **Show image 2A–9: A meteoroid and a shooting star**

7.  *Evaluative* [Show Image Card 5 (Meteorite Crater).] How are these three images related? (*Meteoroid* is the name for a piece of space debris. If it enters a planet’s atmosphere, it is called a meteor, and when we can see it burning up, we call it a shooting star. If it hits the planet, it is called a meteorite, and if it’s big enough, it can create a crater.)
  8. *Inferential* What is a dwarf planet? (It is a spherical celestial body that orbits the sun and has not cleared space debris from its orbit.) What two dwarf planets did you hear about in today’s read-aloud? (Ceres and Pluto)
  9.  *Evaluative* [Show Image Cards 6 (Ceres and the Asteroid Belt) and 7 (Pluto).] Compare and contrast Ceres and Pluto and the eight major planets. (Like some of the planets, Ceres and Pluto are rocky, spherical, celestial bodies that have a regular orbit around the sun; they are smaller than all but Mercury and have more debris than the other planets in the path of their orbits around the sun.)
  10. *Evaluative* *What? Pair Share:* Asking questions after a read-aloud is one way to see how much everyone has learned. Think of a question you can ask your neighbor about the read-aloud that starts with the word *what*. For example, you could ask, “What is the difference between a meteoroid, a meteor, and a meteorite?” Turn to your neighbor and ask your *what* question. Listen to your neighbor’s response. Then your neighbor will ask a new *what* question, and you will get a chance to respond. I will call on several of you to share your questions with the class.
  11. After hearing today’s read-aloud and comprehension questions and answers, do you have any remaining questions?
-  You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.

## Word Work: Core

5 minutes

1. In the read-aloud you heard, “Many astronomers believe that all eight planets have a rocky or solid *core*, or center layer.
2. Say the word *core* with me.
3. The core of an object is its center or rocky center.
4. After she ate the apple, Sindri put the apple core in the compost.
5. Can you think of an object that has a core? Be sure to use the word *core* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students’ responses to make complete sentences: “\_\_\_\_\_ has a core that . . .”]
6. What’s the word we’ve been talking about? What part of speech is the word *core*?

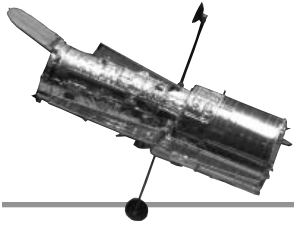
Use a *Making Choices* activity for follow-up. Directions: I will read a statement that is either about something that is the core of an object or is not the core. After I read the statement, you will say, “That is the core,” or “That is not the core.”

1. the skin of a peach (That is not the core.)
2. the rocky center of Jupiter (That is the core.)
3. a person’s torso or part of the body with the stomach, lungs, and heart (That is the core.)
4. the oceans, rocks, and trees on the surface of the Earth (That is not the core.)
5. the middle part of an apple that you don’t eat (That is the core.)
6. the iron and nickel at the center of Earth (That is the core.)

**Note:** You may wish to share that sometimes the word *core* is used to name the central or main part of an idea. For example, you might say, “Being kind to others is a core idea in getting along in our classroom.”



## Complete Remainder of the Lesson Later in the Day



# Our Solar System, Part I

# 2<sub>B</sub>

## Extensions

20 minutes

### KWL Chart

Using the KWL chart you created in Lesson 1, review briefly with students what they said they knew about outer space and astronomy. Ask students if after hearing today's read-aloud, there is anything they would like to change in the 'K' (Know) column.

**Note:** If there are any factual inaccuracies in the Know column that were addressed in today's read-aloud, prompt students to recognize and correct them.

Then, remind students of the 'W' (Wonder) column to see if they can find answers to some of their questions from today's read-aloud. Ask students if there is anything from today's read-aloud that they would like to add to this column. Finally, point to the 'L' (Learn) column. Ask students if there is anything from today's read-aloud that they would like to add to this column.

✈ You may wish to have some students create their own KWL charts and keep them in their Space Notes notebooks or folders.

### 10 Planet Research (Instructional Master 2B-1)

**Note:** For this short, two-day research project, you may choose to assign students a specific planet or allow them to research the planet of their choice or one of the well-known dwarf planets, Ceres or Pluto. You may guide students through this activity as a whole group, place them into small groups, or have them work with partners as you see fit. Provide a variety of trade books from the Recommended Resources list and/or media sources.

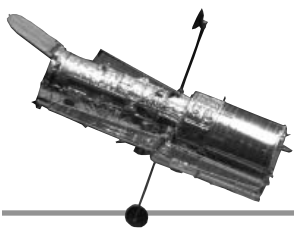
Review the graphic organizer provided on Instructional Master 2B-1 with students so they are familiar with the kinds of information they are likely to find about each of the planets or dwarf planets. Discuss with students that much of the information they will be finding is considered factual. Tell students that we usually consider facts to be things that exist and are true; they can be observed or measured.

Tell students that as they do their research, they will sometimes find different facts in different books and sources. Ask students why they think different sources may have different facts. Discuss the students' ideas, and guide them to understand that our understanding of facts can change over time as new observations and measurements are gathered. Share with students the example of better telescopes allowing astronomers to discover additional moons orbiting the planets. Also, share that new and better technology allows scientists to more accurately measure distances that are very large and very far away. Suggest that they look at the copyright date to see how up-to-date the materials are and record the most recent information.

On Instructional Master 2B-1, students will write the name of the planet or dwarf planet they are researching. If choosing a dwarf planet, have students indicate this in parentheses after the name. Then, in each of the surrounding boxes, students will write words and/or phrases that describe particular characteristics of that celestial body.

On the back of the worksheet, have students illustrate some aspect of the celestial body inspired by their research. Students may also capture more information there if they do not have enough room on the template. You may wish to have students keep their worksheets in their Space Notes notebooks or folders.

**Note:** You may wish to allow students to use these topics and research for the research paper they complete in the Skills Strand.



# Our Solar System, Part II

# 3

## Lesson Objectives

### Core Content Objectives

Students will:

- ✓ Identify the sun as a constant source of heat and light energy
- ✓ Identify our planet Earth as the third planet from the sun and ideally suited for life
- ✓ Describe the eight planets of our solar system and their sequence from the sun
- ✓ Identify our solar system as the sun and all of the smaller bodies that orbit it, e.g., the planets, moons, asteroids, etc.
- ✓ Explain that Pluto has been reclassified as a dwarf planet
- ✓ Describe the asteroid belt

### Language Arts Objectives

The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ Sequence the names of the eight planets in order of their position from the sun (RI.3.3)
- ✓ Describe the relationship between a planet's atmosphere and the affect it has on the planet's temperature as presented in "Solar System, Part II" using language that pertains to cause/effect and the greenhouse effect (RI.3.3)
- ✓ Determine the literal and nonliteral meanings of and appropriately use common sayings and phrases, such as "the last leg of the trip," "sister planet," and "shepherd moons" as used in "Our Solar System, Part II" (RI.3.4) (L.3.5a)

- ✓ Compare and contrast the characteristics of a meteoroid, meteor, and meteorite as shown in the images and described in “Our Solar System, Part II” (RI.3.9)
- ✓ Compare and contrast the planets Earth and Venus and the planets Saturn and Neptune as shown in the images and described in “Our Solar System, Part II” (RI.3.9)
- ✓ Compare and contrast the key details as shown in the images and described in “Our Solar System, Part II” that make planet Earth unique among the planets of our solar system (RI.3.9)
- ✓ Conduct a short research project that builds knowledge about a particular planet (W.3.7)
- ✓ Gather information about one of the planets in our solar system from trade books and available digital sources; take brief notes using the graphic organizer provided (W.3.8)
- ✓ Make personal connections to concepts presented in “Our Solar System, Part II” through engagement with a class KWL chart (W.3.8)
- ✓ Categorize and organize statements and questions about space through engagement with the KWL chart used in “Our Solar System, Part II” (W.3.8)
- ✓ Determine the main ideas and supporting details about a chosen research planet as presented in diverse media and formats, including from the read-alouds, discussions, images, trade books, and media sources (SL.3.2)
- ✓ Summarize content from the read-alouds presented thus far about the key characteristics that cause scientists to classify Pluto as a dwarf planet (SL.3.4)
- ✓ Choose words and phrases to effectively describe the characteristics of the planets (L.3.3a)
- ✓ Provide synonyms and antonyms for the word *frigid* (L.3.5b)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial and temporal relationships, to describe the planets in our solar system, such as *orbit*, *rotate*, *axis*, *tilted*, *poles*, *atmosphere*, *day length*, *planetary year*, and *size* (L.3.6)
- ✓ Create drawings and/or diagrams to illustrate and share information learned through research about a planet

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**dense, *adj.*** Compact; having all the parts very close together

*Example:* The bushes in Luca’s backyard are very dense; he can’t see through them at all.

*Variation(s):* denser, densest

**frigid, *adj.*** Extremely cold

*Example:* Jim was unprepared for the frigid weather of a Vermont winter because he had grown up in the much warmer climate of Louisiana.

*Variation(s):* none

**greenhouse, *n.*** A building with a transparent glass or plastic roof and walls made to trap in heat from the sun and grow plants all year round

*Example:* The flowers bloomed in Mrs. Claybourne’s greenhouse even in the middle of January.

*Variation(s):* greenhouses

**NASA, *n.*** An acronym for the National Aeronautics and Space Administration; an organization in the United States that directs space travel and research


*Example:* NASA was the first space research group to put astronauts on the moon.

*Variation(s):* none

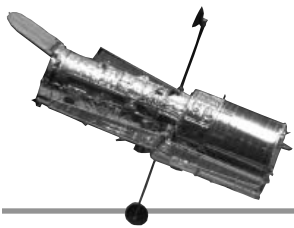
**polar, *adj.*** Related to the pole of a planet or the area surrounding it

*Example:* During the wintertime in North America, polar winds blow from the north and bring frigid temperatures.

*Variation(s):* none

<b><i>At a Glance</i></b>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>What Have We Already Learned?</b>		10
	<b>Purpose for Listening</b>		
<b><i>Presenting the Read-Aloud</i></b>	<b>Our Solar System, Part II</b>	unit cubes made into an 11x11x11 cube (optional) [Advance preparation is needed.]	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>	Images Cards 3, 7–14	15
	<b>Word Work: Frigid</b>		5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>KWL Chart</b>		20
	<b>Planet Research</b>	Instructional Masters 2B-1, 3B-1 (optional)	





# Our Solar System, Part II

3<sub>A</sub>

## Introducing the Read-Aloud

10 minutes

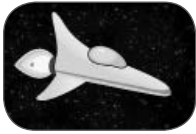
### What Have We Already Learned?

Tell students that today they will continue to learn about the planets in our solar system. Ask students the following questions to review what they learned in the last read-aloud. You may wish to allow students to refer to the KWL chart as they answer the questions.

- How many planets are in our solar system? (eight)
- Name the eight planets in order from the sun. (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune) Which planet position is Earth from the sun? (third)
- What other celestial bodies can be found in our solar system besides the sun and its planets? (dwarf planets, comets, asteroids, meteoroids, moons)
- What is the difference between a meteoroid, a meteorite, and a meteor? (A meteoroid is a piece of space debris. When it enters a planet's atmosphere, it is called a meteor. If it reaches the planet's surface without burning up, it is called a meteorite.)
- What is a dwarf planet? (It is a spherical celestial body that orbits the sun and has not cleared its orbit of debris.)
- What is the atmosphere of a planet and how does it affect the planet? (It is a blanket of gas that surrounds the planet. It holds in heat and keeps the planet at a steadier temperature.)

### Purpose for Listening

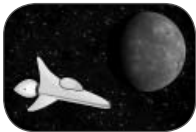
Tell students to listen carefully to find out which planets in our solar system other than Earth have an atmosphere and how the atmosphere affects the characteristics of the planet.



## Our Solar System, Part II

### ← Show image 3A-1: Our imaginary spaceship

Would you like to take an out-of-this-world trip? Over the next few days, we are going to go on an exciting tour of space in our very own classroom “spaceship.” The only luggage you will need to take with you on this adventure is your imagination. Are you ready? Let’s buckle up and get ready for takeoff!



### ← Show image 3A-2: Mercury

We’ll start by traveling to the planet that is closest to the sun: Mercury. As we approach the planet, you will see many craters on its surface. These are the result of hundreds of meteoroids hitting the surface of the planet. You will probably notice right away how small it is compared to our planet Earth. At one-third the diameter of Earth, Mercury is the smallest planet in our solar system.<sup>1</sup>

It’s certainly hot here. Our spaceship is reading the surface temperature as being 750 degrees Fahrenheit!<sup>2</sup> The side of Mercury that is facing the sun is very hot, but the side of the planet that is facing away from the sun—the dark side of Mercury—is **frigid**, dropping to negative 300 degrees Fahrenheit. Brrrrr! It’s hard to imagine being as cold as three hundred degrees below zero.

You might have guessed that Mercury gets very hot during the day because it is so close to the sun. But why does it get so cold at night? It’s because Mercury has no real atmosphere, even though there are occasionally a few gas particles around the planet. Without a real atmosphere, there is nothing to trap the sun’s heat to make it stay warm on the side of the planet that is not facing the sun.

The smallest planet in our solar system, Mercury makes its orbit very quickly around the sun.<sup>3</sup> One planetary year on Mercury is only eighty-eight Earth days. That means it only takes Mercury eighty-eight Earth days to orbit around the sun one time. But even though Mercury’s years are short, it rotates very slowly on its axis, so its days are very long. One day on Mercury takes about fifty-

1 [Ask a volunteer to point out what part of Mercury is considered the diameter.] Earth’s diameter is three times as big as Mercury’s.

2 Water boiling on the stove is 212 degrees Fahrenheit, so 750 degrees Fahrenheit is a lot hotter than boiling water!

3 Who remembers from the last read-aloud how long it takes Mercury to travel once around the sun?

eight Earth days! How would you like to have the sun set and have it stay dark for about a month's worth of Earth days before the sun rises again? Good thing it's time to leave Mercury and head for the second planet from the sun in our solar system—Venus!



← **Show image 3A-3: Venus**

- 4 Venus is called Earth's "sister planet." Why do you think it is called this? [Pause for students to share.] (They are similar in size and location.)
- 5 Carbon dioxide is one of the gases that people and animals on Earth breathe out, and that plants take in.
- 6 Why is that surprising? (Mercury is closer to the sun than Venus.)
- 7 Venus's atmosphere is similar to the plastic or glass covering of a greenhouse, which traps the heat energy from the sun.

The first thing you will notice about Venus is that, besides being Earth's closest neighbor, it is practically the same size as Earth.<sup>4</sup> Like Earth, Venus also has an atmosphere. But unlike Earth, the atmosphere of Venus is made up of very thick gases, including lots of carbon dioxide.<sup>5</sup> Venus's thick, cloudy atmosphere is also very **dense**, with ninety times the pressure or heaviness of Earth's atmosphere.

Venus is actually hotter than Mercury—more than 850 degrees Fahrenheit! Venus is the hottest planet in our solar system.<sup>6</sup> The reason it is hotter than Mercury is that Venus's atmosphere creates a "**greenhouse** effect," which means its dense atmosphere acts like a thick blanket, trapping the sun's heat at the surface of the planet. This causes the planet's surface temperature to rise because the heat can't easily escape into space.<sup>7</sup>



← **Show image 3A-4: Earth**

- 8 How is Earth different from the other planets?
- 9 What do you remember about our home planet from the first lesson? (Earth is a rocky planet that is third from the sun; it has one moon; it is the only known planet that supports life because of its placement, temperature, and atmosphere; etc.)

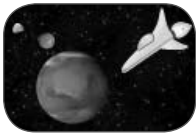
The next stop on our tour of our solar system is home sweet home: Earth, the third planet from the sun. From way out here in space, it looks different from all of the other planets.<sup>8</sup> Planet Earth appears as a swirl of blue, white, and green thanks to our water-filled oceans, the clouds of our atmosphere, and the green of the plants growing on our planet. It looks bright and glowing and alive. We live on a very beautiful planet!<sup>9</sup>



← **Show image 3A-5: Mars**

Let's zoom past Earth and head toward the fourth planet from the sun in our solar system—the red planet, Mars. Mars is the last of the four rocky planets in our solar system. As soon as you see it, you know why it's called the “red planet”—because it really is reddish! The red color is caused by the presence of rust in the surface rocks. Even though Mars is only half the size of Earth, it still takes about twenty-four hours for it to rotate on its axis. So a day on Mars is nearly the same length as a day on Earth.

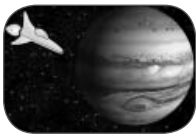
10 Like Earth, Mars has a north pole and a south pole, and these polar parts of the planet receive the least direct sunlight. Where would you find the polar ice caps on Mars?



← **Show image 3A-6: Mars and its moons**

As we prepare to leave the Martian orbit, we will pass by its two moons, Phobos [*FOE- bos*] and Deimos [*DYE-mos*].<sup>11</sup> Why such funny names? The planet Mars was named for the Roman god of war—Mars—who was called Ares [*AIR-eez*] by the ancient Greeks. Phobos and Deimos were Ares' two sons.

11 Here's a little bit of Martian trivia: *Martian* means anything related to Mars.



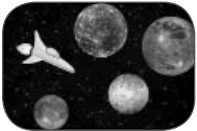
← **Show image 3A-7: Jupiter**

We'll have to go through the asteroid belt to get from Mars to Jupiter, the fifth planet from the sun.<sup>12</sup> The distance between Mars and Jupiter is more than three times the distance we've traveled so far! Do you see Jupiter? There's no way you could miss it if you tried! Remember, Jupiter is the largest planet in our solar system, and it's absolutely gigantic. It's so big that more than 1,300 Earths could fit inside it.<sup>13</sup> Did you know Jupiter has rings? Saturn is famous for its beautiful rings, but Jupiter has them, too. In fact, all four of the gas giants in our solar system—Jupiter, Saturn, Uranus, and Neptune—have rings, though the rings are not visible in many images you see of Jupiter, Uranus, and Neptune.

12 What will we find in the asteroid belt? (thousands of asteroids and the dwarf planet Ceres)

13 If Earth were the size of a math unit cube, Jupiter would be about the size of a cube made with eleven units on each side. [You may wish to show this with unit cubes.]

You may be wondering if we could land on the surface of Jupiter. Like the other gas giants, there's not a solid surface to land on—just hundreds of miles of gas, below which is a sea of liquid hydrogen. Besides, Jupiter's atmosphere is extremely cold, stormy, and windy. These storms are what give Jupiter that marbled appearance. Do you see that giant spot on its side? That's called the Great Red Spot, and it is a gigantic storm that's bigger than the entire Earth! There's no way we could land a spaceship there.



← **Show image 3A-8: Some of Jupiter's moons**

Let's take a look at some of Jupiter's moons. Scientists have discovered more than sixty moons so far, so there are many to choose from! Here are four moons discovered years ago by Galileo Galilei, a scientist you will hear more about later. Their names are<sup>14</sup> Callisto, Ganymede, Io [EYE-oh], and Europa. Made of materials ranging from frozen ice to molten or melted rock, these natural satellites have amazing sights which include frozen oceans and volcanoes.

14 [named clockwise from the top center]

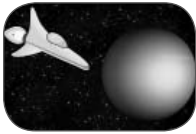


← **Show image 3A-9: Saturn**

Are you ready to head to the next planet? Saturn, here we come! The distance we must travel to get to the sixth planet from the sun in the solar system, Saturn, is about the same distance it took for us to get from Mars to Jupiter—it's far! Like Jupiter, Saturn is another gas giant, and its atmosphere has winds that are even stronger than hurricane winds on Earth. But what may take your breath away is the sight of the rings. They are absolutely beautiful! You might be surprised to learn that Saturn's rings aren't solid—they're made up of millions of pieces of rock and ice!

Astronomers believe that the debris in some of Saturn's rings is held in place by a combination of the pull from Saturn and the pull of some of Saturn's many moons. The moons that are believed to help hold some of Saturn's outermost rings in place are called "shepherd moons."<sup>15</sup>

15 How are the "shepherd moons" like a shepherd?



### ← Show image 3A-10: Uranus

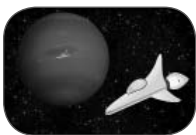
It's time to head to the seventh planet from the sun in our solar system—Uranus. If you thought the trip between Jupiter and Saturn was far, then you may want to sit back and take a nap. The space between the planets gets bigger out here where the gas giants are. Uranus is about twice as far from the sun as Saturn is! No wonder astronomers didn't discover Uranus until after the telescope was invented. It's a long way away from Earth! It took the **NASA** spacecraft *Voyager 2* twelve years to get to Uranus from Earth. Good thing our special classroom spaceship goes faster than *Voyager 2*, or we'd be out here in space a long time!<sup>16</sup>

16 *NASA* is an acronym that stands for the National Aeronautics and Space Administration, the part of the U.S. government in charge of space, science, technology, and exploration.

17 A "leg of a trip" is a section of a trip. What would "the last leg of a trip" mean? How would you refer to the beginning of a trip?

As we approach Uranus, you may be wondering why it appears to be rolling on its side. The poles of Uranus are in a different position than the poles of other planets. Uranus's axis is tilted a lot more to its side than the other planets in our solar system. Many scientists think the axis became so far tilted during a collision that happened when the solar system was forming. Like the other gas giants, Uranus also has rings and moons, though the rings are not easy to see like Saturn's rings.

After that long trip from Saturn to Uranus, you may be wondering how far away the next planet is. It's just a little farther than the last leg of our trip from Saturn to Uranus—which is to say, very far!<sup>17</sup>



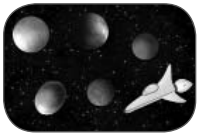
### ← Show image 3A-11: Neptune

Finally, we have arrived at the last planet—eighth from the sun in our solar system—Neptune.<sup>18</sup> Even though astronomers knew a celestial object was there before they identified it, the planet Neptune was discovered fewer than two hundred years ago, in 1846. It is the last of the four gas giants in our solar system. Neptune has two rings around it that are hard to see—many fewer than Saturn. Scientists don't know as much about Neptune as they do about some of the other planets. It's hard to study because it's so far away. Astronomers think Neptune has at least thirteen moons.<sup>19</sup> Like Jupiter, Saturn, and Uranus, Neptune doesn't have a solid surface to land on—making it a bad place for spaceship landings!<sup>20</sup>

18 You may remember from *The Ancient Roman Civilization* domain that Neptune was the Roman god of the sea, similar to the Greek god Poseidon.

19 Do you think we can land on Neptune? Why or why not?

20 Who remembers what these four outer planets are called? (gas giants)



## ← Show image 3A-12: Beyond Neptune

21 [Show Image Card 7 (Pluto), and ask students to find Pluto in the flip book image.] (top middle) Who remembers some things about Pluto? (Pluto is the most famous dwarf planet, because it was considered to be a major planet until 2006 when it was reclassified; it is small and has not cleared its orbit of most other objects; it is very far away; etc.)

22 What do you think *astronomical* means?

Let's look beyond the last planet, Neptune, farther out into space. Objects beyond our eight planets are called "trans-Neptunian." Here is where we find the dwarf planet Pluto.<sup>21</sup>

There are many other trans-Neptunian celestial bodies in our solar system even farther away than Pluto that astronomers are only beginning to discover. The distances in space between these objects are astronomical!<sup>22</sup> And beyond our solar system, there's a whole neighborhood of stars. And beyond that neighborhood of stars, there are billions of other neighborhoods of stars! Why, there's a whole universe out there just waiting for us to learn more about!

## Discussing the Read-Aloud






20 minutes

### Comprehension Questions


15 minutes

If students have difficulty responding to questions, reread pertinent passages of the read-aloud and/or refer to specific images. If students give one-word answers and/or fail to use read-aloud or domain vocabulary in their responses, acknowledge correct responses by expanding the students' responses using richer and more complex language. Ask students to answer in complete sentences by having them restate the question in their responses. **It is highly recommended that students answer at least one question in writing and that some students share their writing as time allows.** You may wish to have students collect their written responses in their Space Notes notebooks or folders to reference throughout the domain as source material for longer writing pieces and as preparation for written responses in the Domain Assessment.



1. *Inferential* What is the smallest planet of the eight planets in our solar system? (Mercury) [Show Image Card 8 (Mercury).] What are some facts that scientists know about Mercury? (It rotates slowly; its planetary year is eighty-eight Earth days; its day length is fifty-eight Earth days; it has a rocky terrain with many craters; it has no real atmosphere; it is very hot on the side facing the sun and frigid on its dark side; it is the closest planet to the sun.)

2.  *Inferential* How does a planet's atmosphere act like a greenhouse? (It traps the heat from the sun and warms the planet.) Which planets did you hear about in today's read-aloud that have atmospheres dense enough to have this "greenhouse effect"? (Venus and Earth)
3.  *Evaluative* [Show Image Card 3 (Earth) and Image Card 9 (Venus).] Compare and contrast the "sister" planets Earth and Venus. How are they similar? (They are the second and third planets from the sun; they both have atmospheres that are dense enough to help warm the planet; they are similar in size.) How are they different? (Venus' atmosphere is much denser than Earth's; Venus is much hotter than Earth; we do not know of living things on Venus.)
4.  *Inferential* [Show Image Card 10 (Mars).] What are some facts scientists know about Mars? (It is covered by reddish, dusty soil; has a very thin atmosphere; has polar ice caps; is about half the size of Earth; is the fourth planet from the sun; has two moons or satellites named Phobos and Deimos.)
5.  *Inferential* [Show Image Card 11 (Jupiter).] Describe the planet Jupiter. (It is a gas giant far from the sun; its atmosphere is very stormy and constantly moving; it has rings that are hard to see; it has more than sixty moons; it is the fifth planet from the sun.) What is the Great Red Spot on Jupiter? (It is a gigantic storm on the surface of the planet.)
6. *Evaluative* [Show Image Card 12 (Saturn) and Image Card 14 (Neptune).] Compare and contrast Saturn and Neptune. How are they similar? (They are both gas giants far from the sun; they both have rings and moons.) How are they different? (Saturn is much bigger than Neptune; we have known about Saturn much longer; Saturn's rings are more visible; they are the sixth and seventh planets from the sun.)
7. *Inferential* [Show Image Card 13 (Uranus).] What characteristic makes Uranus unique in our solar system? (Its axis is tipped far to the side.)
8.  *Inferential* [Show Image Card 7 (Pluto).] Why has Pluto been reclassified as a dwarf planet rather than a planet? (Scientists have made more discoveries and established new criteria for identifying a planet. Pluto has not yet cleared its orbit of debris; other celestial bodies of similar size have been discovered.)



9. *Literal* What does the acronym *NASA* stand for? (National Aeronautics and Space Administration) What does NASA do? (It is part of the United States government that has to do with space technology and exploration.)
10.  *Evaluative* You have learned that the sun is a constant source of heat and light. If all of the planets receive light and heat from the sun, why are the planets not all the same temperature? (Many of the planets are too far away to be warmed very much by the sun; Venus and Earth are the only two inner planets that have enough of an atmosphere to trap the heat that reaches their surfaces, enabling them to keep the dark side of the planets warm.)

I am going to ask a question. I will give you a minute to think about the question, and then I will ask you to turn to your neighbor and discuss the question. Finally, I will call on several of you to share what you discussed with your partner.

11.  *Evaluative Think Pair Share:* Scientists have learned a great deal about our solar system, but they still have much more to learn. What planet or object in the solar system would you like scientists to explore more and why? (Answers may vary.)
  12. After hearing today's read-aloud and comprehension questions and answers, do you have any remaining questions?
-  You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.

## Word Work: Frigid

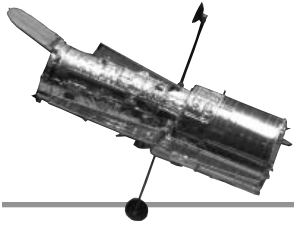
5 minutes

1. In the read-aloud you heard, “The dark side of Mercury is *frigid*, dropping to negative 300 degrees Fahrenheit.”
2. Say the word *frigid* with me.
3. *Frigid* means very cold.
4. Without our atmosphere, Earth would be extremely hot during the daylight hours and frigid during the nighttime hours.
5. Do you know of any places or things that are frigid? Be sure to use the word *frigid* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students’ responses to make complete sentences: “\_\_\_\_\_ is frigid because . . .”]
6. What’s the word we’ve been talking about? What part of speech is the word *frigid*?

Use a *Synonyms and Antonyms* activity for follow-up. Ask students, “What does *frigid* mean? What are some synonyms, or words that have a similar meaning?” Prompt students to provide words like *cold*, *freezing*, *chilly*, *wintry*, *icy*, etc. Then ask, “What are some words or phrases you know that are antonyms, or opposites, of *frigid*?” Prompt students to provide words and phrases like *hot*, *boiling*, *summery*, *tropical*, etc.



**Complete Remainder of the Lesson Later in the Day**



# Our Solar System, Part II

3<sub>B</sub>

## Extensions

20 minutes

### KWL Chart

Using the KWL chart you created in Lesson 1, review briefly with students what they said they knew about outer space and astronomy. Ask students if after hearing today's read-aloud, there is anything they would like to change in the 'K' (Know) column.

**Note:** If there are any factual inaccuracies in the Know column that were addressed in today's read-aloud, prompt students to recognize and correct them.

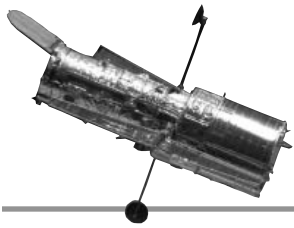
Then, remind students of the 'W' (Wonder) column to see if they can find answers to some of their questions from today's read-aloud. Ask students if there is anything from today's read-aloud that they would like to add to this column. Finally, point to the 'L' (Learn) column. Ask students if there is anything from today's read-aloud that they would like to add to this column.

✈ You may wish to have some students create their own KWL charts and keep them in their Space Notes notebooks or folders.

### 10 Planet Research (Instructional Master 2B-1; 3B-1, optional)

Remind students of the planet and dwarf planet research they began during the last lesson. Allow students to continue their research and to record the information they gather on Instructional Master 2B-1.

✈ Some students may be ready to use Instructional Master 3B-1 to record additional information from their research. Students may also illustrate and/or capture more information about their topic on the back of the worksheet if they do not have enough room on the template. Have students keep their worksheets in their Space Notes notebooks or folders.



# Galaxies

# 4

## Lesson Objectives

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### Core Content Objectives

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Students will:

- ✓ Identify the sun as a constant source of heat and light energy
- ✓ Classify the sun as a star
- ✓ Identify our planet Earth as the third planet from the sun, and ideally suited for life
- ✓ Describe the eight planets of our solar system and their sequence from the sun
- ✓ Identify our solar system as the sun and all of the smaller bodies that orbit it, e.g., the planets, moons, asteroids, etc.
- ✓ Describe stars as hot, distant, and made of gas
- ✓ Compare and contrast our sun and other stars
- ✓ Describe a galaxy as a very large cluster of many stars
- ✓ Identify the Milky Way as our own galaxy and Andromeda as the closest spiral galaxy in our universe
- ✓ Describe the universe as a vast space that extends beyond the imagination

### Language Arts Objectives

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The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ Describe our sun, other stars, the Milky Way, other galaxies, and the universe as presented in “Galaxies,” using language that pertains to their size and position in relationship to each other (RI.3.3)

- ✓ Determine the literal and nonliteral meanings of and appropriately use common sayings and phrases, such as “the naked eye” as used in “Galaxies” (RI.3.4) (L.3.5a)
- ✓ Describe images of galaxies, noting the galaxy shapes using the words *spiral*, *elliptical*, and *irregular* as conveyed in “Galaxies” (RI.3.7)
- ✓ Describe mental images of the word *billions* as conveyed by the examples in “Galaxies” (RI.3.7)
- ✓ Compare and contrast our sun and other stars as shown in the images and described in “Galaxies” (RI.3.9)
- ✓ Compare and contrast the key details as shown in the images and described in “Galaxies” between two different views of the Milky Way Galaxy (RI.3.9)
- ✓ Make personal connections to concepts presented in “Galaxies” through engagement with a class KWL chart (W.3.8)
- ✓ Make personal connections to the words *spiral* and *irregular* by identifying familiar objects and situations they describe (W.3.8)
- ✓ Categorize and organize statements and questions about space through engagement with the KWL chart used in “Galaxies” (W.3.8)
- ✓ Categorize the sun as a star and the Milky Way as a galaxy (W.3.8)
- ✓ Categorize the characteristics of objects and situations as regular or irregular (W.3.8)
- ✓ Make predictions before being introduced to “Galaxies” about the next line of the school’s “space address,” and then add *Milky Way Galaxy* to the address on the envelope (SL.3.1a)
- ✓ Summarize the main ideas and supporting details of “Galaxies” from the information presented through text and images (SL.3.2) (SL.3.4)
- ✓ Choose words and phrases to effectively describe our solar system and the universe (L.3.3a)
- ✓ Determine the meaning of a new word when a known affix is added to a known word, such as *fuse/fusion* and *regular/irregular* (L.3.4b)
- ✓ Use the known root *astro-* and the known words *astronomy* and *astronomer* as clues to the meaning of unknown words, such as *astronomical* (L.3.4c)

- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial relationships, to describe the school’s space address, such as *street, city or town, state, ZIP code, country, planet, solar system, galaxy, and universe* (L.3.6)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial relationships, to describe the distances between stars and galaxies and within the universe, such as *vast, gigantic, astronomical, billions, and beyond imagination* (L.3.6)
- ✓ Create a stamp to accompany the school’s “space address” that illustrates or represents information learned thus far in *Astronomy: Our Solar System and Beyond*

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**astronomical, *adj.*** Really large; enormous in number, size, or distance

*Example:* Listening to her teacher describe the distances between galaxies, it was hard for Marianna to imagine such astronomical distances!

*Variation(s):* none

**atoms, *n.*** The tiny particles from which all substances are made

*Example:* Water is made of oxygen atoms and hydrogen atoms.

*Variation(s):* atom

**cluster, *n.*** A number of things of the same kind that are together in a group

*Example:* Carmen was curious to know what the teacher was talking about with the cluster of students gathered around her in the gymnasium.

*Variation(s):* clusters

**fuse, *v.*** To join together

*Example:* When two atoms of hydrogen fuse together, a lot of energy is produced.

*Variation(s):* fuses, fused, fusing

**galaxy, n.** A large collection of stars, dust, and gas, held together by a powerful force and separated from other star systems by an extensive amount of space

*Example:* It takes light more than two million years to travel to the Andromeda Galaxy from our own galaxy.

*Variation(s):* galaxies

**irregular, adj.** Uneven; not regular in shape, size, or other characteristics

*Example:* Most of the farmer’s crops were prize-winners, but this season, his pumpkins all had a strange, irregular shape.

*Variation(s):* none

**light-years, n.** Distance traveled by light over a period of years; a measure of length used in astronomy


*Example:* Five light-years is the distance that light travels in five Earth years.

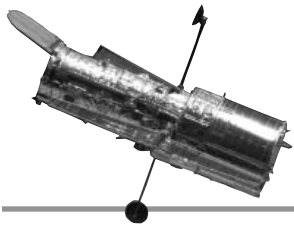
*Variation(s):* light-year

**spiral, adj.** Curved in shape; gradually winding around a center point

*Example:* Jamil was intrigued by the spiral shape of the seashell he found on the beach.

*Variation(s):* none

<i>At a Glance</i>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>What Have We Already Learned?</b>	Poster 1 (Our Solar System); KWL Chart	10
	<b>Space Address</b>	Poster 2 (A Galaxy Like the Milky Way); envelope with space address; dark permanent marker	
	<b>Essential Background Information or Terms</b>		
	<b>Purpose for Listening</b>		
<b><i>Presenting the Read-Aloud</i></b>	<b>Galaxies</b>	Image Card 15; envelope with space address; dark permanent marker	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>	Poster 2; Image Card 2	15
	<b>Word Work: Irregular</b>	Poster 3 (Galaxy Shapes)	5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>KWL Chart</b>		20
	<b>Space Address</b>	Instructional Master 4B-1; drawing tools; images of astronomy-related stamps (optional)	



# Galaxies

4<sub>A</sub>

## Introducing the Read-Aloud

10 minutes

### 10 What Have We Already Learned?

Remind students that in the previous lessons, they learned about our solar system. Tell students that you are going to review some of the things they have learned about the solar system by asking them to listen to some statements and determine what would make them true statements.

**Note:** You may wish to allow students to refer to Poster 1 (Our Solar System) and the KWL chart as you read the statements below.

Explain that you will read a statement about the solar system. One word in the statement will be incorrect. If that one incorrect word is replaced with the correct word, the statement will be true. Ask students to listen carefully to each statement and identify the incorrect word. Then ask a student to repeat the sentence, replacing the correct word for the incorrect word and making the statement true.

1. There are seven planets in our solar system. (eight)
2. Earth is the fifth planet away from the sun. (third)
3. The four gas giants are Jupiter, Mars, Uranus, and Neptune. (Saturn)
4. The comet belt lies between the planets Mars and Jupiter. (asteroid)
5. Pluto is a dwarf planet and lies in the asteroid belt between Mars and Jupiter. (Ceres)
6. Moons are natural meteors that orbit a planet. (satellites)
7. It is hot on the side of Mercury facing “away” from the sun. (frigid)  
(Alternative correction: It is hot on the side of Mercury facing “toward” the sun.)
8. The terrain of Venus acts like a greenhouse and traps the heat energy from the sun. (atmosphere)



## Space Address

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Ask students to look at the envelope you began in “Our Planet Earth” showing your school’s “Earth address” and the first parts of your “space address.” You may wish to ask a student to read the address, or you may read the address chorally as a class. Tell students that today you will add the next two lines to the “space address” on the envelope. Ask students if they have any ideas about what you might add.

Show students Poster 2 (A Galaxy Like the Milky Way). Tell students that the image is an actual photograph taken using a telescope.

Explain to students that a galaxy is a gigantic cluster of stars, gas, and dust. Tell students that our solar system is a small part of a galaxy called the Milky Way, which looks very much like the galaxy in the image. Also tell them that our sun is only one of billions of other stars in this galaxy. Add “Milky Way Galaxy” to the address on the envelope.

## Essential Background Information or Terms

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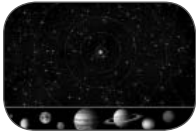
It’s hard to imagine a billion stars or how much a billion of anything is. Here are some ways to think about just how big a billion is.

- A dump truck full of sand contains about a billion grains of sand.
- It would take you almost thirty-two years to count to a billion if you counted one number each second without stopping.
- A giant cube of ice the length and width of a football field (not including the end zones) and thirty-five building stories high would weigh about a billion pounds.

## Purpose for Listening

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Tell students to listen to learn more about galaxies and to listen to find out why our galaxy is called the Milky Way.



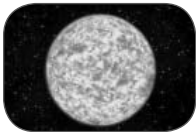
## Galaxies

### ← Show image 4A-1: The planets of the solar system

1 [Point to the sequence of planets and have students name them. Then, point to the four inner orbits, and explain that these are much closer to the sun than the four outer orbits of the gas giants.]

I hope you have enjoyed the tour of our solar system so far! We have learned that our solar system is made up of the sun and all of the objects that orbit around it, including the eight planets and their satellites, asteroids, and comets.<sup>1</sup>

Isn't space amazing? The thing that may amaze you most is how much distance there is between the planets in our solar system. No wonder they call it space! Now that we have reached the edge of our solar system, do you want to see more closely what lies in the center? Before you can understand what lies beyond our solar system, you need to know a little more about what stars are. And the best place to start (get it, *star-t*?) is with the star that lies at the center of our solar system that you see every day: our very own sun. Let's buckle up, put our classroom spaceship into super drive, and continue our tour!



### ← Show image 4A-2: Our sun, one of billions of stars

2 We are close enough to the sun that its light reaches Earth in only a little more than eight minutes!

You know that you should never look directly at the sun because it will damage your eyes. But with the special equipment on our spaceship, we are able to look directly at it. Wow, is the sun bright! And the sun is so much brighter and bigger than all the rest of the stars because we are so much closer to our star than we are to any other star.<sup>2</sup> We only see our star, the sun, in the daytime because that's when we're facing it. And when the sun lights up our skies, it is so bright that we can't usually see any other stars in the daytime.

3 Atoms are the tiny particles from which all substances are made. You may have heard cells described as the basic building blocks of tissues. Atoms and cells are similar in that both are basic parts of bigger things.

You can tell just by looking that there is no way a spaceship could land on the sun—it's a big mass of incredibly hot gas! There's no solid surface to land on. The sun, like all stars, is made mostly of a gas called hydrogen. Hydrogen **atoms** in the center of the sun crash into each other under intense heat and pressure.<sup>3</sup> The hydrogen atoms **fuse**, or join together, to form another gas called helium, and this fusion creates energy you can see and feel in the form of light and heat. So, hydrogen turning into helium produces vast amounts of energy and is what causes the sun to shine.

4 Who remembers how hot boiling water is? (212 degrees Fahrenheit)

5 Later, you will learn about the four different colors of stars—blue, white, yellow, and red—and their various temperatures.

6 Imagine a box filled with cotton balls. Now, imagine pressing those cotton balls together so that you could fit even more into the same size box. Stars are like that—the substances in stars are like the cotton balls, some are more packed together, or denser, than others.

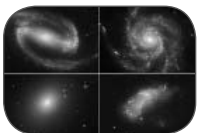
7 How many Earths could fit inside the sun?

The amount of heat and light being produced by a star determines its color. The surface of our sun is about ten thousand degrees Fahrenheit, not nearly as hot as the *inside* of the star!<sup>4</sup> Even though ten thousand degrees is *really* hot compared to boiling water, our sun is still only considered a medium-hot, yellow star. Some stars are even hotter and some are not as hot as our sun. In fact, our sun is not as hot as it used to be.<sup>5</sup>

Scientists believe that all stars are made of more or less the same things: hydrogen, helium, and smaller amounts of other basic substances. But just because stars are made from huge amounts of hydrogen and helium doesn't mean that all stars are the same—they aren't. The amount of substance or mass that makes up each star can vary. And the substances that make up some stars are more packed together than in others.<sup>6</sup>

Stars have different ages, too. Some stars in the universe were literally just born yesterday, and some—like the sun—are believed to be billions of years old. But our sun is not at the end of its life either; many scientists believe our sun still has billions of years yet to live! So stars can be very different from each other.

Our sun seems large to us, and it is. In fact, it's so large that . . .<sup>7</sup> more than one million Earths could fit inside it! That's a lot of Earths—and just one Earth is pretty big. But believe it or not, our sun is small compared to many other stars. There are stars in the universe that are two thousand times as big as the sun! Our sun seems very bright to us, and it is. But there are stars that are more than four million times as bright! Even so, there are stars that are smaller than our sun and some that are less bright. So you see, stars can differ in size, mass, color, brightness, temperature, and age. But the one thing that most stars have in common is that they exist in groups called galaxies.



← **Show image 4A-3: Galaxy shapes**

Do you remember how we defined our solar system as a neighborhood of planets, asteroids, and other objects in orbit around a star? Well, a **galaxy** is a **cluster** of many stars that orbit around together as an even bigger neighborhood—like a country.

8 [Point to the two spiral galaxies.]  
What are some other examples of a spiral? (spiral staircase, snail shell, plant tendril, various seashells, etc.)

9 Who remembers what *elliptical* means? In some galaxies it is easy to see the ellipse, but in others the ellipse sometimes looks circular. [Point to the galaxy in the lower left.]

10 [Point to the image in the lower right corner.]



11 Can you think of a candy bar whose name was inspired by our galaxy? (Milky Way Bar)



12 [Show Image Card 15 (Side View of a Galaxy like the Milky Way).] Here is a side view of a galaxy like the Milky Way Galaxy. You can't see the spiral arms in this view, but it is easy to see the thick, dense cluster of stars in the center of the galaxy.

So, a galaxy is basically a gigantic country of stars. But all galaxies are not the same; they come in many shapes and sizes. Some galaxies are **spiral**.<sup>8</sup> Some galaxies are elliptical in shape.<sup>9</sup> Still other galaxies are **irregular** in shape, with no particular pattern like this one.<sup>10</sup>

← **Show image 4A-4: The Milky Way in our night sky**

The galaxy that our solar system is in is called the Milky Way Galaxy, which is a spiral galaxy.<sup>11</sup> When you are standing on Earth you are in the Milky Way Galaxy. If you look up into the sky on a very clear, dark night away from the lights of a city, you can see a narrow band of thousands of stars going through the sky. When you look at this cloudy-looking band, you are looking into the thickest, densest part of the Milky Way. The ancient Greeks called this band of stars The Milky Circle, and the ancient Romans called it The Milky Road. But guess what? When you stand outside of the Milky Way and look at it, it looks like a spiral. Would you like to see it? Let's fire up our engines and go!

← **Show image 4A-5: Spiral-shaped galaxy similar to the Milky Way**

Here we are outside of a spiral galaxy like the Milky Way, looking down on it. Astronomers know what the Milky Way Galaxy looks like, but no person or spaceship has ever traveled outside of the Milky Way to take a picture of the whole galaxy. Scientists have figured out by using modern scientific instruments that the Milky Way is a spiral galaxy and looks very much like other spiral galaxies that we *can* take pictures of.

As you can see, this spiral galaxy has a bright center, or hub, of many bright stars with star-studded arms swirling out from it amid clouds of gas. Isn't it beautiful? And *huge!*<sup>12</sup>

13 It's hard to imagine a billion of something. Who remembers one example of a billion you heard earlier?

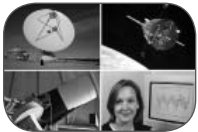
Did you realize that galaxies were so gigantic? How many stars do you think are in one galaxy? A single galaxy usually contains between one billion and a few hundred billion stars.<sup>13</sup> And that's not even counting any planets or other objects that may be in orbit around all of those billions of stars. In addition to billions of stars, galaxies also contain clouds of gas and pieces of dust which can eventually come together to form new stars.

14 Who remembers from the *Light and Sound* domain what a light-year is?

And don't forget—galaxies also include the space in between the stars that are in it. There is a huge amount of space *in space!* Stars in the Milky Way Galaxy can be one hundred thousand **light-years** away from each other, or they can be five light-years away from each other, but most are somewhere in-between.<sup>14</sup>

15 Do you remember what *astronomical* means?

A light-year is the distance that light travels in one year. Light travels at a speed of 186,282 miles per *second*. So one light-year is nearly six *trillion* miles! That's about six thousand billion miles. And you thought a billion was big! Well, as you can see, stars in the same galaxy are *very* far away from each other. Those are **astronomical** distances!<sup>15</sup>



← **Show image 4A-6: Gathering information about space**

How do we know so much about the Milky Way Galaxy? For starters, imagine being in a house at night far away from bright lights. You could look out a window on one side of the house and see several stars in a dark, starlit sky. If you went to the other side of the house and looked out a different window you would see several different stars. All of the stars you see can be seen together if you walk outside and look up at the whole night sky.

16 Have you ever heard this expression? What do you think it means? (*With the naked eye* means without the use of a telescope.)

People all over the world can look up into the sky and see the stars. Just as when you look out different windows of the same house, people in one part of the world see certain stars, while people looking into the sky on the other side of the world see different stars. Astronomers tell us that in all of Earth's skies people can see a total of about two thousand individual stars with the naked eye.<sup>16</sup> Those two thousand stars are all in our very own galaxy—the Milky Way.

Not only that, astronomers use different kinds of powerful telescopes to see even more distant parts of the Milky Way Galaxy. Some of those telescopes are on Earth, and some are in orbit around the Earth. And there are even a few telescopes zooming through our solar system. Astronomers share their observations, their photographs, and the data they have gathered with each other—and luckily, with us, too. Even with all of our powerful equipment, there are still things in the Milky Way Galaxy—and beyond it—that no one has ever seen. Sometimes there is something in the way, like a star or another galaxy, and some things are still too far away even for our most powerful telescopes. There are more stars and galaxies in the universe than we can imagine!



← **Show image 4A-7: The Andromeda Galaxy**

17 Who remembers what the shape of the Andromeda Galaxy is called? (spiral)

18 The Andromeda Galaxy is also known as M31, which gets its name from being thirty-first on a list of discoveries made by a French astronomer named Charles Messier [MESS-ee-ae].

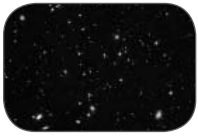
As you look out at the Milky Way, you may wonder about the other galaxies out there. One of the closest galaxies to our Milky Way Galaxy is called the Andromeda [an-*DR*OM-eh-dah] Galaxy.<sup>17</sup> The Andromeda Galaxy is a spiral galaxy like our Milky Way. Even though Andromeda is the closest spiral galaxy to our galaxy, the Andromeda Galaxy is still very far away, and there is still much that remains unknown about it. Several other small irregular galaxies lie between the Milky Way Galaxy and the Andromeda Galaxy.<sup>18</sup>



← **Show image 4A-8: Planet Earth; our solar system; a galaxy like the Milky Way Galaxy**

19 [Point to *Milky Way Galaxy* on the envelope.] Let's read the address together. [Read the address chorally.]

Now you know a lot more about our school's "space address." We live on the planet Earth. Earth is the third planet from the sun in our solar system, one of four small, rocky planets. Our solar system is just one planetary system located in one of the spiral arms of the Milky Way Galaxy.<sup>19</sup>



← **Show image 4A-9: Distant galaxies**<sup>20</sup>

20 This image was taken from the Hubble Telescope, which orbits Earth. It took many hours to receive enough light from these distant galaxies to create this image.

21 Let's add *The Universe* as the last line of our "space address." We will continue to learn more about our amazing universe!

You may be thinking about all of the other galaxies that exist besides our galaxy. There are *billions* of galaxies in the universe. Another astronomical number! "Wait," you may be thinking, "let me get this right. There are billions of galaxies . . . and all of them have billions of stars in them? Wow—that's so big I can't even get my mind around it!" The universe truly is an incredibly gigantic and vast place.<sup>21</sup>



## Discussing the Read-Aloud





**20** minutes

### Comprehension Questions

**15** minutes

If students have difficulty responding to questions, reread pertinent passages of the read-aloud and/or refer to specific images. If students give one-word answers and/or fail to use read-aloud or domain vocabulary in their responses, acknowledge correct responses by expanding the students' responses using richer and more complex language. Have students answer in complete sentences by having them restate the question in their responses. **It is highly recommended that students answer at least one question in writing and that some students share their writing as time allows.** You may wish to have students collect their written responses in their Space Notes notebooks or folders to reference throughout the domain as source material for longer writing pieces and as preparation for written responses in the Domain Assessment.

1.  *Inferential* [Show Image Card 2 (Sun).] What kind of celestial body is our sun? (a star) Explain why you would classify it that way. (It is very hot and made of gas—mostly hydrogen and helium gas; it constantly gives off vast amounts of heat and light.)
2.  *Evaluative* Compare and contrast our sun with other stars. (Our sun is a medium-sized, middle-aged, yellow star. Most stars are bigger, but some are smaller; many stars are hotter, and others not as hot as the sun; many stars are different colors; our sun is brighter than some stars and less bright than others; some stars are younger, and some are older than our sun. Our sun looks bigger and brighter than other stars because it is so much closer to us than other stars. Like our sun, most stars are part of a galaxy.)

3. *Inferential* How do the sun and other stars produce constant heat and light? (The atoms of hydrogen in the star fuse together to form helium; this fusion releases vast amounts of energy in the form of heat and light; this is a continuous process.)
4. *Literal* In the read-aloud today, you learned that even though all stars look like they are the same distance away, they are not. What do scientists use to measure the astronomical distances between stars and other celestial bodies? (the light-year) How far is a light-year? (One light-year is the distance light travels in one year; nearly six trillion miles.)
5.  *Inferential* [Show Poster 2 (A Galaxy Like the Milky Way).] What is the Milky Way? (It is the spiral galaxy of which our solar system is a part.) How did the Milky Way get its name? (The ancient Greeks and Romans thought that it looked like a milky band in the sky.)
6.  *Literal* What is a galaxy? (A galaxy is a very large collection or cluster of gas, dust, and stars, separated from other star systems by lots of space.)
7. *Literal* There are billions of galaxies in space. What is the name of the closest spiral galaxy to the Milky Way? (The closest spiral galaxy is the Andromeda Galaxy.)
8.  *Evaluative* Describe a spiral shape. What are other examples of things that have a spiral shape? (Answers may vary, but may include certain seashells, a spiral staircase, a metal spring, a snail shell, etc.)
9.  *Evaluative* What words and phrases would you use to describe the universe? (Answers may vary, but may include words and phrases like *vast*, *gigantic*, *astronomical*, *filled with stars*, *beyond the galaxy*, etc.) Do you think scientists could measure the entire universe? Why or why not? (Answers may vary, but may include the idea that the universe is a vast space that is larger than we can imagine or currently measure.)



10. *Evaluative What? Pair Share:* Asking questions after a read-aloud is one way to see how much everyone has learned. Think of a question you can ask your neighbor about the read-aloud that starts with the word *what*. For example, you could ask, “What was the most interesting thing you learned about galaxies?” Turn to your neighbor and ask your *what* question. Listen to your neighbor’s response. Then your neighbor will ask a new *what* question, and you will get a chance to respond. I will call on several of you to share your questions with the class.
11. After hearing today’s read-aloud and comprehension questions and answers, do you have any remaining questions?
  - You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.

### **Word Work: Irregular**

5 minutes

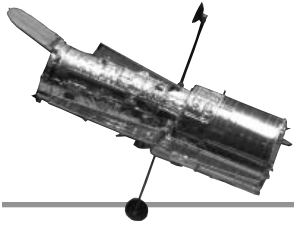
1. In the read-aloud you heard, “Some galaxies are spiral. Some galaxies are elliptical in shape. Still, other galaxies are *irregular* in shape, with no particular pattern.”
2. Say the word *irregular* with me.
3. Something that is irregular is uneven or not regular in shape, size, or a particular characteristic.
4. Martin noticed that the flow of water in the creek is irregular; sometimes the water is high and fast, and other times there is only a trickle.
5. Have you seen something that is irregular in one of its characteristics? Where did you see it? What characteristic was irregular? Be sure to use the word *irregular* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students’ responses to make complete sentences: “\_\_\_\_\_ was irregular because . . .”]
6. What’s the word we’ve been talking about? What part of speech is the word *irregular*?

Use a *Making Choices* activity for follow-up. Directions: I am going to describe an object or situation. If what I name is an example of something that is even and regular, say, “That is regular.” If what I name is an example of something that is uneven and irregular, say, “That is irregular.”

1. The surface of the wooden floor in the gymnasium is smooth and polished. (That is regular.)
2. The pavement in the old playground is full of cracks, lumps, and weeds growing through it. (That is irregular.)
3. My mother says it is important to have a healthy breakfast every day. (That is regular.)
4. [Show Poster 3 (Galaxy Shapes) and point to the bottom right image.] This galaxy has no particular shape or pattern to it. (That is irregular.)
5. The pile of play dough formed an odd, lumpy shape. (That is irregular.)
6. Verbs like *walk* and *jump* have the regular past tenses *walked* and *jumped*, but the past tense of *run* is *ran*. (That is irregular.)
7. The outside of the ball is smooth and even. (That is regular.)
8. The path of a roller coaster is surprising and unpredictable! (That is irregular.)



**Complete Remainder of the Lesson Later in the Day**



# Galaxies

4B

## Extensions

20 minutes

### KWL Chart

Using the KWL chart you created in Lesson 1, review briefly with students what they said they knew about outer space and astronomy. Ask students, if after hearing today's read-aloud there is anything they would like to change in the 'K' (Know) column.

**Note:** If there are any factual inaccuracies in the Know column that were addressed in today's read-aloud, prompt students to recognize and correct them.

Then, remind students of the 'W' (Wonder) column to see if they can find answers to some of their questions from today's read-aloud. Ask students if there is anything from today's read-aloud that they would like to add to this column. Finally, point to the 'L' (Learn) column. Ask students if there is anything from today's read-aloud that they would like to add to this column.

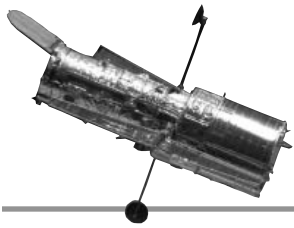
✈ You may wish to have some students create their own KWL charts and keep them in their Space Notes notebooks or folders.

### Space Address (Instructional Master 4B-1)

**Note:** A template is provided for this extension activity. However, you may wish to allow students to address a real envelope. You may also wish to allow some students to write a "space address" for their home address.

Tell students that today you will each be writing a "space address" like the one you have created together as a class. Display the class envelope with its "space address" for students to reference as they work. Remind students that each line should begin directly below the beginning of the previous line.

Tell students that they will design and draw the stamp on their "envelope." The drawing should be related to astronomy. You may wish to collect and display some examples of stamps that have images related to astronomy. Have students collect their work in their Space Notes notebooks or folders.



# Gravity

5

## Lesson Objectives

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### Core Content Objectives

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Students will:

- ✓ Classify the sun as a star
- ✓ Identify our planet Earth as the third planet from the sun
- ✓ Describe the sequence of the planets from the sun
- ✓ Identify and describe our solar system as the sun and all of the smaller bodies that orbit it, e.g., the planets, moons, asteroids, etc.
- ✓ Identify the Andromeda Galaxy as the closest spiral galaxy in our universe
- ✓ Describe gravity
- ✓ Describe the effects gravity has on Earth, within the solar system, and in the universe

### Language Arts Objectives

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The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ Determine the main idea of the text; describe the key details of the diagram and explain how they support the main idea (RI.3.2)
- ✓ Follow a sequenced set of directions to illustrate the forces involved in holding the moon in orbit around the earth (RI.3.3)
- ✓ Describe the relationship between two objects and the effects of gravity as presented in “Gravity” using language that pertains to cause/effect (RI.3.3)

- ✓ Interpret and describe diagrams related to celestial bodies and gravity and how they illustrate information conveyed by the words in “Gravity” (RI.3.7)
- ✓ Through hands-on exploration of materials, conduct research that builds knowledge about gravity (W.3.7)
- ✓ Make personal connections to the concepts of force, gravity, and friction as presented in “Gravity” through engagement in observation, discussion, and acting during demonstrations and hands-on activities (W.3.8)
- ✓ Determine the main idea illustrated in the images showing the effect of mass on the force of gravity (SL.3.2)
- ✓ Choose words and phrases to effectively describe the Milky Way Galaxy (L.3.3a)
- ✓ Use the known root *grav-* as a clue to the meaning of the word *gravitational* (L.3.4c)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial relationships, to describe the force of gravity and its effects, such as *orbit*, *atmosphere*, *gravitational pull*, *attraction*, *size*, *mass*, and *distance* (L.3.6)
- ✓ Draw a diagram that illustrates the effect of a large celestial body’s gravity on the movement of a smaller celestial body in orbit around it, as depicted in “Gravity”

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**attraction, n.** Something between two objects that draws them together  
*Example:* When Khara held the north and south poles of two magnets near each other, she could feel the attraction between them.  
*Variation(s):* attractions

**black hole, n.** An object or area in space that has such a strong gravity that not even light beams can escape its gravitational pull  
*Example:* Our sun is not massive enough to ever become a black hole.  
*Variation(s):* black holes


**force, n.** A pull or a push on an object or system  
*Example:* The force of gravity keeps us all firmly on Earth.  
*Variation(s):* forces

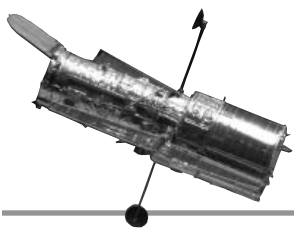
**gravitational pull, n.** The force that draws all objects in the universe toward each other  
*Example:* Spaceships require a lot of power to escape the gravitational pull of planet Earth.  
*Variation(s):* none

**gravity, n.** The force or pull created by the mass of objects that attracts them to one another  
*Example:* There is less gravity on the moon than on Earth, which is why astronauts on the moon seem to bounce when they walk.  
*Variation(s):* gravities

**matter, n.** The substances all objects on Earth are made of; all substances that take up space  
*Example:* Jesse was thrilled to learn that he is made up of the same matter as the stars.  
*Variation(s):* none

**tides, n.** The periodic or regular rise and fall of the surface of large bodies of water on Earth that are caused by the interaction of the moon’s gravity with Earth  
*Example:* Chin Ho enjoys reading about the ways seashore animals have adapted to the rising and falling of the ocean waves due to the tides.  
*Variation(s):* tide

<i>At a Glance</i>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>Observation and Inquiry</b>	feather or piece of paper; a ball or similar compact object	10
	<b>Purpose for Listening</b>		
<b><i>Presenting the Read-Aloud</i></b>	<b>Gravity</b>	Image Card 1	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>	Image Card 18	15
	<b>Word Work: Gravity</b>		5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>Gravity Experiment</b>	one piece of paper and one marble for each student	20
	<b>Gravity and Orbits</b>	drawing paper, drawing tools; chart paper, chalkboard, or whiteboard	



# Gravity

5<sub>A</sub>

## Introducing the Read-Aloud

10 minutes

### Observation and Inquiry

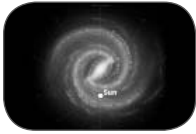
Explain to students that during this lesson they will be learning about some important forces. Ask students to describe what they think a force is. Guide students to understand that a force is a push or a pull on an object. Explain that most forces are invisible, but we can often see the result the force has on other objects. Ask students to share other examples of forces at work in their lives.

Tell students that you are going to throw an object straight up into the air. (Use an object that is not noticeably affected by friction, such as a ball or a whiteboard eraser.) Ask students to observe what happens and to think about the forces that have an effect on the object. Discuss with students the force of the person's arm in throwing, and the invisible force that seems to pull the object back down to the ground. (Some students may notice that there is a force when the object hits the ground.) Tell students that the reason an object thrown up into the air comes back down to the ground is the same reason why Earth and the other planets stay in orbit around the sun, and it is the same reason why all of the gas and dust and stars that exist in galaxies don't just disappear farther into space. Guide students to understand that this invisible force is called gravity.

Explain to students that you will throw another object (a feather or a piece of paper) up into the air that will help them understand another invisible force at work in our everyday lives—friction. Explain to students that friction is a force that resists or tries to stop motion. Ask students to observe and then describe how the friction of the air affects the movement of the object as the force of gravity pulls it back down. Guide students to understand that the force of friction acts to slow the motion of the object. Ask students to share other examples of the force of friction at work in their lives.

### Purpose for Listening

Tell students to listen to find out more about the force of gravity and how it keeps objects on Earth and keeps the planets in orbit around the sun.



**Gravity**

← **Show image 5A-1: Our location in the Milky Way Galaxy**

The last time we met, we talked about our amazing Milky Way Galaxy. I still have the incredible image of it in my head—a whirling spiral of dust and gas and the light of billions of stars. It is gigantic, and it is beautiful. Can you believe we live in it?

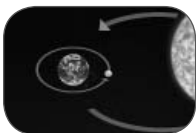
Let’s review what we have learned and seen so far. We live on planet Earth, which is part of a neighborhood called the solar system. <sup>1</sup> And the solar system has eight planets that orbit the sun. <sup>2</sup> And you remember how scientists classify the sun, right? <sup>3</sup> The sun and the solar system are in a galaxy called the Milky Way. And a galaxy is basically a vast cluster of celestial bodies in space that contains billions, or hundreds of billions, of stars, along with gas and dust. And there are billions of galaxies besides the Milky Way in the universe, each of which has billions of stars in it.

What exactly holds all of this stuff together in this huge universe? Why don’t all these stars and planets just go flying off in any direction all over the universe? Why do they stick together in groups and clusters like solar systems and galaxies? These are excellent questions, and the answer is . . . **gravity!**

← **Show image 5A-2: The moon orbiting Earth; Earth orbiting the sun**

Gravity is an invisible **force of attraction** between objects. It’s the force that holds galaxies and solar systems together. It’s the force that keeps us firmly planted on planet Earth instead of flying off into space. It’s the force that keeps Earth orbiting around the sun, and keeps the moon orbiting around Earth. Doesn’t gravity sound pretty powerful? It is, and it affects you and me all the time. You can’t see gravity or touch it, but gravity is present between everything in the universe that has mass. Because of gravity, every single bit of **matter** in the universe pulls on every other piece of matter in the universe.

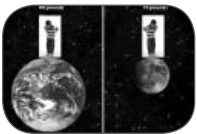
- 1 Who can point to the sun in this image of our galaxy?
- 2 Let’s name the planets together in order from the sun—Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune.
- 3 What kind of celestial body is our sun? (a star)





4 If gravity is a force of attraction between objects, what do think *gravitational pull* means?

5 [Show Image Card 1 (Earth's Atmosphere).] Who can point to the thin layer of Earth's atmosphere in this image? Less massive celestial bodies like our moon and Mercury don't have enough gravitational pull to keep gases from escaping into space. That is why they don't have an atmosphere.



6 Perhaps you have seen images of astronauts "bouncing" as they walk on the moon. This is because the moon has less pull on their bodies, and when they walk, the weaker pull of gravity changes their movements.

You and I exert a pull on each other, but because we have very little mass in our bodies compared to celestial bodies, our **gravitational pull** on each other is very small—so small we can't feel it at all.<sup>4</sup>

Gravity depends greatly on mass . . . so what exactly is mass? Mass is just the amount of matter in an object. You and I are small compared to, say, a planet, or a star. We're made of less "stuff," so our mass is much, much smaller. Mass is important when you are trying to understand gravity, because the larger the mass, the larger the gravitational pull. So objects with really large masses, like stars and planets, have a really big gravitational pull on other objects. And objects with really small masses, like you or me, have really small gravitational pulls on other objects—so small we don't even notice the pull at all. The more mass an object has, the more gravity, or pull, it is capable of. Because Earth has so much mass compared to all of the things that are on the surface of the Earth, its surface gravity keeps the things on Earth from flying off into space. You, your house, your bed, a ball you throw up into the air—all of these things stay on Earth due to gravity! Even the earth's atmosphere and the oxygen we breathe are held close to Earth by its gravitational pull!<sup>5</sup>

← **Show image 5A-3: Force of gravity on the moon compared to Earth**

Gravity also causes you to have weight when you stand on a scale! Earth's gravity pulls down on you. The more mass you have, the harder the pull, and the higher the numbers on the scale. Think about an astronaut who is standing on the moon. The astronaut stays on the surface of the moon because of the moon's gravity. If the astronaut stood on a scale on the moon, the astronaut's weight would be six times less than the weight of the same astronaut on a scale on Earth! So, a person who weighs sixty pounds on Earth would weigh only ten pounds on the moon—about the weight of a bag of flour—because the moon has less mass than Earth, and its force of gravity is not as strong.<sup>6</sup>

But the astronaut does not get pulled off the moon and back through space to Earth! Earth still has a larger mass than the moon, and it still has a larger gravitational pull than the moon. But because

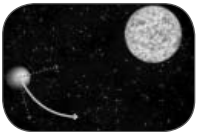
the astronaut is far away from Earth and very close to the moon, the gravitational pull of the moon has the most effect. It keeps the astronaut on the moon.



← **Show image 5A-4: Sun’s gravity is strong and distant**

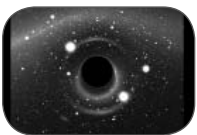
That’s the same reason we stay on Earth—and the moon stays in orbit around Earth—and don’t get pulled by the sun’s gravity out into space toward the sun. It’s another important thing to know about gravity—the *distance* between two objects affects the gravitational pull between them. Objects that are close to each other pull harder than objects that are farther away. The effect of an object’s gravitational pull lessens as you get farther away from it. The sun has a lot more mass than Earth does. But the sun is also a lot farther away, and because we are on the surface of Earth, Earth’s gravity has a much bigger effect on us, keeping us firmly on Earth—one of the many benefits of gravity!

The sun contains ninety-nine percent of all the mass in our solar system. Because the sun has more mass by far than anything else in the solar system, it also has more gravity than anything else in the solar system. The sun’s gravity—or force of attraction—is so strong that it constantly pulls the planets toward it.



← **Show image 5A-5: Forces holding a planet or moon in orbit**

You may be wondering why the planets don’t crash into the sun if the sun is pulling on them. Don’t worry; that never happens because the planets are also moving really fast in their own orbits around the sun. The combination of the planets’ own speed and the sun’s gravitational pull toward it is what keeps the planets constantly circling in orbit around the sun. It’s a perfect balance—the planets continue in their predictable movements around the sun.



← **Show image 5A-6: Emptiness of a black hole**

Sometimes gravity is so powerful that a **black hole** is formed—an object or area with an extremely strong gravitational pull. There are many black holes in space, and a black hole’s gravity is so strong that once something gets close enough, nothing can escape its gravitational pull—not even light! Astronomers find black holes in

7 Similarly, you can't see the wind, but you can see the effect the wind has on the objects that it blows around.

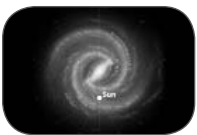


space by noticing the movement of objects around them. You can't see gravity, but you can observe the way the force of gravity affects objects.<sup>7</sup> Scientists are still learning about black holes, like many other things in outer space.

← **Show image 5A-7: The moon and the ocean's waves**

On a clear night we can often see the moon moving across our night sky. Have you ever been curious about why Earth has a moon? Many scientists think that about four and a half billion years ago there was a massive collision between Earth and a very large asteroid. The information they have gathered shows that the moon may have formed from the leftover debris from this amazing impact. Earth's gravity was able to hold the moon in its orbit. There is a strong gravitational pull between Earth and the moon.

The moon's gravity pulls on all of the things on the Earth—including people! But the Earth's gravity is strong enough to keep us on Earth. Phew! The moon's gravity also pulls on Earth's oceans, but the Earth's gravity pulls back—and it's a good thing it's stronger! The moon's gravity is just strong enough that it can move the water on Earth enough to cause **tides** in the oceans. Tides cause the regular rise and fall of the ocean's waters. People can see the effects of tides if they are at the seashore. High tides cause the waves to come high up on the beach, and when low tides occur, the waves don't come up as far. Low tide is a good time to walk the beach and look for shells and creatures that live in the sand.





← **Show image 5A-8: Our location in the Milky Way Galaxy**

So, yes, the powerful effects of gravity can explain a lot of interesting things in the universe—it's what holds our moon in orbit around Earth. It's what causes ocean tides on Earth day after day. Gravity is why we stay on Earth and why objects we throw into the air come back down. Gravity even helps create new stars and planets by helping pull together the gases and dust that form them. We can't see gravity, but we can see its effects all around us—on Earth, in our solar system, and throughout our galaxy!

### Comprehension Questions

15 minutes

If students have difficulty responding to questions, reread pertinent passages of the read-aloud and/or refer to specific images. If students give one-word answers and/or fail to use read-aloud or domain vocabulary in their responses, acknowledge correct responses by expanding the students' responses using richer and more complex language. Have students answer in complete sentences by having them restate the question in their responses. **It is highly recommended that students answer at least one question in writing and that some students share their writing as time allows.** You may wish to have students collect their written responses in their Space Notes notebooks or folders to reference throughout the domain as source material for longer writing pieces and as preparation for written responses in the Domain Assessment.

1. *Literal* Gravity is an important force that exists in the universe. What is a force? (A force is a push or pull on an object.)
2.  *Inferential* What is gravity? (It is a force of attraction that pulls between two objects.) Give an example that you heard in the read-aloud of how gravity acts as a force. (Answers may vary, but may include some of the following: objects fall back to Earth; the moon is held in orbit by Earth; the planets are held in orbit by the sun; people and objects stay on Earth.)
3. *Inferential* What are the two factors that affect how strong the gravity is between two objects? (One factor is the mass of the objects; the other factor is the distance between them.)
4. *Evaluative* [Show Image Card 18 (Gravity of the Sun vs. Gravity of Earth).] What is the main idea illustrated in this diagram? (Objects with larger masses exert more gravity on other objects than objects with smaller masses do.) What features of the diagram help demonstrate the main idea? (The thickness of the arrows shows how strong the gravity is; if the objects are similar in how packed together the atoms are, then the larger objects have more mass than the smaller ones.)
5.  *Evaluative* How are our everyday lives affected by the gravitational pull of Earth? (It holds objects to the ground; keeps the atmosphere on the planet so some heat is trapped, and we can breathe; keeps people and other objects from being thrown out into space; and causes ocean tides.)

6. *Evaluative* How are you affected by the gravitational pull of the sun? (The sun’s gravity holds Earth in its orbit around the sun. It keeps us at the right distance—a distance ideal for life to exist.)
7. *Evaluative* Why is there less gravity on some planets or heavenly celestial bodies than on others? (An object with less mass exerts less gravity on surrounding objects.) What happens when there is less gravity on a celestial body, such as the moon, than there is on Earth? (An object will weigh less on the body with less mass because it has less gravity; gases may escape into space; movement of humans will be different.)

I am going to ask a question. I will give you a minute to think about the question, and then I will ask you to turn to your neighbor and discuss the question. Finally, I will call on several of you to share what you discussed with your partner

8. *Evaluative Think Pair Share:* Think about one of your favorite activities. If Earth’s gravity were stronger, how would it change the activity? If Earth’s gravity were weaker, how would it change the activity? (Answers may vary.)
  9. After hearing today’s read-aloud and comprehension questions and answers, do you have any remaining questions?
- ✍ You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.

### Word Work: Gravity

5 minutes

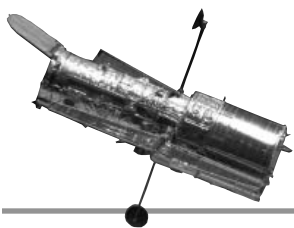
1. In the read-aloud you heard, “*Gravity* is an invisible force of attraction between objects,” and “The more mass an object has, the more *gravity*, or pull, it is capable of.”
2. Say the word *gravity* with me.
3. Gravity is a force created by the mass of an object that attracts another object to it. The amount of gravity created by an object depends on how much mass it has.
4. A celestial body like Earth has a lot of mass, so it exerts more gravity on other objects than a smaller body like the moon would.

5. What do you think it would be like to live on a planet that has less gravity than Earth? Would it be harder or easier to move around or jump? Be sure to use the word *gravity* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students' responses to make complete sentences: "If we lived on a planet with less gravity, it would be . . ."]
6. What's the word we've been talking about? What part of speech is the word *gravity*?

Use an *Acting and Sharing* activity for follow-up. Have students act out what it would be like to live on a planet with more gravity, or gravitational pull, than Earth. Then, have students act out what it would be like to live on a planet with less gravitational pull than Earth. Have students discuss what it would be like to jump, run, or even just stand up from their seats. Have students share their experience with a partner. As students share, make sure they use the word *gravity* in a complete sentence.



### **Complete Remainder of the Lesson Later in the Day**



# Gravity

5<sub>B</sub>

## Extensions

20 minutes

### Gravity Experiment

Tell students that they are going to perform an experiment to observe how the force of gravity affects different objects. Remind students that gravity is at work at this very moment. It is keeping them, their desks, and their chairs on the ground. Ask students to define gravity and describe some of the things it does in addition to keeping them on the ground. (Gravity is a force of attraction that brings two objects together; keeps the atmosphere on Earth; keeps the moon in orbit around Earth, and Earth and the other planets in orbit around the sun; etc.)

Give each student a piece of paper and a marble. Tell students that they are going to drop both of these objects from the same height at the same time to see which hits the ground first. Ask students to predict how gravity will affect each object.

Students will notice that the marble falls faster than the flat sheet of paper. Ask students to explain why this is. (Air friction slows the fall of the piece of paper; friction, in this case air friction, is a force that works against gravity.) Ask students what they can do to reduce the amount of friction on the paper. (Answers may vary, but may include: crumple it, drop the paper vertically, fold the paper, etc.) Have students test their ideas and repeat the experiment dropping both the marble and the paper several times.

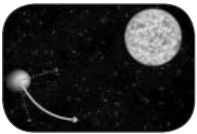
Ask students to describe what they notice about the fall of the two objects. (The crumpled paper and the marble should hit the ground at about the same time, though it is sometimes difficult to tell. The paper dropped vertically over a short distance should fall more quickly and encounter less resistance due to air friction. Folding the paper should also reduce the air resistance, especially if it is folded several times. Students may also find it difficult to release the two objects at exactly the same time. Encourage students to experiment with improving their technique.)

Explain to students that the earth’s gravity exerts the same force on all objects, no matter how much mass each object has. Explain also that it is friction that causes some items to fall more slowly than others. Guide students to understand that resistance due to friction can be reduced by changing an object’s shape or how it is dropped.

**Note:** You can think of gravity as exerting the same force on each atom of matter; an object with greater mass hits the ground with more force, but each atom is pulled by gravity at the same rate. You may further explain that in a vacuum, unlike in this experiment, there are no air particles to slow an object down. In a vacuum, two falling objects—despite their size or weight—will not be affected by air friction and will therefore fall at the same rate.

Finally, have students repeat the experiment with different objects in the classroom. Ask students whether they found other objects that were slowed down by air friction. You may wish to discuss how these objects are lighter and tend to have a bigger surface that is affected by the air friction as they fall.

**Note:** You may wish to have students record predictions and observations in their Space Notes notebooks or folder.



## Gravity and Orbits

### ← Show image 5A-5: Forces holding a planet or moon in orbit

Remind students that in the read-aloud today, they learned that gravity is what keeps objects with less mass orbiting around objects with more mass. Ask students to look at the example of Earth and the sun shown in the image. Ask, “In this example, which celestial body has the greater mass?” (the sun) “Which celestial body has the lesser mass?” (Earth)

Tell students that you will draw the diagram on chart paper, a chalkboard, or a whiteboard while each student creates the same diagram on a blank piece of paper. Instruct the students to turn the paper horizontally.

Start the diagram by drawing the sun. Ask students what they know about the gravity of the sun.

Draw Earth near the periphery of the paper. Ask students what they know about the gravity of Earth. Guide students to use domain vocabulary such as *orbit*, *gravity*, *gravitational pull*, and *force* to describe the diagram.



Draw the dotted arrow (shown in image 5A-5) that represents the gravitational pull between the sun and Earth. Remind students that the sun's gravitational pull on Earth is very strong.

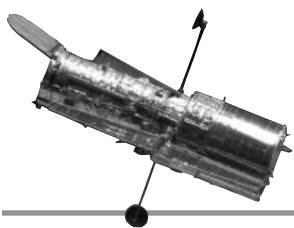
Draw the dotted arrow (shown in image 5A-5) that represents the direction Earth would be moving in space if it was not affected by the sun's gravity. Explain to students that if the sun and its gravitational pull were not there, the earth would travel in a straight path.

Draw the solid, curved arrow that represents Earth's orbit around the sun. Explain that the combination of both effects (the force of gravity plus the motion of Earth moving sideways to the sun) causes Earth to orbit the sun in a curved path.

Have students label the arrows as they are labeled in image 5A-5. Ask students to write one or two sentences below the diagram that explain the main idea of the diagram.

As time allows, you may wish to have students use the back side of their papers to draw a similar diagram illustrating the forces of gravity at work in the orbit of the moon around Earth.

Have students place their diagrams in their Space Notes notebooks or folders.



# Pausing Point 1

PP<sub>1</sub>

## **Note to Teacher**

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This is the halfway mark of the *Astronomy: Our Solar System and Beyond* domain. Students have studied the planets (their order and description), the force of gravity, and galaxies. It is highly recommended that you pause here and spend two days reviewing, reinforcing, or extending the material taught thus far.

You may have students do any combination of the activities listed below. The activities may be done in any order. You may wish to do one activity on successive days. You may also choose to do an activity with the whole class or with a small group of students who would benefit from the particular activity.

## **Core Content Up to This Pausing Point**

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Students will:

- ✓ Identify the sun as a constant source of heat and light energy
- ✓ Classify the sun as a star
- ✓ Identify our planet Earth as the third planet from the sun and ideally suited for life
- ✓ Demonstrate how day and night on Earth are caused by Earth's rotation
- ✓ Explain why the sun seems to rise in the east and set in the west
- ✓ Explain what happens during a solar eclipse and lunar eclipse
- ✓ Explain the reasons for seasons
- ✓ Describe the eight planets of our solar system and their sequence from the sun
- ✓ Identify our solar system as the sun and all of the smaller bodies that orbit it, e.g., the planets, moons, asteroids, etc.
- ✓ Describe the characteristics of a planet
- ✓ Explain that Pluto has been reclassified as a dwarf planet
- ✓ Describe the asteroid belt

- ✓ Compare and contrast asteroids, meteoroids, and comets
- ✓ Describe stars as hot, distant, and made of gas
- ✓ Compare and contrast our sun and other stars
- ✓ Describe a galaxy as a very large cluster of many stars
- ✓ Identify the Milky Way as our own galaxy and Andromeda as the closest spiral galaxy in our universe
- ✓ Describe the universe as a vast space that extends beyond the imagination
- ✓ Describe gravity
- ✓ Describe the effects gravity has on Earth, within the solar system, and in the universe

## Activities

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### The Solar System

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#### **Materials: Poster 1; chart paper, chalkboard, or whiteboard**

Using Poster 1 (Our Solar System), have students identify each of the planets in our solar system and sequence them starting with those closest to the sun. You may wish to have students draw an example of the solar system on chart paper, a chalkboard, or a whiteboard. You may also choose to have students create three-dimensional models/mobiles of the solar system. Be sure to encourage domain vocabulary as students create their artwork.

### Image Review

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Show the Flip Book images from any read-aloud again, and have students retell the read-aloud using the images.

### On Stage: Eclipses

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#### **Materials: Image Cards 16 and 17**

Ask students to define the terms *solar eclipse* and *lunar eclipse*. Have three student volunteers participate in acting out a solar eclipse. Ask students which celestial bodies, or natural objects seen in space, are involved in a solar eclipse. (the moon, Earth, the sun) Appoint each student to act as one of these three celestial bodies. Show students Image Card 16 before having the volunteers act out a solar eclipse. Have

student volunteers explain orally what happens during a solar eclipse using Image Card 16 (Diagram of a Solar Eclipse). (The moon passes between the sun and Earth and blocks the sunlight from reaching Earth.) Show Image Card 17 (Diagram of a Lunar Eclipse), and have three volunteers act out a lunar eclipse. Have student volunteers explain orally what happens during a lunar eclipse using Image Card 17. (Earth passes between the sun and the moon; it blocks the sun's light from reaching the moon; the moon is in Earth's shadow.)

## **Image Card Review**

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### **Materials: Image Cards 1–18**

In your hand, hold Image Cards 1–18 fanned out like a deck of cards. Ask a student to choose a card but to not show it to anyone else in the class. The student must then give a clue about the picture s/he is holding. For example, for Mars, a student may say, "I was named after the Roman god of war who was believed to be the father of Romulus and Remus." The rest of the class will guess what celestial body is being described. Proceed to another card when the correct answer has been given.



## **Domain-Related Trade Book or Student Choice**

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### **Materials: Trade book**

Read an additional trade book to review the solar system, galaxies, or gravity; refer to the books listed in the Introduction. You may also choose to have the students select a read-aloud to be heard again.

If students listen to a read-aloud a second time, you may wish to have them take notes about a particular topic. Be sure to guide them in this important method of gathering information. You may wish to model how to take notes, construct an outline, etc.

## **Key Vocabulary Brainstorming**

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### **Materials: Chart paper, chalkboard, or whiteboard**

Give students a key domain concept or vocabulary word such as *solar system*. Have them brainstorm everything that comes to mind when they hear the word, such as *the sun is the center of the solar system*, *the Earth is the third planet from the sun*, etc. Record their responses on chart paper, a chalkboard, or a whiteboard for reference.

You may also wish to have students do this brainstorming activity individually or with a partner.

## Multiple-Meaning Word Activity: Debris

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**Materials:** Chart paper, chalkboard, or whiteboard; various images depicting meanings of *debris* [da-BREE]

**Note:** You may wish to have students find, cut out, and mount pictures portraying the various meanings of the word *debris*—material from objects in space; leftover material from broken or destroyed things; and material that is thrown away.

1. In the read-aloud “Our Solar System, Part I” you heard, “Meteoroids are space debris made of rock or metal that range in size from tiny pebbles to large boulders.” Using the context of this sentence as a clue, who can tell me what the word *debris* means? [Pause for students to share.] Here *debris* means bits and pieces of leftover dust and rocks.
2. Say the word *debris* [da-BREE] with me.
3. *Debris* also means something else. It is what remains when something is broken down or destroyed, such as buildings, cars, or trees, as in this sentence: “Debris covered the road after the mudslide.”
4. A third meaning for *debris* is something that is discarded or thrown away, such as litter or garbage, such as in this sentence: “After the parade, there was debris scattered all over the sidewalks.”
5. [One at a time, hold up the variety of pictures that show the different meanings of the word *debris*. As you show each one, call on students to form complete sentences to share. Remind them to be as descriptive as possible. Record the sentences on chart paper, a chalkboard, or a whiteboard.]

## 10 Riddles for Core Content

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Ask students riddles such as the following to review core content:

- I provide all the heat and energy for the Earth. What am I? (the sun)
- I am the third planet from the sun. What am I? (Earth)
- I am made up of the sun, and all eight planets, including Earth, as well as other celestial bodies. What am I? (solar system)
- I am made up of stars, gas, and dust, and your solar system is a part of me. I am spiral shaped. What am I? (Milky Way Galaxy)

- I am the closest spiral galaxy to the Milky Way. What am I? (Andromeda Galaxy)
- I am a force of attraction that brings two objects together; I keep you on the surface of Earth. What am I? (gravity)
- I consist of thousands of asteroids that orbit the sun and lie between Mars and Jupiter. What am I? (the asteroid belt)
- I occur when Earth's shadow darkens the face of the moon. What am I? (a lunar eclipse)
- I have three different names, depending on where I am found. I am also known as a shooting star when I blaze through Earth's atmosphere. What am I? (a meteor, meteoroid, or meteorite)
- I orbit a planet. I can be natural, like the moon, or made by humans. What am I? (a satellite)

## 10 Sequencing the Planets

**Materials: Image Cards 2 and 3, 8–14; Image Cards 6 and 7, optional**

Provide the Image Cards of the sun, the planets, and the dwarf planets (optional). Allow the students to work together to place the image cards in their correct order of sequence from the sun. Once students have the images in the correct order, they can recite their names. You may wish to allow students to include the dwarf planets Ceres and Pluto in their sequence.

**Class Book: *Astronomy: Our Solar System and Beyond***

**Materials: Posters 1–4, drawing paper, drawing tools**

Tell the class or a group of students that they are going to make a class book to help them remember what they have learned thus far in this domain. Show students Posters 1–4. Have students brainstorm important information about our solar system, galaxies (specifically the Milky Way and Andromeda), the planets, and gravity. Have each student choose one idea to draw a picture of, and ask him or her to write a caption for the picture. Bind the pages to make a book to put in the class library for students to read again and again. You may choose to add more pages upon completion of the entire domain before binding the book.

### **Research Activity: The Sun; The Moon**

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Give students the opportunity to research the sun and/or moon, learning more about its makeup and special features. Some may wish to create a poster sharing what they learn. Allow students time to share their findings with a small group or with the class.

### **Research Activity: Asteroids, Meteoroids, or Comets**

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Some students may wish to research and learn more about one of these space objects or related topics, such as Halley's comet or other famous comets, the asteroid belt, or meteorite craters on Earth. Allow students time to share their findings with a small group or with the class.

### **Research Activity: The Mars Rovers**



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Give students the opportunity to research the Mars rover missions. They may wish to learn about the various rovers, past and current, and their challenges and discoveries. Some may wish to create a poster sharing what they learn. Allow students time to share their findings with a small group or with the class.

### **Writing Prompts**

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Students may be given an additional writing prompt such as the following:

- The most interesting thing I've learned thus far is \_\_\_\_\_ because . . .
- The sun is important to life on Earth because . . .
- The importance of gravity here on Earth (or in the solar system; in the galaxy) is . . .
- Imagine that space travel and technology have advanced enough that you could safely visit any planet you choose. Which one would you visit and why? Be sure to use characteristics of the planet when describing why you would want to visit it.
-  Imagine that you work for NASA and it is your job to protect Earth from a large shooting star. Describe how you would do this.
-  Choose a place in our solar system. Imagine that you are there and looking out into space. Use sentences with interesting words and phrases, as well as domain vocabulary, to describe what you see.

## **Astronomy Poetry**

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### **Materials: Chart paper, chalkboard, or whiteboard**

On chart paper, a chalkboard, or a whiteboard, have students brainstorm facts learned during this domain, and encourage students to describe the shapes and colors of objects in the universe. As you create a list of these objects, place students' descriptive words next to each corresponding object. Then, instruct students to reference this list to write poems about what they have learned about astronomy and space, using a variety of vocabulary. You may wish to model writing a poem for students.

## **Venn Diagram**


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### **Materials: Instructional Master PP1-1; chart paper, chalkboard, or whiteboard**

Tell students that together you are going to compare and contrast two things students have learned during *Astronomy: Our Solar System and Beyond* by asking how they are similar and how they are different. Use Instructional Master PP1-1 to list two things at the top of the diagram and then to capture information provided by students. Choose from the following list, or create a pair of your own:

- any two planets
- a planet and a dwarf planet
- an asteroid and a comet
- our solar system and the Milky Way Galaxy
- the sun and one of the planets
- Earth and its moon
- Earth and its “sister” planet, Venus
- the Milky Way Galaxy and the Andromeda Galaxy

You may wish to create several copies of the Venn diagram to compare and contrast several things. You may also wish to have students use these diagrams as brainstorming information for further writing.

-  You may wish to have some students use Instructional Master PP1-1 to complete this activity independently.



- ✈ You may wish to have some students create a three-way Venn diagram to compare and contrast three things, e.g., comets, asteroids, and meteoroids; three planets; Earth, our moon, and the sun; etc.

### **Spiral Search**

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**Materials: Magazines with a variety of photos and/or a collection of objects with spiral shapes; drawing paper; scissors; glue or tape**

Have students make a collage of photos or drawings of objects that are spiral in shape. You may wish to allow students to share or display their collages.

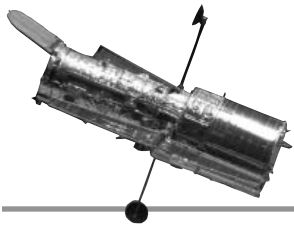
### **Earth's Rotation and Orbit**

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**Materials: Globe, large hoop or large ball**

Spin the globe to demonstrate how Earth rotates on its axis. Remind students that Earth not only spins on its axis but it also orbits the sun. Place a hula hoop or large ball on a table, and explain that the hula hoop represents the sun. Walk around the table with the large hoop or large ball while continuing to spin the globe. Explain that the Earth's elliptical path around the sun is what astronomers call Earth's orbit. Ask one or two students to walk around or "orbit" the hula hoop or ball. Make sure that students keep the tilt of the globe facing in the same direction (for example, pointed towards a particular door or window) as they orbit. Tell students that it takes Earth one year to travel all the way around the sun.

Explain to students that Earth is always orbiting the sun and at the same time rotating on its axis.



# Stars and Constellations

# 6

## ☑ **Lesson Objectives**

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### **Core Content Objectives**

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Students will:

- ✓ Describe the characteristics of stars
- ✓ Compare and contrast our sun and other stars
- ✓ Describe a galaxy as a very large cluster of many stars
- ✓ Identify the Milky Way as our own galaxy and Andromeda as the closest spiral galaxy in our universe
- ✓ Explain what constellations are and how they are useful
- ✓ Recognize and name important constellations in the hemisphere in which you live

### **Language Arts Objectives**

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The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ Recall the main idea presented in “Galaxies” by providing key details about galaxies (RI.3.2)
- ✓ Describe the sequence of steps used to find north using the star patterns the Big Dipper and the Little Dipper (RI.3.3)
- ✓ Describe the relationship between constellations observed long ago and today and the groups of people who used and continue to use them as a source of stories and to navigate, as presented in “Stars and Constellations” using language that pertains to time and sequence (RI.3.3)

- ✓ Determine the literal and nonliteral meanings of and appropriately use common sayings and phrases, such as “the naked eye” as used in “Stars and Constellations” (RI.3.4) (L.3.5a)
- ✓ Distinguish what parts of space are visible depending on one’s point of view (RI.3.6)
- ✓ Interpret images of star patterns in relation to the words in the read-aloud that describe particular stars (RI.3.7)
- ✓ Make personal connections to concepts presented in “Stars and Constellations” through engagement with a class KWL chart (W.3.8)
- ✓ Make personal connections to star patterns by looking for and describing constellation images and hearing related stories (W.3.8)
- ✓ Categorize and organize statements and questions about space through engagement with the KWL chart used in “Stars and Constellations” (W.3.8)
- ✓ Categorize information about star colors and temperatures by completing the graphic organizer (W.3.8)
- ✓ Choose words and phrases to describe a chosen constellation in an interesting and informative way (L.3.3a)
- ✓ Determine the meaning of a new word when a known affix is added to a known word, such as *cluster/clustered/clustering* (L.3.4b)
- ✓ Use the known root words *mass* and *orient* as a clue to the meaning of the unknown words with the same root, *massive* and *orienting* (L.3.4c)
- ✓ Use the newly learned Latin root words *canis*, *ursa*, *major*, and *minor* as clues to the common names of well-known constellations *Canis Major*, *Canis Minor*, *Ursa Major*, and *Ursa Minor* (L.3.4c)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial and temporal relationships, to describe stars and constellations, such as *astronomical distances*, *massive*, *light-year*, *hemisphere*, and *equator* (L.3.6)
- ✓ Create a drawing or diagram to illustrate the poem “Escape at Bedtime”

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**constellations, n.** Groups of stars in the sky thought to look like people, objects, or animals

*Example:* Theresa and her family enjoy looking for familiar constellations on dark nights when the sky is filled with stars.

*Variation(s):* constellation

**ladle, n.** A spoon or dipper with a long handle and a cup-like end used for serving liquids

*Example:* Jeremy’s family uses a ladle to serve the soup for dinner.

*Variation(s):* ladles

**magnetic, adj.** Exerting a strong attractive force

*Example:* The needle of a compass has an attraction to an invisible magnetic force around Earth.

*Variation(s):* none

**navigate, v.** To find one’s way

*Example:* With the bandana covering his eyes during the game, Joey had to navigate across the playground using his sense of hearing and the feel of the ground.

*Variation(s):* navigates, navigated, navigating

**orient, v.** To identify your position in relation to things around you

*Example:* When Marissa wakes up in the darkness of her bedroom, she has to orient herself to know where the door to her room is.

*Variation(s):* orients, oriented, orienting

**orienteering, n.** A modern sporting competition in which participants orient their movements by compass or GPS (Global Positioning System) to accomplish a set of goals


*Example:* Victor’s older brother is very skilled at orienteering and loves the challenge of using a compass to find his way around.

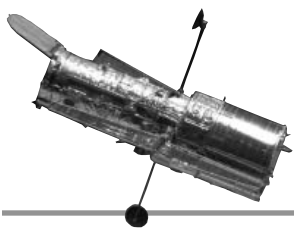
*Variation(s):* none

**Polaris, n.** The North Star; a bright star above the northern pole of Earth

*Example:* Travelers today, like explorers in the past, use Polaris to help them navigate.

*Variation(s):* none

<i>At a Glance</i>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>What Have We Already Learned?</b>	Posters 2–4	10
	<b>Essential Background Information or Terms</b>	Image Card 19	
	<b>Purpose for Listening</b>		
<b><i>Presenting the Read-Aloud</i></b>	<b>Stars and Constellations</b>	Image Cards 19, 20; globe	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>	Image Card 19	15
	<b>Word Work: Constellations</b>		5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>KWL Chart</b>		20
	<b>Poetry Reading</b>	drawing paper, drawing tools; images of constellations and star patterns (optional)	
<b><i>Take-Home Material</i></b>	<b>Family Letter</b>	Instructional Master 6B-1	



# Stars and Constellations

6<sub>A</sub>

## Introducing the Read-Aloud

10 minutes

### What Have We Already Learned?

Remind students that in an earlier read-aloud they learned about galaxies. Ask students to share what a galaxy is. (A galaxy is a large collection or cluster of stars, dust, and gas held together by a force called gravity and separated from other star systems by a vast amount of space.) Show students Poster 2 (A Galaxy Like the Milky Way). Ask students to name the galaxy in which our solar system is found and describe the shape of our galaxy. (Our solar system is in the Milky Way Galaxy; it is shaped like a giant spiral disk with arms. Most of the stars are found in the middle; some stars exist in the arms.) Remind students that we don't have an actual photograph of the whole Milky Way Galaxy because no human or man-made spacecraft has ever left our galaxy to take a picture of it.

Show students Poster 3 (Galaxy Shapes). Ask students what other shapes galaxies can have besides a spiral shape. (elliptical, irregular) Ask students to identify the shape of each of the galaxies pictured on the poster. Ask students to name the closest spiral galaxy to the Milky Way. (Andromeda)

Show Poster 4 (Distant Galaxies). Remind students that the universe is a vast space larger than we can imagine. Tell students that this image shows some of the billions of galaxies that exist in the universe. Tell students that the galaxies are various ages, sizes, shapes, and colors. Tell students that the smallest and reddest of the galaxies are some of the most distant galaxies for which we have images. Explain that the image was taken from space using the Hubble Telescope and that it took about half a year to capture enough light to make this image.

Remind students that they've learned that galaxies are large collections of stars and that the sun is our closest star. Tell students that today they will be learning more about some of the stars we see when we look out into our own night sky at the stars of our galaxy, the Milky Way.

## Essential Background Information or Terms

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Ask students if they have ever looked up at the stars in the night sky. Ask, “What do you notice about the stars? Do groups of stars resemble familiar objects or people? Are some brighter than others?” Show students Image Card 19 (Orion and His Hunting Dogs). Ask students if they see any shapes in this well-known group of stars, and allow students to share their ideas. Tell students they will learn more about this group of stars in the read-aloud.

Say to students: “Perhaps you have observed a very hot flame, maybe on a gas stove or a Bunsen burner, and noticed that different parts of the flame have different colors. The blue and white parts of the flame are much hotter than the yellow or red parts. This is the same for stars: blue and bluish-white stars are the hottest; white stars are very hot; yellow stars (like our sun) are medium hot; and red stars are the least hot.”

Tell students that this image has some interesting stars. Point out the large, white star, Sirius, and tell students that this is the very brightest star in our sky. Point to the reddish star and ask students if they have ever heard of the star Betelgeuse [*BEET-el-jooz*]. Tell students that this star is one of the brightest in our night sky because it is both very large *and* fairly close to us—in astronomical distances! Explain that Betelgeuse is red because it is not a very hot star anymore; Betelgeuse is a dying star that is starting to cool off. Tell students that astronomers predict that Betelgeuse will eventually explode and that it will be so hot and bright that we will be able to see it during the daytime. (Explain that stars become hotter again once they die and explode or implode.)

Point out the bluish-white star. Tell students that this star is called Rigel [*RYE-jel*] and that it, too, is a very big star. Explain that because of its size and very hot temperature, it is one of our sky’s brightest stars. Tell students that the blue star Bellatrix is one of the very hottest stars.

## Purpose for Listening

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Tell students to listen closely to learn more about the colors of stars and why some stars look brighter than others, and to learn what we call the shapes that groups of stars appear to make in the night sky.



## Stars and Constellations

### ← Show image 6A-1: Earth and our star, the sun

It's time for us to head back home to planet Earth. From our home, we can see glimpses of space by looking up into the sky. After our journey, perhaps you won't see the stars as just little twinkling lights in the sky anymore. Now you know they are like our sun, the star that is the center of our solar system. You know that up close, stars are really massive powerhouses of super-hot gas.<sup>1</sup>

1 If *mass* is the amount of matter in an object, what does it mean for a star to be *massive*?



### ← Show image 6A-2: Looking up at the night sky

The next time you stand looking up into the night sky, perhaps you will study the stars in a new way. They all look about the same size from where you stand on Earth, but you know they're not. They are different sizes. Some are brighter than others, and some are hotter than others. Maybe you once thought the stars in the sky were pretty close together, but after taking a ride in our special classroom spaceship, you remember that even though stars look close together in the sky, they are really very, very, very far apart. It's true that stars cluster together to form galaxies. Even when they are clustered together, most stars are still incredibly far apart from other stars in the same galaxy. And they are even farther apart from the stars of *other* galaxies. There's a lot of space in space!



### ← Show image 6A-3: The Andromeda Galaxy

Look up at the sky and try to count the stars. There are a lot of them! On a clear evening, depending on where you are, you can see many of the two thousand or so stars that can be seen from Earth with the naked eye. All the stars you see are in our own Milky Way Galaxy. You can't see individual stars from other galaxies without the use of a telescope. But, looking between the stars of our galaxy, you may be able to see the distant Andromeda Galaxy if it's a very dark night and you know just where to look.<sup>2</sup>

2 Who can tell me something about the Andromeda Galaxy that you learned earlier? (Andromeda is the closest spiral galaxy to the Milky Way; it is spiral-shaped; it is very far away; not a lot is known about it; it is also known as M31; etc.)



For thousands and thousands and thousands of years, people have been looking up at the night sky—just like you. Human beings have tried to understand the location of the stars and predict their positions each night in the sky. In the grand scheme of the universe, it is human nature for us to try to understand why things are the way they are and where we fit in.



← **Show image 6A-4: Night sky showing constellations**

Since ancient times, people have grouped the stars into patterns called **constellations**. Ancient civilizations saw these constellations as figures of people, animals, and objects. They played “connect the dots” with the stars by drawing imaginary lines between them to form pictures in the sky.<sup>3</sup> These pictures often told familiar mythological stories about heroes like the Greek hunter, Orion, who stands ready with his shield to fight a bull. They were about mythological animals like Pegasus, the beautiful winged horse. And they were about animals such as Canis Major and Canis Minor. *Canis* means dog in Latin and *major* means greater.<sup>4</sup> If Canis Major is commonly known as the Great Dog, it’s easy to see who might be following behind.<sup>5</sup> In the stories about Orion the great hunter, these two constellations are Orion’s faithful hunting dogs, forever following at the heels of their master as they move through the night sky.<sup>6</sup> The very brightest star in our sky, Sirius [*SEER-ee- us*], is in the constellation Canis Major and is often called the Dog Star.<sup>7</sup> Sirius is a very large star compared to our sun and one of the closest stars to our solar system—*only* a little over eight and a half light-years away!

People who live in Earth’s Northern Hemisphere see a different set of constellations than people in Earth’s Southern Hemisphere do.<sup>8</sup> Those constellations above Earth’s North Pole can only be seen by people in the Northern Hemisphere. Those above Earth’s South Pole can only be seen by people in the Southern Hemisphere. However, the constellations above the Earth’s equator can be seen from both hemispheres. Maybe someday you’ll cross the equator, travel to another part of the world, and experience the constellations of the night sky from another point of view!

- 3 What constellations do you know? (Answers may vary, but students who participated in the Core Knowledge Language Arts program in Grade 1 may be familiar with Scorpio and Taurus.) [Point to and name the constellations in the image.]
- 4 What do you think Canis Major means? (Greater Dog)
- 5 What would another name for Canis Minor be? (Lesser Dog or the Little Dog)
- 6 [Show Image Card 19 (Orion and His Hunting Dogs). Point to the stars as you read.] Here is reddish Betelgeuse which forms Orion’s right shoulder, and bluish-white Rigel which forms Orion’s left foot. This bluish star in Orion’s left shoulder is Bellatrix [*BEL-la-trix*], a very hot young star.
- 7 Who remembers the other name for Canis Major? (Greater Dog) [Point to Sirius on the Image Card.]
- 8 [On a globe, have a student point to the Northern Hemisphere, the Southern Hemisphere, and the equator.]



## ← Show image 6A-5: Polaris and the Big and Little Dippers

9 [Show Image Card 20 (Stars Circling Polaris).] This time-lapse photograph is taken over a period of time during a dark night. Can someone point to the part of the sky around which all the other stars circle?

10 To orient by the stars means to use your knowledge of the stars to determine which directions are north, south, east, and west.

11 *Ursa Minor* is Latin for “Smaller Bear”; we commonly call them the “Great Bear” and the “Little Bear.” Who can point to the Little Dipper and the Big Dipper in the image?

Since ancient times, people have noticed that the stars in the sky and the familiar constellations move in a predictable and interesting way. All of the stars in the sky move in a circular pattern around one point.<sup>9</sup> In the Northern Hemisphere, the half of planet Earth north of the equator, there is a star located very near that point in the sky that we call the North Star, or **Polaris** [poh-LAIR-is]. Even though all the rest of the stars in the sky change their positions throughout the night, the North Star is always located almost directly north.

Knowing this has helped sailors and travelers in the Northern Hemisphere for thousands of years to **orient** themselves.<sup>10</sup> Long before modern navigational tools like compasses and GPS were invented, sailors relied on the star Polaris. Technology has advanced a great deal since those days, so much so that some people like to participate in a modern sporting competition known as **orienteering** where they use **magnetic** compasses and GPS to orient themselves and accomplish a task or goal. You might remember from an earlier lesson that the earth has a North Pole and a South Pole. These poles act like a magnet. A magnetic compass works because of the earth’s magnetic field. A GPS is a modern device that uses man-made satellites orbiting the earth to find and tell your position on Earth.

Two patterns of stars you may already be familiar with that are visible in the Northern Hemisphere are the Big Dipper and the Little Dipper. Each one looks like a **ladle** in the sky. The Big Dipper and the Little Dipper are not the official names of the constellations themselves, but are part of two very famous larger constellations. The Big Dipper is a group of stars that is part of the constellation *Ursa Major*, which means “Greater Bear” in Latin. The Little Dipper is a smaller group of stars that is part of the constellation *Ursa Minor*.<sup>11</sup>

Suppose it is a dark, starry night and you are trying to find your way through the countryside. You can look up into the night sky and find the Little Dipper. The last star on its handle is the brightest

12 What is this star's other name? (the North Star) Who can point to this star in the image?

13 [You may also wish to refer to the mnemonic reviewed in *The Viking Age* for clockwise directions: "Never Eat Soggy Waffles."]

14 [Now or in the Pausing Point, you may wish to have students identify which direction is north from your classroom, and then label north, south, east, and west on the walls.]

15 [Ask a volunteer to point to the stars in the image as you read the following two sentences.]

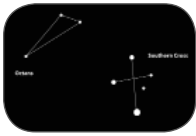
16 These two stars are called the "Pointer Stars."

17 Who remembers who Zeus was? (king of the Greek gods)

star in the constellation. You just heard about this star, named Polaris.<sup>12</sup> It is called Polaris because it is almost directly above the Earth's North Pole. Once you find Polaris, you can find north simply by facing this star. When you are facing north, your back is to the south. Your right side is to the east, and your left side is to the west.<sup>13</sup> Now all you have to do is decide which direction to go!<sup>14</sup>

Sometimes the Big Dipper is easier to see than the Little Dipper. You can also use the Big Dipper to find the North Star.<sup>15</sup> Just line up the two stars opposite the handle of the Big Dipper's bowl and draw a line through them. The line points up out of the bowl of the Big Dipper right to the North Star on the tip of the Little Dipper's handle!<sup>16</sup> And if you've got the North Star—Polaris—to point you in the right direction, who needs a GPS? People have been using the stars to **navigate**, or find their way, for thousands of years. People who live in the Northern Hemisphere today can still see these and other constellations when they look up in the sky at night. The runaway slaves before the time of the U.S. Civil War saw the ladle in the sky and sang a song telling them to "follow the drinking gourd" north to freedom.

Throughout history, people in different cultures have looked up at the Big Dipper and have seen other pictures besides the famous water dipper. In one Greek myth, or story, about Ursa Major, the jealous goddess Hera, wife of Zeus, turns a maiden named Callisto into a bear.<sup>17</sup> Then, to protect Callisto the Bear, Zeus placed her in the sky as a constellation. An Arabian myth describes a coffin that is followed by three mourners. One Native American group saw a bear being followed by three hunters, one of them carrying the pan in which to cook the bear meat. The Norse people of northern Europe saw Odin's wagon.



← **Show image 6A-6: Constellations of the Southern Hemisphere skies**

18 [Use a globe and show how people who live in countries south of the equator would look out into a different part of the sky than people in countries north of the equator. You may wish to ask students to point on the globe to the countries named.]

19 Why do you think ancient people may have pictured an octant in this part of the sky? (Both the constellation and the tool were used to help travelers navigate.)

20 [Point to these constellations in the image.]



21 Let's practice naming them together. [Point to each constellation as you read the name.]

But what do you see if you live in the Southern Hemisphere? People who live south of the equator in places like Chile, South Africa, and Australia see a different set of constellations than people in the Northern Hemisphere in places like the United States, Canada, Norway, Turkey, and China. On the other side of the world, as they rotate around the South Pole, people look out into the stars of the Milky Way Galaxy from a different direction than people north of the equator do.<sup>18</sup> You might be surprised to learn that there is no star directly over the South Pole! There is *no* South Star around which the rest of the stars circle. But there is a small constellation—named Octans—very close by which circles around the spot where a South Star would be, if it was there! Octans resembles an octant, an early instrument used for navigation.<sup>19</sup> Not too far away is another constellation familiar to stargazers in the Southern Hemisphere—the Southern Cross.<sup>20</sup>

← **Show image 6A-7: Night sky showing constellations**

How many of these constellations have you seen in the night sky?<sup>21</sup> The constellations you've heard about today are just a few of the eighty-eight constellations astronomers have identified in Earth's skies. Next time you have a chance to enjoy a dark starlit night, gaze up into the sky and see if you can find some familiar constellations. If not, have some fun and make up some constellations and stories of your own.

Maybe someday you'll cross the equator, travel to another part of the world, and experience the constellations of the night sky from another point of view!

## Comprehension Questions

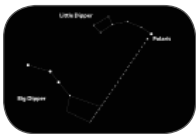
15 minutes



1. *Literal* What is a constellation? (It is a group of stars in the night sky that appears to form a picture of an object, animal, or person; constellations often have stories that explain how they came to be in the sky.)


← **Show image 6A- 4: Night sky showing constellations**

2. *Literal* [Show Image Card 19 (Orion and His Hunting Dogs).] What are some of the constellations and star patterns you heard about in the read-aloud? (Orion, Canis Major—Big Dog, Canis Minor—Little Dog, Big Dipper, Little Dipper, Pegasus, Ursa Major—Great Bear, Ursa Minor—Little Bear, Octans, the Southern Cross)
3. *Evaluative* Choose one of the constellations in the images to describe, using interesting and descriptive words and phrases. (Answers may vary depending upon the constellation chosen.)



← **Show image 6A- 5: Polaris and the Big and Little Dippers**



4. *Literal* What do we call the star in the Northern Hemisphere that never seems to move? (Polaris, the North Star) Why is it called the North Star? (It is always found in the north.)
5. *Literal* Which important star patterns that circle closely around the star Polaris are known by many today as a pair of ladles? (The Big Dipper and the Little Dipper are ladles.)
6. *Evaluative* How does your point of view on Earth affect what you see in the sky? (People in different hemispheres or parts of the world look out into space from different angles and see different constellations during the various seasons.)
7. *Evaluative* We know that the sun is a star and appears very bright to us. Why is the sun not a part of any constellation that we see in the night sky? (The sun is too bright for us to be able to see other stars in the sky at the same time; when we are looking at the stars of the night sky, the sun is on the other side of planet Earth.)
8. *Inferential* What are some of the characteristics of stars that you heard about in this read-aloud? (Stars have different colors depending on how hot they are; stars are at different distances from Earth; some stars appear brighter than others depending on their size and distance from Earth.)

9.  *Evaluative* What is the difference described in the read-aloud among blue, white, red, and yellow stars? (Blue stars are the hottest, white stars are very hot, yellow stars are medium hot, and red stars are the least hot.) What does this information tell us about our sun in comparison to other stars? (Because our sun is a yellow star, it is a medium-hot star; some stars are hotter, and some are not as hot as our sun.)
10. *Evaluative* What is the difference between the verb *orient* and the activity called *orienteering*? (To orient is to determine one's position or location in comparison to other things; orienteering is a sports activity/competition in which participants use a magnetic compass or GPS to find their way and accomplish a set of goals.) How are *orient* and *orienteering* similar? (Orienteering requires a person to orient to a location.)

I am going to ask a question. I will give you a minute to think about the question, and then I will ask you to turn to your neighbor and discuss the question. Finally, I will call on several of you to share what you discussed with your partner.



← **Show image 6A-5: Polaris and the Big and Little Dippers**

11.  *Evaluative Think Pair Share:* Explorers and travelers have long used the stars to orient themselves, or to find out in which direction they are traveling. For example, people in the Southern Hemisphere use the Southern Cross to help guide them. Explain the sequence of steps people in the Northern Hemisphere use to find north with the help of the stars. (First, find the Big Dipper because it is easy to see. Locate the two stars on the right side of the dipper. These are called the pointer stars; follow them upward until you reach a star. This is the end of the handle of the Little Dipper and it is also the North Star or Polaris. It is always in the north.)
12. After hearing today's read-aloud and comprehension questions and answers, do you have any remaining questions?
  -  You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.

## Word Work: Constellations

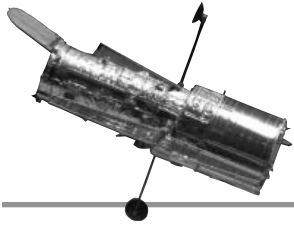
5 minutes

1. In the read-aloud you heard, “Since ancient times, people have grouped the stars into patterns called *constellations*.”
2. Say the word *constellations* with me.
3. Constellations are groups of stars that appear to make a picture of an animal, person, or object.
4. It is easy to pick out constellations like Orion and star patterns like the Big Dipper, especially when there are no clouds or light pollution in the sky.
5. Which constellations did you hear about today that you found most interesting and why? Be sure to use the word *constellations* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students’ responses to make complete sentences: “The constellations I found the most interesting were \_\_\_\_\_ because . . .”]
6. What’s the word we’ve been talking about? What part of speech is the word *constellations*?

Use a *Discussing* activity for follow-up. Ask students, “Do you think constellations looked the same two hundred years ago? Do you think they will look the same two hundred years from now?” Tell students, “I will give you a few minutes to discuss the question with your partner, and then I will call on one or two of you to share your partner’s comments with the class. Be sure to use the word *constellations* in a complete sentence when you share.”



**Complete Remainder of the Lesson Later in the Day**



# Stars and Constellations

# 6<sub>B</sub>

## Extensions

20 minutes

### KWL Chart

Using the KWL chart you created in Lesson 1, review briefly with students what they said they knew about outer space and astronomy. Ask students if after hearing today's read-aloud, there is anything they would like to change in the 'K' (Know) column.

**Note:** If there are any factual inaccuracies in the Know column that were addressed in today's read-aloud, prompt students to recognize and correct them.

Then, remind students of the 'W' (Wonder) column to see if they can find answers to some of their questions from today's read-aloud and the last read-aloud about gravity. Ask students if there is anything from today's read-aloud that they would like to add to this column. Finally, point to the 'L' (Learn) column. Ask students if there is anything from today's read-aloud that they would like to add to this column.

**Note:** This is the last lesson in which the KWL chart is included as an extension. If you have time, you may wish to continue using it in Lessons 7–10. Additionally, you may wish to allow students to research to find the answers to any remaining questions in the 'W' column. You may wish to review the KWL chart at the end of the domain.

➤ You may also wish to have some students continue to update their own KWL charts and keep them in their Space Notes notebooks or folders.

### Poetry Reading

Tell students that people are often inspired by the stars and constellations of the night sky to write poetry. Tell students they are going to hear a poem titled "Escape at Bedtime" written by Robert Louis Stevenson in the 1800s. Explain that the poem is about a child looking out the window at bedtime and marveling at the stars of the night sky. Tell students to listen for the comparisons the poet makes about the number of stars in the sky, and to listen for the names of the celestial



bodies and star patterns that the child recognizes. You may wish to read the poem a second time after discussion.

**Note:** Students may have heard Robert Louis Stevenson’s poem “Bed in Summer” in the Grade 2 *Cycles in Nature* domain. You may wish to share that Stevenson is the author of several classics, including *Treasure Island*.

*Escape at Bedtime*  
by Robert Louis Stevenson

*The lights from the parlour and kitchen shone out  
Through the blinds and the windows and bars;  
And high overhead and all moving about,  
There were thousands of millions of stars.  
There ne’er were such thousands of leaves on a tree  
Nor of people in church or the Park,  
As the crowds of the stars that looked down upon me,  
And that glittered and winked in the dark.*

*The Dog, and the Plough, and the Hunter, and all,  
And the star of the sailor, and Mars,  
These shone in the sky, and the pail by the wall  
Would be half full of water and stars.  
They saw me at last, and they chased me with cries,  
And they soon had me packed into bed;  
But the glory kept shining and bright in my eyes,  
And the stars going round in my head.*

After reading the poem, ask students what the poet compares the number of stars in the night sky with on Earth. (leaves on a tree, people in church or the park) Ask students if they think these are good comparisons for the number of stars in the sky. Ask students to share other ideas they may have about what would make a good comparison.

Ask students what star patterns and celestial bodies are mentioned in the poem. Ask students if they recognize them, and what other names we may know them as. Share with students that the Dog is probably the constellation Canis Major. Ask students if they remember the name for the constellation of the smaller dog (Canis Minor) and the name of the Dog Star. (Sirius) Share with students that the Plough is what we commonly call the Big Dipper, and the Hunter is the constellation we know as Orion. Guide students to name and understand that the star of the sailor would be the North Star. Ask students if they remember the other name for the North Star. (Polaris) Ask students what planet is mentioned in the poem. (Mars)

Reread these lines from the poem, “. . . and the pail by the wall / Would be half full / of water and stars.” Ask students if they know what a pail is and why it would be full of stars.

Tell students that you are going to read the poem again. Ask students to listen for words and phrases that tell how the child feels while looking up at the night sky. Discuss the words and phrases the students share.

Allow students time to illustrate the poem “Escape at Bedtime” and provide a caption. You may wish to provide images of the star patterns so that students may refer to them as they illustrate the stars in the night sky. Have students share their drawings and captions. Students may save their drawings in their Space Notes folder.

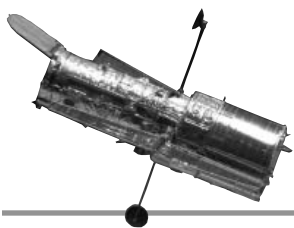
## ***Take-Home Material***

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### **Family Letter**

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Send home Instructional Master 6B-1.



# The Big Bang

7

## Lesson Objectives

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### Core Content Objectives

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Students will:

- ✓ Classify the sun as a star
- ✓ Describe the sequence of the eight planets from the sun
- ✓ Describe stars as hot, distant, and made of gas
- ✓ Describe a galaxy as a very large cluster of many stars
- ✓ Identify the Milky Way as our own galaxy and Andromeda as the closest spiral galaxy in our universe
- ✓ Describe the universe as a vast space that extends beyond the imagination
- ✓ Describe the effects gravity has on Earth, within the solar system, and in the universe
- ✓ Describe tools and methods used to study space and share information
- ✓ Identify and use vocabulary important to the process of science
- ✓ Explain the Big Bang Theory as an important scientific theory of the origin of the universe

### Language Arts Objectives

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The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ Sequence the names of the eight planets in order of their position from the sun (RI.3.3)

- ✓ Describe the formation of the universe as explained by the scientific theory presented in “The Big Bang,” using language that pertains to the vast amounts of time and distance that are part of the sequence of events (RI.3.3)
- ✓ Describe the relationship between a guess and a theory as presented in “The Big Bang,” using language that pertains to cause/effect, such as *prediction, theory, evidence, observation, and data* (RI.3.3)
- ✓ Distinguish events that happened long ago in the universe from more recent events such as scientific prediction of the Big Bang, observation, and gathering of evidence (RI.3.3)
- ✓ Interpret and describe the three important pieces of evidence conveyed in the images that support the Big Bang Theory (RI.3.7)
- ✓ Describe the logical connections between sentences by identifying particular words and phrases that provide clues to the correct sequence of events in the Big Bang Theory of the formation of the universe (RI.3.8)
- ✓ Sequence sentences that describe the timeline steps of the formation of the universe as described in “The Big Bang” (RI.3.8)
- ✓ Through observation of an expanding balloon demonstrated by the teacher, conduct research that builds conceptual understanding of the expansion of the universe (W.3.7)
- ✓ Make personal connections to the word *expanding*, in order to build understanding of how the universe is expanding (W.3.8)
- ✓ Categorize statements about stars and galaxies as true or false (W.3.8)
- ✓ Make predictions prior to the expanding balloon demonstration, based on the images and text heard thus far, and then compare the actual outcome to predictions (SL.3.1a)
- ✓ Summarize the facts of the three major groups of evidence that predict the Big Bang Theory, as presented by the text and images of “The Big Bang” (SL.3.4)
- ✓ Choose words and phrases to effectively describe the vast amounts of time, distance, and size involved in the formation of the universe (L.3.3a)
- ✓ Determine the meaning of a new word when a known affix is added to a known word, such as *expand/expanded/expanding/expansion* (L.3.4b)

- ✓ Provide synonyms and antonyms for the word *compressed* (L.3.5b)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial and temporal relationships, to describe the events of the Big Bang, such as *compressed, expanding, tiny speck, vast distances, universe, and beyond imagination* (L.3.6)
- ✓ Create a drawing to illustrate the word *expanding*

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**Big Bang, *n.*** A scientific theory of how the universe began  
*Example:* The Big Bang Theory is based on a great deal of scientific observation, facts, and discussion.  
*Variation(s):* none

**compressed, *v.*** Pressed together into less space  
*Example:* Tonya explained that when she pumps up her basketball, there is more air compressed inside the ball that makes the ball bounce better.  
*Variation(s):* compress, compresses, compressing

**data, *n.*** Facts or pieces of information that have been collected, often in the form of measurements  
*Example:* Sam’s math class recorded their data as they used meter sticks to measure various objects in their classroom.  
*Variation(s):* datum

**elements, *n.*** The basic substances found on Earth and in the universe, each made of only one kind of atom  
*Example:* Hydrogen is the most plentiful of all elements in the universe.  
*Variation(s):* element

**evidence, *n.*** Something that makes a statement clear and believable  
*Example:* Violet’s dad said he needed to see evidence that she could take good care of the family cat before he would get her a new puppy.  
*Variation(s):* none

**expanding, v.** Becoming larger; increasing in area; spreading out  
*Example:* As Leroy blew air into the balloon, we watched in amazement as it kept expanding.

*Variation(s):* expand, expands, expanded


**phenomenon, n.** An interesting fact or event that can be studied  
*Example:* Cheng’s class was fascinated to learn about the phenomenon of a solar eclipse.

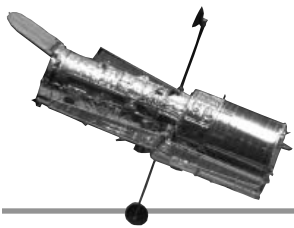
*Variation(s):* phenomena

**theories, n.** Suggested or widely accepted explanations for why things in the world happen

*Example:* Scientific theories are explanations about why things in the world happen based on a lot of experiments, observations, and data.

*Variation(s):* theory

<i>At a Glance</i>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>What Have We Already Learned?</b>		10
	<b>Essential Background Information or Terms</b>		
	<b>Purpose for Listening</b>		
<b><i>Presenting the Read-Aloud</i></b>	<b>The Big Bang</b>	Image Card 21	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>		15
	<b>Word Work: Expanding</b>	drawing paper, drawing tools	5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>Big Bang Balloon</b>	balloon; permanent marker; chart paper, chalkboard, or whiteboard	20
	<b>Sequencing the Big Bang</b>	Instructional Master 7B-1	



# The Big Bang

7A

## Introducing the Read-Aloud

10 minutes

### 10 What Have We Already Learned?

Remind students that in the last lesson and in an earlier read-aloud they learned about stars, galaxies, and constellations. Tell students that you are going to read some statements to review what they have learned. Explain that if students think the statement is a true statement they should stand up, and if they think the statement is a false statement they should stay seated. Tell students that if they think the statement is false to raise a hand to tell why it is false.

1. A star is a star: all stars are the same. (false—All stars are not the same; they are different in age, color, temperature, size, and brightness.)
2. Reddish stars like Betelgeuse are not as hot as bluish stars like Rigel. (true)
3. Our galaxy, the Milky Way, is irregular in shape. (false—The Milky Way is a spiral galaxy.)
4. Our sun is a yellow, medium-size, medium-age star. (true)
5. Galaxies are clusters of billions of stars. (true)
6. Another name for the North Star is Sirius. (false—Polaris is another name. We call Sirius the Dog Star.)
7. Stars contain a lot more mass than planet Earth. (true)

Remind students that the universe contains billions of galaxies and extends to vast distances beyond the imagination.

### Essential Background Information or Terms

Tell students that for thousands of years, people have had beliefs and have told stories about how the universe began. Explain to students that in today's read-aloud they will hear one theory about how the universe began, the Big Bang Theory. Explain to students that a theory is an idea or explanation that people have for how something came to be. Share

with students that the Big Bang Theory is a modern theory based on a great deal of evidence—observations, measurements, thinking, and discussion by scientists. Ask students what they think the Big Bang Theory might be based on its name.

Explain to students that as with all theories, scientists continue to examine this theory and will continue to change it as they gain more evidence and information.

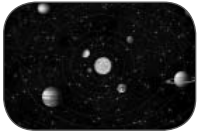
**Note:** You may wish to share that as with all theories, not everyone believes that the Big Bang Theory explains how the universe began. However, nearly all astronomers support the Big Bang Theory.

### **Purpose for Listening**

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Tell students to listen to see what they can learn about the Big Bang Theory.





## The Big Bang

### ← Show image 7A-1: Our solar system

1 Who remembers what matter is?

2 What things do you picture?  
[Pause for students to share.]

3 Who can name the eight planets of the solar system in order from the sun? Between which two planets is the asteroid belt? (Mars and Jupiter)

We've been talking a lot about the universe these last few days. But what exactly is "the universe"? The universe is everything that exists—all matter, all energy, and all the space between things.<sup>1</sup> Look around you—look at the room you are in, at the people who are around you, even at the air you breathe. (It's there, though it's kind of hard to see.) Think about your school, your neighborhood, your community, your state, and your country. Picture the whole Earth in your mind.<sup>2</sup> Picture all of the oceans and mountains, animals and plants, and rocks and water—all of the things that you have ever heard about or seen on the Earth! All these things are part of the universe. But the universe is much bigger than all of these things on Earth.

The sun, the eight planets in our solar system that orbit the sun, and the huge distances between them are all part of the universe, too. So are all of the other objects in our solar system—all the satellites that orbit the planets, the asteroid belt, comets, and meteoroids. But the universe is bigger than the solar system.<sup>3</sup>



### ← Show image 7A-2: The Milky Way in the night sky

When you look up at the sky at night, you sometimes see the moon or a planet that is part of our solar system. You also see beyond our solar system—stars and constellations that are all part of our Milky Way Galaxy. The Milky Way is *huge*, and every single part of it is also part of the universe! There are billions of stars in the Milky Way.

4 Who can tell me the name of this galaxy?

The Milky Way Galaxy is enormous, but the universe is even more astronomical in size than the Milky Way. If the sky is very clear and you know where to look in the night sky, you can see another nearby spiral galaxy.<sup>4</sup> That's right, the Andromeda Galaxy. Like the Milky Way, it is a spiral galaxy, but it may have up to twice as many stars as our Milky Way. Scientists believe there are billions

of galaxies each containing billions of planetary systems and all of them together make up the universe. But the universe doesn't just include the matter, or "stuff," that the stars are made of. The universe also includes all energy, time, and space. As you can tell, the universe is *big*, and it includes things we can see as well as things we can't see. In fact, the universe is so big that we don't even know for sure how big it is! But just because we don't know exactly how big it is doesn't mean that we can't study it and learn more and more about it.



← **Show image 7A-3: Scientists making observations and gathering evidence**

Scientists learn more about the universe every day. The new discoveries they make help form ideas—or **theories**—about the universe. A theory is an explanation about something or a reason for something. Scientific theories are not just guesses—they are explanations based on **evidence** or information that scientists get by making observations and taking measurements. Frequently there are several different theories that seek to explain the same **phenomenon**. So, scientists gather new **data** to help select between these theories. They share the data and study it to look for patterns and answers to their questions.

When new evidence is discovered that supports a theory, scientists' belief in that theory is strengthened and it becomes clearer and more certain. When something new is discovered that goes against a theory, the theory can be changed or readjusted to take the new evidence into account. Sometimes new evidence can show that a theory is totally wrong. Then a new theory takes its place that explains the evidence better than the old theory.

Here is an example of a theory that changed based on new evidence. For many, many years, humans have looked up into the sky and observed the stars. They have developed stories and theories to explain the universe. In the distant past, most humans believed the theory that Earth was the center of everything that was known. But then in more recent history, around the time that Columbus made his famous voyage from Spain to the "New World,"

5 You will learn more about Copernicus and Galileo in another lesson.

scientists like Copernicus and Galileo discovered new evidence that proved this was not true.<sup>5</sup> So, a new theory—that Earth was *not* the center of the universe—took its place.

Today, there is a common theory about how the universe first developed called the **Big Bang** Theory. It is a theory that is well-tested and widely accepted by many scientists, but not by everyone. The Big Bang Theory seeks to explain how the universe may have come to be. And it began with—a tiny speck!



← **Show image 7A-4: The tiny speck before the Big Bang**

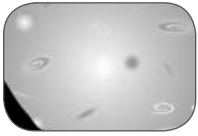
That’s right! According to the Big Bang Theory, before the universe was the way it is today, it was believed to be very different. There were *no* billions of galaxies. There was *no* Milky Way. There were *no* stars at all. *No* sun, *no* solar system, *no* planets, *no* Earth, *no* moons, *no* asteroids, *no* comets. There may not have even been time or space! All of the ingredients to make everything we see today were there; they were just in a very different form. It’s hard to imagine, but the Big Bang Theory traces the universe back to a point where all of what we can now see in the universe was **compressed** into a teeny-tiny speck. This speck was jam-packed full of, well—everything! It was unbelievably dense and crowded.<sup>6</sup> This speck was also super-hot. Hotter than anything on Earth. Hotter than the sun!

6 All of these words and phrases are synonyms for the word *compressed*—*pressed together, jam-packed, dense, and crowded*. Can you think of any other words or phrases that might describe what all this matter compressed together might be like? (*thick, hot, smashed together, full of energy, etc.*)



← **Show image 7A-5: Rapid expansion of the universe**

Around fourteen billion years ago, something amazing happened to all that compressed stuff. *Kaboom!* A bursting forth! A moving outward! A rapid unfolding! It’s been called many things by many people, but this amazing thing that happened is believed to be the “Big Bang”—the birth of the universe. It was hot and it was sudden and it was powerful. In a fraction of a second, space that had not been there before was suddenly everywhere all at once. Tiny new particles formed and began crashing into each other, creating energy and eventually joining to form larger bits of matter. The universe kept **expanding** and expanding—all of its matter spreading out as the universe kept getting larger! And as the universe expanded, it began cooling down a little at a time.



← **Show image 7A-6: Swirling matter**

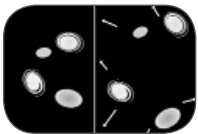
According to this theory, the newborn universe was nothing like it looks now, an estimated fourteen billion years later. Back then there were no stars yet—and there wouldn't be for the first one hundred million years after the Big Bang! The universe kept expanding and cooling. Substances kept crashing into each other, and brand new bits of matter were formed. Eventually new gases formed. As these gases began to cool, they collapsed because of gravity, and formed the first stars.<sup>7</sup> The universe kept expanding and stretching, and more and more stars were born. Then galaxies formed. About nine billion years after the Big Bang, our sun and solar system were born when gases collapsed in on themselves and formed our sun. That was believed to be a little over four and a half billion years ago, but the expansion of the universe, and the creation of new stars, still goes on today.

7 Why do you think gravity would cause the gases to collapse into stars? (Gravity is a force that pulls substances toward each other.)

Many scientists believe that the universe is about fourteen billion years old. But no one on Earth has been alive nearly that long. Even Earth hasn't been around that long. The truth is that no human being saw the universe as it was being formed. So how did scientists come to believe this theory is true? Good question!

8 Who can tell me what it means to make a prediction? (To predict means to say or think in advance what might happen.)

You know how you sometimes make predictions before you hear a read-aloud?<sup>8</sup> Over many years, scientists have made predictions based on three pieces of evidence they have observed to be true. This evidence supports their prediction that there was a Big Bang.



← **Show image 7A-7: The universe still expanding**

The first piece of evidence that supports the Big Bang Theory is that the universe is expanding. Remember how we said when the Big Bang happened there was a sudden unfolding and spreading out of the universe? The expansion continues today, and it has never stopped. Scientists have taken many measurements that prove this to be true. The data that astronomers have gathered are evidence that the galaxies are still moving farther and farther away from each other. And the farther away the galaxies are, the faster they are moving. Because scientists know that galaxies are now moving away from each other, it makes sense that they were closer

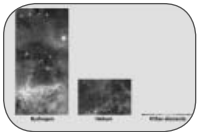
together in the past. This is exactly what the Big Bang Theory says—that about fourteen billion years ago, everything was all together in one, single, incredibly hot, dense speck.



← **Show image 7A-8: Cosmic Microwave Background**

The second piece of evidence is the discovery of something called the Cosmic Microwave Background. Remember how we said when the Big Bang happened everything was incredibly hot, and then gradually cooled down? The Cosmic Microwave Background is believed to be the glow, or leftover heat, from the Big Bang itself. This glow, or heat, does not come from any object in the universe, but has been discovered to exist *everywhere* in the universe.<sup>9</sup> Microwaves are one of the types of light energy given off by the sun and other stars. Even though they are invisible to us, scientific instruments allow us to view them. The Big Bang Theory predicted this leftover microwave light energy would exist in the universe, and it was indeed discovered in the 1960s.

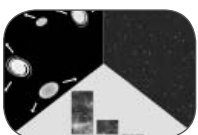
9 [Show Image Card 21 (Light Energy from the Sun).] Who remembers from the *Light and Sound* domain what this image card shows? (It shows the different wavelengths of light energy from the sun.) [Point to the microwave light waves on the image.]



← **Show image 7A-9: The light elements**

The third piece of important evidence that supports the Big Bang Theory is the amount of the very lightest **elements** that exist in the universe.<sup>10</sup> Some elements are heavier—like lead and silver—and some are lighter—like hydrogen and helium. The Big Bang Theory predicted that these lightest elements were created in specific amounts shortly after the Big Bang occurred. By measuring and collecting data scientists have found that the amounts of the light elements in the universe today are extremely close to the amounts of light elements that were predicted by the Big Bang Theory.

10 Elements are the basic substances found on Earth and in the universe.



← **Show image 7A-10: The evidence for the Big Bang**

The Big Bang Theory seeks to explain how the universe may have first come to be. These three pieces of evidence are great examples of how actual measurements of the universe support and strengthen the idea that the universe began with—*kaboom!*—a rapid and sudden expansion known as the Big Bang. For many scientists, discovering these three pieces of evidence that support the Big Bang Theory has been a real *blast!*





Often in science, finding answers leads to new questions. As astronomers find more and more evidence to support the Big Bang Theory, they also continue to ask new questions and continue to discuss this theory. Maybe someday one of you will help to present a new theory that will include parts of this one or that is completely different. But, for now, scientific evidence points to—the Big Bang!

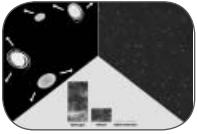
## Discussing the Read-Aloud

20 minutes



### Comprehension Questions

15 minutes



1.  *Inferential* What is a theory? (A theory is a suggested or widely accepted explanation for why something happens.) How is a theory different from a guess? (A theory is based on a lot of experiments, observations, and data.)
2. *Literal* What does the Big Bang Theory explain? (This theory is an explanation astronomers have for how the universe began.)
3.  *Inferential* What was the universe believed to be like before the Big Bang? (It was a tiny point or speck; everything in the universe was compressed into one tiny point. It was very hot and very dense.)
4.  *Inferential* Describe what nearly all astronomers believe happened at the very beginning of the Big Bang. (The universe expanded quickly from a tiny speck; all of the material was flung out into the universe.)
5. *Inferential* You heard in the read-aloud today that according to the Big Bang Theory, after the universe's first quick expansion, new matter formed and darted around the then-small universe. What happened when the new bits of matter slowed down? (They stuck together, forming larger bits of matter, and then began to expand and cool down.)
6.  *Evaluative* What kinds of things do scientists do to gather evidence? (They make observations through telescopes; they take measurements; they collect and share their data and study it to look for patterns and answers.)



← **Show image 7A-10: The evidence for the Big Bang**

7.  *Evaluative* Summarize the three major pieces of evidence that led many astronomers to believe in the Big Bang Theory. (Astronomers observed that the universe is expanding; there is a lot of leftover microwave energy; the predicted amounts of light elements closely match the actual amounts in the universe.)
8.  *Evaluative* How would you describe the size of the universe before the Big Bang? (All of the matter of the universe was in one tiny, dense speck that is too small to even imagine.) How would you describe the size of the universe today? (The universe is still expanding, and it is so vast that it is hard to imagine.)
9. *Evaluative* The author of “The Big Bang” writes about events that began long ago and far away. Describe what it is like for you to think about and imagine such events. (Answers may vary.)

I am going to ask a question. I will give you a minute to think about the question, and then I will ask you to turn to your neighbor and discuss the question. Finally, I will call on several of you to share what you discussed with your partner.

10.  *Evaluative Think Pair Share:* In today’s read-aloud, you learned that astronomers still have many unanswered questions about the Big Bang Theory and other interesting phenomena in the universe. If you were a scientist studying the universe and the Big Bang Theory, what kinds of questions would you have? How would you go about trying to find the answer? (Answers may vary.)
11. After hearing today’s read-aloud and comprehension questions and answers, do you have any remaining questions?  
 You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.

## Word Work: Expanding

5 minutes

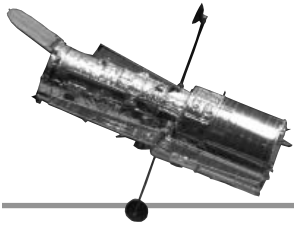
1. In the read-aloud you heard, “The universe kept *expanding* and *expanding*.”
2. Say the word *expanding* with me.
3. When something is *expanding*, it means it is growing in size.
4. The tire on Erica’s bike is expanding as she pumps air into it.
5. What are some other things that you have seen expand or that could expand? Be sure to use the word *expanding* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students’ responses to make complete sentences: “A \_\_\_\_\_ would be expanding when . . . ”]
6. What’s the word we’ve been talking about? What part of speech is the word *expanding*?

Use a *Drawing and Sharing* activity for follow-up. Have students draw a picture of something they have seen expand or that could expand. On the left side of the piece of paper, have students draw the item as it looked before it expanded. On the right side of the paper, have students draw a picture of the same item after it expanded. Last, have students share with a partner what item they drew and how it looked while it was expanding. As students share, make sure they use the word *expanding* in a complete sentence.



**Complete Remainder of the Lesson Later in the Day**





# The Big Bang

7<sub>B</sub>

## Extensions

20 minutes

### Big Bang Balloon

Tell students that they are going to observe you recreate a simple version of the Big Bang using a balloon. Hold up an uninflated balloon. Remind students that according to the Big Bang Theory, all matter first existed in an extremely small, dense, hot speck. Tell students that the balloon represents how some scientists believed the universe to be before the Big Bang; imagine the balloon is a “speck” that contains all matter in its own mini-universe. Use a marker to draw small dots on the balloon to represent the galaxies that formed after the universe suddenly expanded. Ask students to name the galaxy in which our own solar system exists. (Milky Way) Draw a dot for the Milky Way in a different color. Ask students what facts they remember about the Milky Way. (Our Milky Way Galaxy is shaped like a spiral disk with stars in the middle; has billions of stars; and has neighbor galaxies.)

Explain to students that when scientists perform experiments like the one they are about to observe, they first predict what they think will happen. Have students predict what they think will happen to the galaxy dots on the balloon when the balloon is blown up, and to share their predictions with a partner. You may wish to record several predictions on chart paper, a chalkboard, or a whiteboard.

Then, blow up the balloon. You may wish to inflate and deflate the balloon more than once so students can have multiple chances to watch the balloon as it expands. Once all students have had a chance to watch the balloon expand, discuss with students what they noticed. Ask students to describe what happened as the balloon expanded. (The space between each of the “galaxies” increased.) Compare what actually happened with what students predicted. You may wish to record their answers on chart paper, a chalkboard, or a whiteboard. Make sure that students include the following:

- The “galaxies” move away from each other in all directions—up, down, front, back, and to both sides.
- The farther apart the galaxy dots are, the faster they separate.

Explain that the way the balloon expanded in three dimensions with the galaxy dots moving apart in several different ways (up, down, front, back, and both sides) is the same way that some scientists believe the universe expanded, according to the Big Bang Theory.

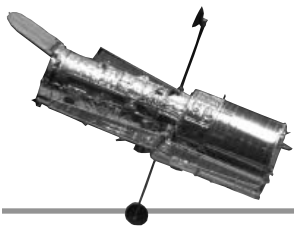
**Note:** You may wish to point out to students that as the balloon expanded, the dots that represent galaxies also expanded in size. Tell students that in the Big Bang Theory, as the real universe expanded, the galaxies in it did not expand in size in the same way as the dots on the balloon did. You may wish to ask students what force they think might keep real galaxies from expanding as the universe expands, or you may wish to simply tell them that gravity helps real galaxies keep their shape.

### 10 Sequencing the Big Bang (Instructional Master 7B-1)

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Use Instructional Master 7B-1 to have students sequence the events of the Big Bang in order from start to finish. Write the number 1 next to the first event, 2 next to the second, and so on. Help students describe the logical connection between events by identifying particular words and sentences that provide clues to the order of events in the formation of the universe.

You may wish to have students complete this activity individually, in small groups, or as a class. Have students collect their worksheets in their Space Notes notebooks or folder.



# Nicolaus Copernicus

## 8

### Lesson Objectives

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#### Core Content Objectives

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Students will:

- ✓ Describe the effects gravity has on Earth, within the solar system, and in the universe
- ✓ Describe tools and methods used to study space and share information
- ✓ Identify and use vocabulary important to the process of science
- ✓ Describe the life and contributions of Copernicus
- ✓ Explain the Big Bang Theory as an important scientific theory of the origin of the universe
- ✓ Recall key details about the history of space exploration

#### Language Arts Objectives

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The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ Describe the relationship between a hypothesis and a theory as presented in “Nicolaus Copernicus,” using language that pertains to cause/effect, such as *evidence*, *observation*, *calculations*, *logical*, *opposed*, and *data* (RI.3.3)
- ✓ Distinguish beliefs and ideas that Aristotle and Aristarchus had in ancient Greece from beliefs and ideas that Copernicus and Galileo had in the early 1500s (RI.3.3)
- ✓ Distinguish between the point of view of a person looking at space from Earth and the point of view that space-based equipment gives us (RI.3.6)

- ✓ Describe the celestial bodies shown in the geocentric and heliocentric views as conveyed by the words and interpreted from the diagrams in “Nicolaus Copernicus” (RI.3.7)
- ✓ Compare and contrast the key details as shown in the images and described in “Nicolaus Copernicus” between the geocentric, heliocentric, and modern views of the solar system (RI.3.9)
- ✓ Use the graphic organizer to clearly record descriptive details about the life of Nicolaus Copernicus in preparation for writing a nonfiction narrative piece in the form of a biography (W.3.3a)
- ✓ Use temporal words and phrases to signal event order during the planning step of the narrative writing piece (W.3.3c)
- ✓ With guidance and support from peers and adults, use the steps of the writing process such as plan, draft, revise, edit, and publish to create a narrative writing piece that will be developed and strengthened over an extended time frame (W.3.5) (W.3.10)
- ✓ Make personal connections to the process of forming a hypothesis and defining an area of interest or a passion to further explore (W.3.8)
- ✓ Gather information from their notebooks, the KWL chart, and other print and digital sources, and sort the information using the graphic organizer provided as a planning tool (W.3.8)
- ✓ Categorize information about Copernicus listed on the graphic organizer, telling whether it best fits his Early Life, Achievements, or Impact (W.3.8)
- ✓ Determine the main ideas and supporting details of the geocentric and heliocentric views of the solar system presented in “Nicolaus Copernicus” through text, diagrams, and discussion (SL.3.2)
- ✓ Determine the main ideas and supporting details about Copernicus’s life and the significance of his ideas from information presented in diverse media and formats, including the read-aloud, images, trade books, and available media (SL.3.2)
- ✓ Choose words and phrases to effectively describe Nicolaus Copernicus and his ideas (L.3.3a)
- ✓ Determine the meaning of a new word when a known affix is added to a known word, such as *hypothesis/hypotheses* and *phenomenon/phenomena* (L.3.4b)

- ✓ Use the known roots *geo-*, *helio-*, *bio-*, *-centri*, *-ology*, and *-ography* to determine and better understand the meaning of unknown and newly learned words, such as *heliocentric*, *geocentric*, *geology*, *heliology*, and *biography* (L.3.4c)
- ✓ Distinguish shades of meaning among related words that describe degrees of certainty, such as *predict*, *hypothesis*, *theory*, *believe*, and *prove* (L.3.5c)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial and temporal relationships, to describe differing views of the solar system, such as *orbiting*, *center*, *view*, *long ago*, and *today* (L.3.6)

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**calculations, n.** Mathematical methods used to answer a question

*Example:* Jocelyn had to do some calculations in order to decide whether or not she had enough money to buy a pet rabbit.

*Variation(s):* calculation

**diurnal, adj.** Having a daily cycle or occurring daily as a result of the earth’s twenty-four hour rotation around its axis

*Example:* When Nyia watches the sun rise over the Atlantic Ocean, she likes to think about the diurnal cycle of the sun and how we count on the sun rising and setting every day!

*Variation(s):* none

**geocentric, adj.** Having the earth as the center

*Example:* For thousands of years, people had a geocentric view of the universe and believed that Earth was at the center of everything.

*Variation(s):* none

**heliocentric, adj.** Having the sun as the center

*Example:* Copernicus feared punishment for expressing his belief in a heliocentric, or sun-centered solar system.

*Variation(s):* none

**hypothesis, n.** An idea that is based on observation and experimentation but that is not commonly accepted

*Example:* Liam has a hypothesis about why his dog hides under his bed at night, but he still has to gather more evidence to convince his parents of his idea.

*Variation(s):* hypotheses

**logical, adj.** Makes sense in an organized, step-by-step way


*Example:* Whenever Lola wrote an opinion paragraph, she would try to give logical explanations to support her opinion.

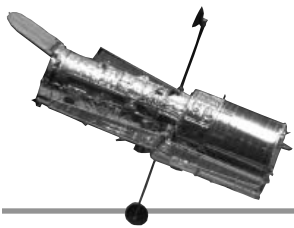
*Variation(s):* none

**opposed, v.** Resisted; was against

*Example:* Although she opposed the idea at first, Julie’s mom eventually said she could go to camp for the summer.

*Variation(s):* oppose, opposes, opposing

<i>At a Glance</i>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>What Have We Already Learned?</b>	Instructional Master 7B-1 (optional)	10
	<b>Essential Background Information or Terms</b>	Image Card 22	
	<b>Purpose for Listening</b>		
<b><i>Presenting the Read-Aloud</i></b>	<b>Nicolaus Copernicus</b>	Image Card 23; world map or globe	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>	Image Card 22	15
	<b>Word Work: Geocentric and Heliocentric</b>	chart paper, chalkboard, or whiteboard	5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>Narrative: Plan</b>	Instructional Master 8B-1; chart paper, chalkboard, or whiteboard	20



# Nicolaus Copernicus

8A

## Introducing the Read-Aloud

10 minutes

### What Have We Already Learned?

Remind students that in the previous lesson they learned about the Big Bang Theory. Ask students to define the word *theory* and to explain what the Big Bang Theory is specifically. (A theory is a reason or explanation for the way something happens; the Big Bang Theory is one explanation, based on a lot of scientific evidence for how the universe began.) You may wish to review with students using the basic sequence of the Big Bang Theory as listed on Instructional Master 7B-1.

### Essential Background Information or Terms

Tell students that in today's read-aloud, they will again hear vocabulary words that are related to the process or work of science and also sometimes to our everyday lives. Ask students if they have ever heard the word *hypothesis* and what they think it means. Explain that people often come up with a hypothesis to explain why something happens as it does. For example, tell students that they might make a hypothesis to explain why a pet behaves a certain way. Tell students that people often make a hypothesis about why they get sick or don't get sick. Explain that people make hypotheses as they try to get a better understanding about how something in the world works. Ask students if they can think of an example of a hypothesis that they or someone they know has made. Encourage students to use the word *hypothesis* as they share.

Tell students that after a person makes a hypothesis about why something happens, the next step is to gather evidence by observing closely and finding a way to test the idea. The evidence they find might cause them to change the hypothesis or to be more certain of it. Tell students that if a lot of evidence is found in support of a hypothesis and lots of people accept that it is true, then it becomes a theory.

Tell students that today they will hear more about our solar system as they learn about an important astronomer who lived in the late 1400s and the 1500s named Nicolaus Copernicus. Show students Image Card 22 (Statue of Copernicus). (You may wish to tell students that later in

the year, during the domain *European Exploration of North America*, they will learn about Columbus and other explorers who made voyages of exploration during Copernicus's lifetime.) Tell students that Nicolaus Copernicus studied space and that his views and new ideas about space shocked many people, changing what people knew about astronomy forever.

### **Purpose for Listening**

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Explain to students that back when Nicolaus Copernicus was alive, everyone had a very different idea of how the universe was arranged. Tell students to listen to find out how people used to think the universe was arranged and how they responded to Copernicus's new ideas.





## Nicolaus Copernicus

### ← Show image 8A-1: Copernicus, the scholar

How would you like to present the world with a new idea about how something works? What if, besides being new, your idea was so different from the ideas that people had believed for so long that people were **opposed** to even listening to your ideas? That kind of fierce opposition is exactly what a man named Nicolaus Copernicus experienced hundreds of years ago when he had a new idea about astronomy.

Nicolaus Copernicus was a regular person, just like you. He was born in Poland in 1473, and was raised by his uncle because both of his parents died when he was about ten years old. Copernicus went to universities in Poland and Italy and became a clergyman and doctor.<sup>1</sup> Copernicus studied many subjects, including math, philosophy, church law, and medicine. But his favorite subject of all—and the thing that he had a big new idea about—was astronomy.

1 [Have a volunteer point to the countries of Poland and Italy on a world map or globe.]



### ← Show image 8A-2: Aristotle observing sunrise and sunset

As you have learned, astronomy is the study of the stars, space, and the universe, and astronomers are scientists who study these amazing phenomena. Long before Copernicus was born, the Greek philosopher Aristotle observed that the sun appeared to “rise” in the east and “set” in the west. Because Aristotle observed this **diurnal** motion of the sun with his own eyes, he—and many others—believed that the earth was stationary and that the sun and all of the planets orbited around it. These observations and the strong belief in this way of looking at the universe shaped people’s views for a very long time.



← **Show image 8A-3: The geocentric, or Earth-centered, view**

- 2 If *geo-* means earth, and *centric* means to be located at the center, what do you think *geocentric* means? (Earth-centered)
- 3 [Guide students to find Earth at the center, its moon to the left, the sun to the right, and Jupiter and its four moons to the upper left.] How is our modern view of the solar system different from this view? (The sun and Earth are in reverse positions; Uranus and Neptune are not included in this view.)

For more than one thousand years before Copernicus was born, most astronomers and other people believed that the universe was **geocentric**.<sup>2</sup> In other words, scientists thought that Earth was the center of the solar system and the universe. They believed Earth stood still and the sun and all of the planets and the moon circled around it, while the stars remained fixed in a rotating sphere that was farther away.<sup>3</sup>

You have heard that most people believed the geocentric theory of the universe for more than one thousand years. Why? Because it was the best explanation anyone had come up with for why the sun and planets appeared to move the way they did. All of our observations were from Earth. Remember, people did not have all of the scientific tools back then that we have today, such as artificial satellites, spaceships, and high-powered telescopes. These tools have greatly expanded modern understandings of space through new opportunities for observation and gathering data. Think about the difference between a person standing on Earth looking around, and a person in an airplane looking down on the Earth-bound person. The person in the airplane can see a much wider scope of Earth. Powerful telescopes have given us this new kind of perspective when we look up into space.



← **Show image 8A-4: Aristarchus**

Most Greeks, including the famous philosopher Aristotle, believed the geocentric theory. There were a few exceptions, such as the Greek astronomer Aristarchus who, after much study, concluded that the sun was much larger than Earth, and that it was Earth that moved around the sun. His new idea, called a **hypothesis**, was never accepted by ancient astronomers, but after many, many years, Aristarchus's ideas greatly influenced other astronomers in their studies.



← **Show image 8A-5: The geocentric, or Earth-centered, view**

Most ancient Romans believed the geocentric theory. During this time it was the official position of the powerful Roman Catholic Church. Most astronomers were afraid to question it or explore other hypotheses, though there were others before Copernicus who were trying to work out alternative explanations. When Copernicus was born in 1473, almost everyone in Europe believed in this geocentric theory, too. And almost everyone had no idea that this view of the universe was about to change!

How could so many people have a completely different view of the universe than we do today? The answer is easy. All of what we know about the way the universe works—all of science—comes from the observations and **logical** thinking of regular people, just like you and me. Astronomers have always used scientific theories to explain the movement of the stars and planets. Scientific theories aren't necessarily complicated or hard to understand—they are just possible explanations of how or why things happen. But remember, scientific theories aren't just guesses. They are ideas that are based upon evidence and careful observation of the world—such as observing where the stars appear in the sky every night. Sometimes, however, what we think we are seeing is not what actually is, such as the world looking flat but actually being round.<sup>4</sup>

4 [Show Image Card 23 (Horizon).] Notice how when you are looking out over the ocean from the shore, the “edge” of the ocean on the far side looks flat, not round. This is why long ago people thought you could fall off the edge of the world.



← **Show image 8A-6: The strange and unexpected movements of the planets**

A long time ago stargazers spent a lot of time outside looking at the night sky and noticed patterns in the sky. Early astronomers knew that the planets had different movements than the stars which circled around Polaris once a day.<sup>5</sup> Astronomers observed that the planets moved slowly across the night sky along a certain pathway. But people had also started noticing some odd things about the motion of the planets as they followed this pathway. One of these odd things was that sometimes Mars and other planets made a strange backward loop in the sky.<sup>6</sup> Scientists had tried to explain this motion using the geocentric theory of the universe, but the

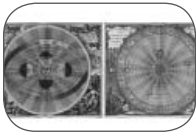
5 Who remembers the word used to describe something like this that happens daily? (*diurnal*)

6 [Point to the backward loop in the image.]

explanations became pretty complicated. Still, most people didn't question that Earth was the center of the universe.

But Copernicus asked himself the question: if the planets were orbiting around Earth, why would they follow such complicated patterns? He didn't think they would, and so he used his logical mind to come up with a different scientific hypothesis that would better explain this strange looping motion. Copernicus also had the work of Aristarchus long before to add to his own studies. In science, often the work of one scientist is built upon the work of the many scientists who have come before him or her.<sup>7</sup>

- 7 Does anyone remember Aristarchus's hypothesis? (He hypothesized that the sun was much larger than Earth, and that Earth moved around the sun.)



← **Show image 8A-7: Heliocentric, or sun-centered, view**

What was the scientific hypothesis that Copernicus decided upon? It was a **heliocentric** hypothesis of the universe.<sup>8</sup> Does this idea sound familiar? This was the hypothesis of Aristarchus more than one thousand years earlier! By using mathematics to make careful **calculations** of the positions of the sun, planets, and other celestial bodies, Nicolaus Copernicus came to the same conclusion: that the sun was at the center of everything. He believed that Earth orbited around the sun along with the rest of the planets.<sup>9</sup> Copernicus also hypothesized that the earth is spinning and rotates on its own axis.

Of course, we now know that the earth *does* rotate on its own axis. And we also know that although the sun isn't the center of the universe, it *is* the center of our solar system. So, the heliocentric scientific hypothesis Copernicus presented in the 1600s (that was built upon the scientific hypothesis Aristarchus had presented more than one thousand years earlier) was much closer to the truth than the geocentric theory that had been held for so many years.

Unfortunately, similar to Aristarchus, Copernicus's hypothesis was not widely accepted by people during his lifetime. For one thing, people thought that if the earth was spinning, all the things on it would be thrown off the earth and into space. They didn't understand that the force of gravity holds us firmly on Earth! Another part of the reason for this is that Copernicus's ideas were

- 8 You may have heard a myth about Helios, the sun god, in Grade 2 *Greek Myths*. Knowing that *helio*— means sun, what do you think *heliocentric* means? (sun-centered)

- 9 [Guide students in locating the six planets, Earth's moon, and Jupiter's four moons.] How was Copernicus's view different from our modern understanding? (It still did not include Uranus and Neptune.)

10 Some people think that Copernicus may have waited to make his hypothesis public until the very last moment in his life because it was such an unpopular hypothesis.

11 Why do you think this was so difficult to accept? (Answers may vary.)



← **Show image 8A-8: Galileo looking through his telescope**

not published until literally the day he died.<sup>10</sup> But another part of the reason that the heliocentric hypothesis was not widely accepted was that Copernicus's ideas challenged the belief held by most people that humans were at the center of the universe. This was very difficult for many people to accept, so change came slowly.<sup>11</sup> Still, as with the studies of Aristarchus, the studies of Copernicus greatly influenced the astronomers who came after him, including the great Italian astronomer Galileo Galilei.

Galileo was inspired by the work of Copernicus and became one of the first astronomers to build and use a telescope to study space in more detail.<sup>12</sup> As you heard earlier, Galileo discovered four of Jupiter's moons. He observed that the moons orbit Jupiter instead of Earth. His discoveries provided further evidence that Aristarchus and Copernicus were—although in the great minority—correct in their heliocentric theories!

12 Who remembers from the domain *Light and Sound* how a telescope works? (Light enters the long tube containing the lenses. The lenses magnify the image.)




← **Show image 8A-9: Copernicus and the heliocentric view**

Nicolaus Copernicus had made careful observations of the stars and other celestial bodies. He recorded these observations with great attention. But it was his willingness to ask questions—even when unpopular—that led him to a clearer answer. Each time you ask questions to help understand something better, you are following in the footsteps of the great astronomer Nicolaus Copernicus. Asking questions to get closer to the truth is what the scientific process is all about. Copernicus's questioning mind and careful observations led him to a new hypothesis about the arrangement of what we now know as the solar system. Though people were slow to accept his hypothesis, the astronomers who followed Copernicus gathered more and more evidence, so that today the heliocentric view is the accepted theory. It's important to remember that new information and evidence often change our views about the world!


## Comprehension Questions

15 minutes



1.  *Evaluative* [Show Image Card 22 (Statue of Copernicus) and tell students that this is a statue in Copernicus's home country of Poland.] Who was Nicolaus Copernicus? (Copernicus was a Polish astronomer from the 1500s; he was also a doctor and a clergyman.) What are some words you might use to describe Copernicus? (Answers may vary, but may include words like *thoughtful*, *curious*, *brave*, *logical*, *educated*, etc.) What tools and methods did Copernicus use for studying space? (He made many observations, he kept records of his data, he performed mathematical calculations, and he studied other astronomers' views.)



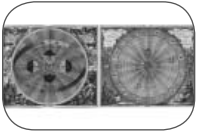
← **Show image 8A-3: The geocentric, or Earth-centered, view**

2.  *Inferential* What did astronomers believe for thousands of years before Copernicus's time about the arrangement of the universe? (They believed that Earth was at the center of everything and that it stood still while all the other celestial bodies orbited it.) What is the word that describes this earth-centered view? (*geocentric*)




← **Show image 8A-6: The strange and unexpected movements of the planets**

3.  *Evaluative* Astronomers in Copernicus's time were puzzled about the movement of Mars and some of the other planets. What question did they have about the planets' movements, and how did this lead Copernicus to a new understanding? (Astronomers wondered why Mars and some of the planets seem to travel backward at times in their paths across the night sky. This led Copernicus to think of other arrangements of the planets and the sun that would explain this odd and unexpected movement.)
4.  *Inferential* Why did people have a difficult time believing that Earth was spinning in space? (They thought that if Earth spun in space they would be thrown off it, as would all of the objects on Earth.) Why don't people, objects, and the air we breathe float off into space? (Earth's gravity is a force that keeps everything from disappearing into space.)







← **Show image 8A-7: Heliocentric, or sun-centered, view**

5.  *Inferential* What was new about Copernicus's view of the world? (He supported a heliocentric view with the sun in the center and Earth and the other planets orbiting the sun.) What did people think about Copernicus's heliocentric ideas? (People were opposed to his ideas and very upset by them; he was afraid he would be punished.)
6. *Inferential* Name another astronomer who later worked to prove Copernicus's heliocentric view that Earth and other planets orbited the sun. (Galileo) How did he support Copernicus's ideas with his own discoveries? (Galileo used a telescope and saw that Jupiter had four moons orbiting it, showing that there were some things in space that didn't orbit around Earth.)
7.  *Evaluative* What is the difference between a hypothesis and a theory? (A hypothesis is an explanation about why something occurs; a theory is a hypothesis that has been tested and has become widely accepted.)
8.  *Evaluative* Describe a hypothesis that you have about something in your life. What evidence do you have for your hypothesis? What else could you do to test your hypothesis more? (Answers may vary.)
9. *Evaluative* What events on Earth occur on a diurnal or daily basis? (Answers may vary, but may include day and night, the tides, and the sun rising and setting.)

I am going to ask a question. I will give you a minute to think about the question, and then I will ask you to turn to your neighbor and discuss the question. Finally, I will call on several of you to share what you discussed with your partner.

10.  *Evaluative Think Pair Share:* Copernicus's curiosity for learning about astronomy led him to observe the night sky and explore new ideas in his mind. Eventually, his passion for astronomy led him to an important new idea for the world. Think about your life and the things in which you are most interested. Is there a topic or activity which you have an interest in or a passion for? What is it, and why does it hold your interest? Is there a way in which you'd like to make a new contribution to this area of life? (Answers may vary.)
  11. After hearing today's read-aloud and comprehension questions and answers, do you have any remaining questions?
-  You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.

## Word Work: Geocentric and Heliocentric

5 minutes

1. In the read-aloud you heard, “Most astronomers and other people believed that the universe was *geocentric*” and “. . . the *heliocentric* scientific hypothesis Copernicus presented in the 1600s . . . was much closer to the truth.”
2. Say the words *geocentric* and *heliocentric* with me.
3. *Geocentric* means having the earth as the center. *Heliocentric* means having the sun as the center.
4. Ancient people long held a geocentric view because their observations told them that all of the celestial bodies traveled around the Earth. Aristarchus and Copernicus both believed that the heliocentric view better explained their very careful observations of the movement of the planets.
5. Which of these two views do you find more interesting: the geocentric view, or the heliocentric view? Why do you think so? Be sure to use the word *geocentric* or *heliocentric* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students’ responses to make complete sentences: “The geocentric view is interesting to me because . . .” or “The heliocentric way of thinking is most interesting because . . .”]
6. What are the words we’ve been talking about? What part of speech are the words *geocentric* and *heliocentric*?

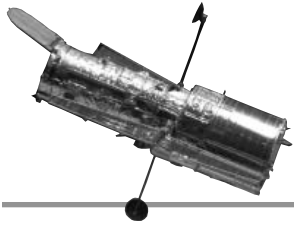
Use a *Word Parts* activity for follow-up. Write the words *geocentric* and *heliocentric* on chart paper, a chalkboard, or a whiteboard. Circle the word part *-centric* on each, and ask students what this word part means. (located at the center, or central) Circle the word parts *geo-* and *helio-*, and ask what these two word parts mean. (earth, ground, or land) (sun) Tell students that *geocentric* therefore means earth-centered, and *heliocentric* means sun-centered.

Ask students if they have ever heard the word *geology*. If the word part, *-ology*, means the study of something, what do you think a person studying geology would be interested in learning about? (the earth, what it is made of, how it changes) Tell students that there are a lot of unfamiliar and little-used words that begin with *helio-*. Ask students what they think *heliology* means. (the study of the sun)



**Complete Remainder of the Lesson Later in the Day**





# Nicolaus Copernicus

8B

## Extensions

20 minutes



### Writing a Narrative: Plan (Instructional Master 8B-1)

Explain to students that the read-aloud they heard today, “Nicolaus Copernicus,” is considered a biography. Write the word *biography* on chart paper, a chalkboard, or a whiteboard. As you write, be sure to leave a space between the ‘o’ of *bio* and the ‘g’ of *graphy*. Tell students that the word *biography* can be separated into parts. Circle the word part *bio-*. Explain to students that *bio-* at the beginning of the word *biography* means life, or pertaining to life. Write *life* below *bio-*. Explain that in the middle of the word is the word part *-graph*, which means to write. Write the word *write* below *-graph*. Ask students what they think a biography is, given the definitions of the two parts of the word: *bio-* and *-graph*. Then, explain to students that a biography is a written account of someone’s life. Often, biographies are written about people who have achieved great things or changed other people’s minds in some way.

Explain to students that because a biography is written about a person who actually existed, it is considered a form of nonfiction. Tell students that some biographies are written in an informational style similar to the pieces they wrote in the *Classification of Animals* and *Light and Sound* domains, whereas other kinds of biographies are written more like narratives, or stories, like the pieces they wrote in the *Human Body: Our Systems and Sense* domain. Explain that even when a biography is written in the form of a narrative, it always strives to remain true to what actually happened to the person and is not made up from the author’s imagination, such as a fictional narrative would be. Remind students that *The Wind in the Willows* is a fictional narrative.

You may also wish to explain that biographies are only one form of nonfiction narratives. Nonfiction narratives can also retell factual events from history, such as the Apollo 11 mission when man first landed on the moon.

Ask students what kind of information they think should be included in a biography. You may wish to list students’ responses on chart paper,

a chalkboard, or a whiteboard. Once students have had a chance to respond, use the list below to fill in any gaps about what should be included in a biography.

- date and place of birth and death
- major events in person’s life
- achievements
- impact the person had on society

Explain that a biography may often be divided into three sections: early life, achievements, and the impact the person had on society, that is, how this person changed the lives or thoughts of a society. Tell students that together as a class, they are going to write a biography of Nicolaus Copernicus. The biography will have at least three paragraphs—one for the beginning of his life, one for his achievements, and one for the impact he had on society.

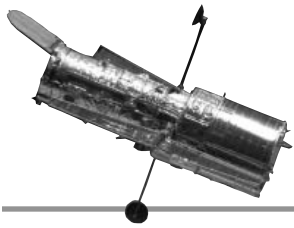
Ask, “Who can tell me the steps of the writing process?” Review the steps—plan, draft, revise, edit, and publish—and tell students that today they will begin the first step of the biography together: plan. Remind students that they have completed these steps while writing pieces in other domains.

Copy Instructional Master 8B-1 onto chart paper, a chalkboard, or a whiteboard. Tell students that they are going to fill out the brainstorming chart together. Write “Nicolaus Copernicus” in the center of the oval. Have students share facts about Nicolaus Copernicus. Record their ideas in the smaller ovals coming off the spokes. You may wish to show Flip Book images again, related to Copernicus and his life and contributions. You may also wish to allow students to research Nicolaus Copernicus further, using domain-related trade books from the classroom book tub and/or other sources. If students include information that they find in these sources in their writing piece, be sure to explain that they need to write this information in their own words in order to avoid plagiarism. Remind students that plagiarism is the act of taking other people’s work exactly as it is written and using it as your own.

After students have completed the brainstorming chart, read through each of the ideas in the smaller ovals, and have students classify each one as “Early Life,” “Achievements,” or “Impact.” If one of the ideas does not fit easily into one of those categories, label it as “Other,” and explain to students that although this information does not fit readily

into one of the three categories, they may still be able to use it to fill out the biography, just as they may have added extra details to their informational writing piece about an animal group in *Classification of Animals*. Tell students that they will begin the draft stage together the next time they meet to work on writing. Tell students to be thinking of a title for this biography.

**Note:** You may wish to have some students use Instructional Master 8B-1 to complete this step of the writing process exercise on their own, collecting the worksheets in their Space Notes notebooks or folders. Some students may write their own biographies during Pausing Point 2.



# Space Exploration

# 9

## Lesson Objectives

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### Core Content Objectives

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Students will:

- ✓ Explain that Pluto has been reclassified as a dwarf planet
- ✓ Describe the effects gravity has on Earth, within the solar system, and in the universe
- ✓ Describe tools and methods used to study space and share information
- ✓ Describe the life and contributions of Copernicus
- ✓ Recall key details about the history of space exploration

### Language Arts Objectives

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The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ With assistance, interpret Copernicus's life events related to the content in "Nicolaus Copernicus" and notes taken in the graphic organizer as they begin to draft the narrative writing piece (RI.3.3)
- ✓ Sequence four to six sentences describing events in Copernicus's life for each paragraph in the narrative writing piece (RI.3.3)
- ✓ Describe the relationship between the historical events and scientific ideas related to Copernicus's heliocentric theory of the solar system, using language that pertains to time, sequence, and cause/effect as they begin to draft the narrative writing piece (RI.3.3)
- ✓ Distinguish between events that occurred in Copernicus's early life, the achievements he made during his adult life, and the impact his ideas and work had on the thinking of people in future years (RI.3.3)

- ✓ Interpret and describe the celestial bodies shown in the heliocentric view as conveyed by the diagram (RI.3.7)
- ✓ Describe the three modules of Apollo 11 and their functions, as shown in the image and conveyed by the words in “Space Exploration” (RI.3.7)
- ✓ Identify and use parts of a paragraph, including a topic or “hook” sentence, supporting details, and a concluding statement, in the narrative writing piece (W.3.3a)
- ✓ Using the paragraph topics established in the planning stage during the last lesson, write an interesting topic or “hook” sentence and organize supporting details, writing sentences that unfold naturally (W.3.3a)
- ✓ Use descriptions of Copernicus’s and others’ actions, beliefs, and thoughts to develop the experiences and events of Copernicus’s life and the response of others to his ideas (W.3.3b)
- ✓ Use temporal words and phrases to signal event order during the drafting step of the narrative writing piece (W.3.3c)
- ✓ Provide a sense of closure in the draft of the narrative writing piece, with special attention given to the role of a concluding sentence (W.3.3d)
- ✓ With guidance and support from peers and adults, use the steps of the writing process such as plan, draft, revise, edit, and publish to create a narrative writing piece that will be developed and strengthened over an extended time frame (W.3.5) (W.3.10)
- ✓ Make personal connections to the process of observing how things work in the world and posing a question to learn more about (W.3.8)
- ✓ Make personal connections to space exploration by describing a type of space exploration in which you could imagine participating (W.3.8)
- ✓ Determine the main ideas and supporting details about Copernicus’s life and the significance of his ideas from information presented in diverse media and formats, including the read-aloud, images, trade books, and available media (SL.3.2)
- ✓ Summarize important information about the life of Nicolaus Copernicus (SL.3.4)
- ✓ Summarize the key points related to Pluto’s classification as a dwarf planet (SL.3.4)

- ✓ Choose words and phrases recorded in the graphic organizer during the planning stage of the writing process to write effective sentences describing Nicolaus Copernicus, his ideas, and the events of his life (L.3.3a)
- ✓ Determine the meaning of a new word when a known affix is added to a known word, such as *triumph/triumphant* (L.3.4b)
- ✓ Use the known roots *astro-*, *cosmo-*, and *-naut* to determine and better understand the meaning of unknown and newly learned words, such as *astronaut* and *cosmonaut* (L.3.4c)
- ✓ Provide synonyms and antonyms for the word *triumph* (L.3.5b)
- ✓ Distinguish shades of meaning while drafting the narrative piece among related words that describe degrees of certainty, such as *predict*, *hypothesis*, *theory*, *believe*, and *prove* (L.3.5c)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial and temporal relationships, to describe the life of Copernicus as well as more modern space exploration, such as *orbiting*, *center*, *heliocentric*, *solar system*, *long ago*, and *today* (L.3.6)

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**module, n.** A segment or section of a spacecraft designed to do a specific job

*Example:* The second lunar module built for the Apollo Project moon missions was only used for ground testing and is now on display at the Smithsonian National Air and Space Museum.

*Variation(s):* modules

**observatory, n.** A building or place especially built for observing the stars, planets, and other space objects

*Example:* When Will’s class went on a field trip to the observatory, he got to look at the Andromeda Galaxy through a powerful telescope.

*Variation(s):* observatories

**probes, n.** Unmanned spacecraft sent to explore space and gather scientific information

*Example:* After thirty-five years of space travel, the space probes *Voyager 1* and *Voyager 2* reached the outermost regions of our solar system.

*Variation(s):* probe

**reusable, adj.** Able to be used again

*Example:* Katya’s mom packs her lunch in reusable plastic containers to help reduce the pieces of trash needing to be thrown away.

*Variation(s):* none

**spacecraft, n.** A manned or unmanned vehicle designed to travel into space for research and exploration

*Example:* The International Space Station is an important spacecraft in which astronauts and scientists from many nations live and work together.

*Variation(s):* none

**space shuttle, n.** A partly reusable, manned spacecraft launched into space for research and exploration that returns to Earth and lands on a runway


*Example:* Space shuttle missions did many things for space exploration, including launching the Hubble Space Telescope and taking supplies to the International Space Station.

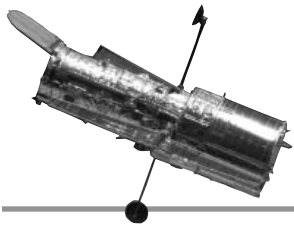
*Variation(s):* space shuttles

**triumph, n.** A special achievement, success, accomplishment, or victory

*Example:* Being given an award for her story was a special triumph for Caroline because learning to write had been difficult for her.

*Variation(s):* triumphs

<i>At a Glance</i>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>What Have We Already Learned?</b>		10
	<b>Essential Background Information or Terms</b>		
	<b>Purpose for Listening</b>		
<b><i>Presenting the Read-Aloud</i></b>	<b>Space Exploration</b>	Poster 4 (Distant Galaxies); Image Cards 24–28; world map or globe	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>	Image Cards 27–29	15
	<b>Word Work: Triumph</b>		5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>Writing a Narrative: Draft</b>	Instructional Masters 8B-1, 9B-1; chart paper, chalkboard, or whiteboard	20



# Space Exploration

9<sub>A</sub>

## Introducing the Read-Aloud

10 minutes



### What Have We Already Learned?

#### ← Show image 9A-1: Copernicus and the heliocentric view

Remind students that they learned about Nicolaus Copernicus in the previous lesson. Ask students to share some key details from Copernicus's life, including why we remember and study about him today. (He was a Polish astronomer, also a clergyman; he said that Earth moved in space; he proposed the heliocentric idea that the sun—not Earth—was at the center of the solar system; he opposed the geocentric view that said that Earth was the center of the universe.)

Ask students to share how Copernicus was able to come to these conclusions. (He studied the movement of the planets; he studied the night sky; he used his mind and his logical thinking; he did mathematical calculations; he studied Aristarchus's ideas.) Remind students that Copernicus made all of his observations before the telescope was invented. Remind students that Galileo used a telescope to learn more about the solar system and gathered further evidence that Earth was not the center of the universe. Ask students what else scientists have discovered with the use of telescopes. (Galaxies are moving away from one another; stars are different colors; there are different shapes of galaxies; etc.)

### Essential Background Information or Terms

Tell students that telescopes are only one way that astronomers learn about the universe. Another way is through space exploration. Share with students that space exploration also depends on astronauts and various kinds of spacecraft to explore space in different ways. Explain that the word *spacecraft* is both the singular and plural form used to describe vessels that are sent into space; there can be one spacecraft or many spacecraft.

Share with students the definition of the word *astronaut*. (a person who is trained for space flight) Ask students if they hear any familiar word part in the word *astronaut*. Prompt students to identify the word part *astro-*



(star). Ask students what they think the word part *-naut* means. Remind students that in “Stars and Constellations” they heard the word *navigate*; *-naut* means having to do with navigation. Guide students to think of an astronaut as a space navigator.

### **Purpose for Listening**

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Tell students to listen closely to learn more about space exploration and the different kinds of telescopes and spacecraft.



## Space Exploration

### ← Show image 9A-1: Copernicus and the heliocentric model

1 Who remembers what *geocentric* means? What other word that ends with *-centric* describes what Copernicus believed and what people today know about the solar system? (*heliocentric*)

Just think—Copernicus, with the help of other scientists before and after him, changed our understandings of astronomy when he discovered that the universe is not geocentric.<sup>1</sup> Copernicus opened our eyes and minds to a whole different way of thinking about the universe.

How were just a handful of people able to come up with an idea that changed the whole world? It's quite simple, really. Copernicus began by studying something he was really interested in: the night sky. His interest led him to make careful observations, to ask questions, to work hard, to study, to think logically to come up with new answers, and to build upon the work of other scientists before him. His willingness to ask questions—even when he had to stand alone with his ideas—led Copernicus to make an important scientific discovery—that our solar system is heliocentric, or sun-centered.<sup>2</sup>

2 Who can name the celestial bodies in the heliocentric view shown in the image? [Point as they are named.]

3 Take a moment now to think of a question you have about the world and how it works. [Pause for a few students to share.] Maybe one day you will discover the answers to your questions!

All of science is based upon careful observations of the world, and a willingness to ask questions about it. Asking questions allows us to come up with new ideas. And new ideas lead to a better understanding about how the world works. That's what the process of science is all about. So, whenever you observe the world around you and ask questions about what you see, you should be proud of yourself because you are thinking like a scientist.<sup>3</sup>



### ← Show image 9A-2: Galileo looking through his telescope; modern telescope

Not too many years after Copernicus died, the telescope was invented. As you heard in the previous read-aloud, Galileo was one of the first astronomers to build and use a telescope. Very soon, many astronomers began using telescopes to take a closer look at the stars. This gave them new information, and so astronomers were able to learn even more about the universe and gather more evidence that supported Copernicus's heliocentric theory. As you

- 4 Sometimes, the more answers you discover, the more questions you generate!
- 5 How do astronomers now classify Pluto? Why is it no longer classified as a planet?



- 6 Why do you think this is? (Answers may vary.)

heard earlier, astronomers discovered the planet Neptune fewer than two hundred years ago, in 1846, when they were finally able to see it with a more powerful telescope. Astronomers continued building different types of and more powerful telescopes, which led to an even better understanding of space—and more questions about it, too!<sup>4</sup> Discovering more objects similar in size to Pluto led scientists to ask again, “How should Pluto be classified?” With more information available, astronomers came up with a brand new answer to that question.<sup>5</sup>

← **Show image 9A-3: Observatory; large telescope**

Today, telescopes that astronomers use are usually located in areas far away from cities.<sup>6</sup> Where there are cities, there is also a lot of light. And where there is a lot of light on Earth, it is harder to see the light of the stars. Light made by humans that hinders or blocks our view of the stars is called light pollution. Besides building telescopes far away from light pollution, astronomers also like to build telescopes on high mountains. You might think it’s so the astronomers can get closer to the stars, but it’s not really that much closer.

An **observatory** is a building designed especially for observing the stars, planets, and other space objects. Placing an observatory high on a mountain allows astronomers to get above as much of Earth’s atmosphere as possible. And as the Earth’s atmosphere thins out in higher places, astronomers can more clearly look at the light of the stars. A more powerful telescope was built for the Lowell Observatory in Arizona for the purpose of finding Pluto. Astronomers thought that Pluto existed before they ever saw it! There appeared to be something in space beyond Uranus and Neptune that was exerting a strong gravitational pull on these planets. Astronomers searched for twenty-five years before they finally discovered Pluto!

But there’s another way that scientists are now able to place telescopes even higher than the highest mountain.<sup>7</sup> Telescopes are launched into space. That’s right! Scientists now use rockets

- 7 Can you guess how scientists do this?

8 There are many space probes, or unmanned spacecraft, exploring space and constantly taking pictures and making new discoveries.



to escape Earth’s surface gravity. The power of rockets enables **spacecraft** to launch telescopes into space. Once beyond Earth’s atmosphere, the telescopes can study the universe more closely and clearly than ever before. Some spacecraft are held in orbit around Earth by its gravity. Other spacecraft have ventured beyond the reach of Earth’s gravity to explore other parts of the solar system. Telescopes and cameras aboard the space **probes** *Voyager 1* and *Voyager 2* have spent the last thirty-five years gathering information about Jupiter, Saturn, Uranus, Neptune, and the outermost reaches of our solar system.<sup>8</sup>

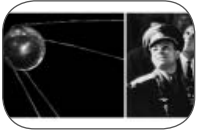
← **Show image 9A-4: Hubble Space Telescope; images taken from the Hubble**

Telescopes that are launched into space are literally “out of this world”—and they are able to take pictures of the universe that are also “out of this world.” The Hubble Space Telescope is the most famous telescope ever to be launched into space. It was carried into orbit by a **space shuttle** in 1990, and it now orbits about 350 miles above the surface of Earth.<sup>9</sup> Because there is very little light pollution in orbit, and because Earth’s atmosphere does not get in the way and cause distortion, this powerful telescope helps scientists see deeper into the universe than ever before. The Hubble Space Telescope has provided scientists with new information—and fantastic pictures—about our own solar system, distant stars, far-away galaxies, and other celestial bodies and occurrences.<sup>10</sup>

9 [Show Image Card 24 (Space Shuttle).] Space shuttles are manned, winged spacecraft that carry supplies, astronauts, and equipment into space and then return to Earth to be used again. The last NASA space shuttle to fly was retired in 2011.

10 [Show Poster 4 (Distant Galaxies) and remind students that this image of distant galaxies was taken with the Hubble Space Telescope.]

New discoveries in science, such as the telescope, always lead to new questions. For most of human history, many of the questions and theories people had about space came from simply gazing up at the night sky. People could look up at the moon and the planets and the stars, but these celestial bodies were completely beyond reach. Once humans invented a way to fly in airplanes—which was only a little more than one hundred years ago—the question soon became, “Can we fly beyond Earth’s atmosphere, all the way into space?”



← **Show image 9A-5: *Sputnik 1*; Yuri Gagarin**

The exciting answer to that question was a loud—yes! In 1957, a group of countries then called the Soviet Union, which included Russia, sent the first satellite made by humans into space.<sup>11</sup> The satellite was called *Sputnik 1*, and it was an aluminum sphere that was only about the size of a beach ball. This small artificial satellite began a whole new revolution in space exploration.

Can you guess what scientists' next question was? It was this: "If we can send a satellite into space, can we also send a living being into space?"<sup>12</sup> A month later Russia sent a dog named Laika [*LIE*-kuh] into space. Laika was the first living being to ever go to space.

After Laika's mission, several more dogs were successfully sent into space. Can you guess what the next question was? Right! "If we can send a dog into space, can we send a human into space?" In 1961, the Soviets again answered this question with a resounding, enthusiastic—yes! The first human being to go into space was Soviet cosmonaut Yuri Gagarin aboard the spacecraft *Vostok 1*.<sup>13</sup> Cosmonaut Yuri Gagarin orbited the globe in *Vostok 1* for 108 minutes before returning to Earth.<sup>14</sup>

11 [Ask a volunteer to point to Russia on a map or globe.]

12 [Show Image Card 25 (Stamps Honoring Space Dog Laika).]  
[Note to teacher: Laika did not survive this mission; you may or may not wish to share this with students.]

13 *Cosmonaut* is the Russian word for *astronaut*.

14 If Yuri Gagarin started at 12:00 noon, 108 minutes later it would have been 1:48, or 12 minutes before 2:00. He was in space for just under two hours!



← **Show image 9A-6: Aldrin on the moon; the *Eagle* lunar module**

With this new **triumph**, or accomplishment, scientists asked a new question: "If we can send a human being into space, can we also send one to land on the moon?" What do you think the answer was? A triumphant—yes! In 1969, the United States sent three astronauts into space— Neil Armstrong, Michael Collins, and Buzz Aldrin.<sup>15</sup> These astronauts traveled to the moon in a spacecraft called Apollo 11, which had three sections. The lunar **module**, or section, of the Apollo 11 was named the *Eagle*, and it landed on the moon with Neil Armstrong and Buzz Aldrin aboard. Meanwhile, astronaut Michael Collins orbited the moon in the Apollo 11 command module, which was called the *Columbia*. A third service module provided power, oxygen, and water.<sup>16</sup>

15 [Show Image Card 26 (Armstrong, Collins, and Aldrin).]

16 [Show Image Card 27 (Apollo 11) and point to each of the modules: service, command, and lunar.] Which of the modules do you think was the main one? (command module)

On July 20, 1969, Neil Armstrong became the first human being ever to walk on the moon. Soon after his feet (which were inside his spacesuit) touched the surface, Neil Armstrong spoke these famous words: “That’s one small step for [a] man, one giant leap for mankind!”

Soon after Armstrong said these famous words, Buzz Aldrin joined him to walk on the surface, where they bounced and hopped to get around because of the moon’s low gravity. The astronauts had to plan their movements six or seven steps ahead because movement on the moon is different from movement on Earth. They also discovered that the fine moon soil was quite slippery. Together, Armstrong and Aldrin collected about forty-eight pounds of moon rocks and brought them back to Earth to be studied. They took many photographs and performed experiments to learn about the moon.<sup>17</sup>

17 [Show Image Card 28 (Aldrin on the Moon; Armstrong in the Reflection).] This is Aldrin with Armstrong’s reflection in his helmet.



← **Show image 9A-7: *Columbia* touching down in the ocean**

Neil Armstrong and Buzz Aldrin rejoined pilot Michael Collins aboard Apollo 11’s *Columbia* where they lived while in space, and they all returned safely to Earth. Thanks to Earth’s gravity, the *Columbia* came back through Earth’s atmosphere and splashed down in the Pacific Ocean.<sup>18</sup> There are lots of pictures of the *Columbia* in magazines and on the Internet, and someday if you ever visit Washington, D.C., you can see the *Columbia* at the Smithsonian Air and Space Museum.

18 [Ask a student to point to the Pacific Ocean on a world map or globe.]

In the past, spacecraft like the Apollo 11 were only able to fly into space and back one time. They were not **reusable**. But with advances in technology, reusable spacecraft have been developed.<sup>19</sup> Reusing the space shuttles has saved time, money, and valuable resources.

19 What type of spacecraft have you heard about that is reusable, or that can be used again? (a space shuttle)







← **Show image 9A-8: Spacecraft**

As scientists continue to explore space in the future, we will continue to better understand both space and the universe. And as we continue to learn more, you can be sure that there will be many new questions that will be asked. Maybe you’ll be asking—and even answering—some of them!



### Comprehension Questions

15 minutes

1.  *Evaluative* [Show Image Card 29 (*Sputnik 1*) and Image Card 27 (Apollo 11).] Why are the *Sputnik 1* and Apollo 11 trips into space considered triumphs? (*Sputnik 1* was the first satellite to be sent into space; Apollo 11 was the first spacecraft to successfully take astronauts to the moon.)
2.  *Inferential* [Show Image Card 28 (Aldrin on the Moon; Armstrong in the Reflection).] Describe Aldrin's and Armstrong's time on the moon. What were some of the things they did and learned while there? (They practiced walking, collected rock samples, took pictures, and performed experiments. They learned that the soil on the moon is fine and slippery, they brought back rocks that could be studied, and they learned about the effects of gravity.)
3. *Inferential* [Show Image Card 27 (Apollo 11).] Describe the three modules of Apollo 11 and the purpose of each. (The service module on the top carried power, oxygen, and water; the command module in the middle was called the *Columbia*, and it was the main part of the spacecraft where the astronauts lived and traveled; the lunar module on the bottom was called the *Eagle*, and it separated from the *Columbia* to land on the moon.)
4. *Evaluative* From its launch until its return to Earth, what effects did gravity have on Apollo 11 and its astronauts? (Apollo 11 needed powerful rockets to be launched in the opposite direction of Earth's gravitational pull; while on the moon, the astronauts had to learn to move with less gravity; Apollo 11 was able to return to Earth with the help of Earth's gravity.)
5.  *Inferential* What factors are important to consider when choosing the site of an observatory? (Being high on a mountain reduces the amount of distortion from the atmosphere; being far away from the light pollution of cities provides darker skies.)

6. *Evaluative* Identify and describe some of the different kinds of spacecraft and tools that scientists use to explore and study space. (A probe is an unmanned spacecraft that takes pictures and gathers information and can travel far out into the solar system; a space shuttle is a winged, manned, reusable spacecraft that carries astronauts and equipment; the Hubble Telescope orbits Earth and can gather information and images from far out in space; observatories are located in dark, high places on Earth and use telescopes to study space.)
7. *Literal* What is unique about space shuttles? (The space shuttles are reusable spacecraft.)
8.  *Evaluative* What do you think Copernicus might think about the discoveries that have been made about space since his time? (Answers may vary.)

I am going to ask a question. I will give you a minute to think about the question, and then I will ask you to turn to your neighbor and discuss the question. Finally, I will call on several of you to share what you discussed with your partner.

9.  *Evaluative Think Pair Share:* If you had a chance to work on or participate in some aspect of space exploration or space travel, what would you choose? Why does this interest you? (Answers may vary.)
  10. After hearing today's read-aloud and comprehension questions and answers, do you have any remaining questions?
-  You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.



## Word Work: Triumph

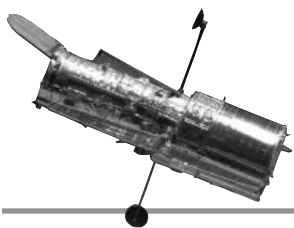
5 minutes

1. In the read-aloud you heard, “With this new *triumph*, or accomplishment, scientists asked a new question.”
2. Say the word *triumph* with me.
3. A triumph is a special achievement, success, accomplishment, or victory.
4. Writing his first chapter book was a triumph for Julian!
5. Have you ever experienced a triumph? Where were you? Be sure to use the word *triumph* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students’ responses to make complete sentences: “I experienced a triumph once when . . . .”]
6. What’s the word we’ve been talking about? What part of speech is the word *triumph*?

Use a *Synonyms and Antonyms* activity for follow-up. Ask students, “What does triumph mean? What are some words or phrases that are synonyms, or words that have a similar meaning?” Prompt students to provide words or phrases like *victory*, *first place*, *accomplishment*, *success*, *a win*, etc. Then ask, “What are some words or phrases you know that are antonyms, or opposites, of *triumph*?” Prompt students to provide words and phrases like *defeat*, *failure*, *disappointment*, *loss*, etc.



## Complete Remainder of the Lesson Later in the Day



# Space Exploration

9<sub>B</sub>

## Extensions

20 minutes



### Writing a Narrative: Draft (Instructional Masters 8B-1 and 9B-1)

Remind students of the steps of the writing process—plan, draft, revise, edit, and publish. Remind them that in the previous lesson they began the planning step of their biography. Tell students that today they are going to finish the “Plan” step and begin the next step: “Draft.” Remind students that this means that they are going to start writing sentences.

Display the brainstorming chart you previously created as a class. Copy Instructional Master 9B-1 onto chart paper, a chalkboard, or a whiteboard. Tell students that they are going to use the words and phrases from each section of the brainstorming chart to create sentences for their first draft about Nicolaus Copernicus’s early life, achievements, and impact. Remind students that together they will write at least three paragraphs—one for Copernicus’s early life, one for his achievements, and one for the impact he had on society.

Have students share ideas for a title, and display these ideas. Tell students that sometimes the title of a biography includes the person’s name. Often, it includes more information. For example, you may wish to show students the cover of the Anthology as an example to review the terms *title* and *subtitle*. You may also wish to show classroom trade books with similar kinds of titles. Explain to students that sometimes the author chooses to add a phrase or word to the second part of the title to interest readers in the biography. Have students think of additional phrases or words they could include in the title after Copernicus’s name. Record students’ original title ideas. You may also wish to suggest some titles. Tell students that you will revisit these when the first draft is finished to see if one of them is a fitting choice.

Remind students that in the opinion and informational paragraphs they have written, they began their paragraphs with a certain type of sentence. Ask, “Who can tell me the name for the type of sentence we used to begin our opinion and informational paragraphs?” (topic sentence)

Tell students that the first sentence of a biography may be a topic sentence, or it may be more of a hook, lead, or opening sentence. Remind students that they used a “hook” sentence when writing a narrative in the *Human Body: Our Systems and Senses* domain. Remind them that the purpose of this “hook” sentence is not necessarily to tell the reader what the story is about, but instead to get the reader interested immediately in the biography. Tell students that a biography may begin with an interesting fact about the person, or a mysterious statement that causes the reader to be curious in finding out more about their story. For example, a first sentence for their narrative biography may be, “This biography is about a man who changed what people thought about the universe forever,” or “Nicolaus Copernicus was an astronomer who challenged the way people thought about the universe.”

Remind students that the narrative they are going to write will have more than one paragraph, so each paragraph may have its own “hook” sentence. Help students form sentences for each paragraph from the brainstorming chart in order to draft the beginning, middle, and end of the biography. Help students formulate the biography so that each part (early life, achievements, and impact) work together. You may wish to show Flip Book images again related to Copernicus and his life and contributions.

As you write sentences onto the draft, model the use of transitional words between sentences and paragraphs to show chronology as well as cause and effect. Use words such as *before*, *after*, *then*, *finally*, *since*, *because*, etc. As you write these sentences, tell students that you are using capital letters at the beginning of your sentences and punctuation at the end. If applicable, tell students that you are using commas between things in a list. Tell students that they will check the grammar and spelling during the editing step, but that they should try to pay attention to these things as they are writing their draft as well. You may wish to intentionally make some minor mistakes to correct later during the editing step.

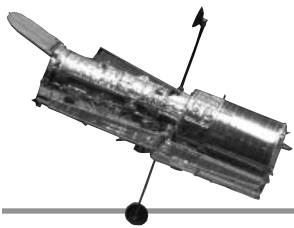
Remind students that in their opinion and informational paragraphs, they ended their paragraphs with a certain type of sentence. Ask, “Who can tell me the name for the type of sentence we used to end our opinion and informational paragraphs?” (concluding sentence)

Explain that a concluding sentence in biographical writing is often used the same way as in opinion and informational writing: to conclude,

or wrap up, the paragraph or biography. Sometimes, the concluding sentence includes a reference to life today, in addition to wrapping up what was previously stated. For example, an ending sentence for a biography may be, “Nicolaus Copernicus’s revolutionary ideas still affect how we view the universe today,” or “Even though his achievements were not recognized while he was alive, Nicolaus Copernicus’s discovery that Earth is a planet is accepted by everyone today.”

Read the completed biography to the class. Ask students if they think each section is clear. Revisit the list of title ideas to see if one of them is a fitting choice. Tell students that you are going to continue to work on this draft together during the next writing session. Encourage students to be thinking of any other title and/or subtitle ideas and other changes that they think are needed in the biography. Tell students that you will help them to revise, or make changes to, this biography during the next writing session.

**Note:** You may wish to have some students use Instructional Masters 8B-1 and 9B-1 to complete this step of the writing process on their own, collecting their worksheets in their Space Notes notebooks or folders. You may need to take more than one day to complete this step of the writing process, as the biography is longer than other genres previously taught.



# Mae Jemison

10

## Lesson Objectives

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### Core Content Objectives

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Students will:

- ✓ Describe tools and methods used to study space and share information
- ✓ Identify and use vocabulary important to the process of science
- ✓ Describe the life and contributions of Copernicus
- ✓ Recall key details about the history of space exploration
- ✓ Describe the life and contributions of Mae Jemison

### Language Arts Objectives

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The following language arts objectives are addressed in this lesson. Objectives aligning with the Common Core State Standards are noted with the corresponding standard in parentheses. Refer to the Alignment Chart for additional standards addressed in all lessons in this domain.

Students will:

- ✓ With assistance, interpret Copernicus's life events related to the content in "Nicolaus Copernicus" and notes taken in the graphic organizer as students continue drafting and revising their narrative writing pieces (RI.3.3)
- ✓ Sequence four to six sentences describing events in Copernicus's life for each paragraph in the narrative writing piece (RI.3.3)
- ✓ Describe the relationship between the historical events and scientific ideas related to Copernicus's heliocentric theory of the solar system, using language that pertains to time, sequence, and cause/effect as they continue drafting the narrative writing piece (RI.3.3)
- ✓ Distinguish between events that occurred in Copernicus's early life, the achievements he made during his adult life, and the impact his ideas and work had on the thinking of people in future years (RI.3.3)

- ✓ Determine the literal and nonliteral meanings of and appropriately use common sayings and phrases, such as “a launch pad” and “a feather in your cap” as used in “Mae Jemison” (RI.3.4) (L.3.5a)
- ✓ Interpret and describe images from “Nicolaus Copernicus” and how they contribute to what is conveyed by the words in the text as the narrative writing piece is developed (RI.3.7)
- ✓ Compare and contrast the lives of Nicolaus Copernicus and Mae Jemison as shown in the images and described in the read-alouds (RI.3.9)
- ✓ Continue to draft and revise paragraphs begun in prior lessons; use the paragraph topics established and draft/revise so that sentences unfold naturally (W.3.3a)
- ✓ Use descriptions of Copernicus’s and others’ actions, beliefs, and thoughts to continue developing the experiences and events of Copernicus’s life and the response of others to his ideas (W.3.3b)
- ✓ Use temporal words and phrases to signal event order during the drafting/revision steps of the development of the narrative piece (W.3.3c)
- ✓ Provide a sense of closure in the draft/revision of the narrative writing piece, with special attention given to the role of a concluding sentence (W.3.3d)
- ✓ With guidance and support from peers and adults, use the steps of the writing process such as plan, draft, revise, edit, and publish to create a narrative writing piece that will be developed and strengthened over an extended time frame (W.3.5) (W.3.10)
- ✓ With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others (W.3.6)
- ✓ Make personal connections to the Apollo 11 mission through discussion of what it meant to the astronauts on the mission, people on Earth at that time, and for us today (W.3.8)
- ✓ Make personal connections to the work that NASA does today and the kinds of jobs and people needed for space missions to be triumphant (W.3.8)
- ✓ Make personal connections to the word *mission* by remembering and sharing the experience of a personal mission (W.3.8)

- ✓ Make personal connections to the way in which Mae Jemison pursued her dreams by identifying an interest or passion they may wish to pursue someday, and by thinking of a personal example of something that was “a feather in their cap” (W.3.8)
- ✓ Determine the main ideas and supporting details about Copernicus’s life and the significance of his ideas from information presented in diverse media and formats, including the read-aloud, images, trade books, and available media (SL.3.2)
- ✓ Summarize Mae Jemison’s achievements (SL.3.4)
- ✓ Choose words and phrases to effectively describe Nicolaus Copernicus and his ideas as they continue to draft/revise the narrative writing piece (L.3.3a)
- ✓ Determine the meaning of a new word when a known affix is added to a known word, such as *national/international* (L.3.4b)
- ✓ Use the known root *-naut* and the newly learned root *aero-* as a clue to the meaning of the unknown word *aeronautics* (L.3.4c)
- ✓ Distinguish shades of meaning while drafting/revising the narrative piece among related words that describe degrees of certainty, such as *predict, hypothesis, theory, believe, and prove* (L.3.5c)
- ✓ Acquire and use accurately grade-appropriate conversational, general academic, and domain specific words and phrases, including those that signal spatial and temporal relationships, to describe the lives of Nicolaus Copernicus and Mae Jemison, such as *orbit, center, heliocentric, solar system, long ago, today, mission, and spacecraft* (L.3.6)

## Core Vocabulary

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**Note:** You may wish to display some of these vocabulary words in your classroom for students to reference throughout the domain. You may also choose to have students write some of these words in a “domain dictionary” notebook, along with definitions, sentences, and/or other writing exercises using these vocabulary words.

**aeronautics, n.** The study or practice of flight and aircraft

*Example:* Anna’s Uncle Charles studied aeronautics before becoming an airplane pilot.

*Variation(s):* none

**applications, n.** Written requests to be considered for a program or job  
*Example:* The manager at the restaurant looks at a lot of applications before deciding who to hire for a job.

*Variation(s):* application

**conducted, v.** Carried out or made something happen

*Example:* The astronauts who live and work on the International Space Station have conducted many experiments.

*Variation(s):* conduct, conducts, conducting

**engineering, n.** The study and work of using science, knowledge, and methods to solve problems in the world

*Example:* When the city decided to build a bridge across the river, they knew it was important to have good engineering so that it would be strong and safe.

*Variation(s):* none

**international, adj.** Among or between two or more nations or countries

*Example:* Protecting the world's oceans is an important international issue.

*Variation(s):* none

**mission, n.** A specific task or job that a person or team is sent to perform

*Example:* Jorge's dad sent him on a mission to pick up a tool at the hardware store.

*Variation(s):* missions

**pursue, v.** To do what it takes to accomplish something

*Example:* It was very important to Mae Jemison to pursue her dreams.

*Variation(s):* pursues, pursued, pursuing

**refugees, n.** People who flee to another country for protection or safety

*Example:* Cameron and his family listened to the news about the poor living conditions for the refugees.


*Variation(s):* refugee

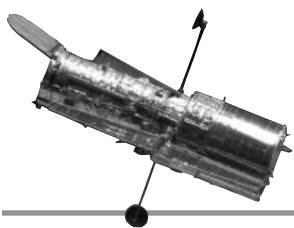
**tragedy, n.** A very sad event or a disaster

*Example:* Emma and her family were saddened to hear the news of the earthquake tragedy in China.

*Variation(s):* tragedies



<i>At a Glance</i>	<b>Exercise</b>	<b>Materials</b>	<b>Minutes</b>
<b><i>Introducing the Read-Aloud</i></b>	<b>What Have We Already Learned?</b>		10
	<b>Essential Background Information or Terms</b>		
	<b>Purpose for Listening</b>	Image Card 30	
<b><i>Presenting the Read-Aloud</i></b>	<b>Mae Jemison</b>	Image Card 24; U.S. map; world map or globe; chart paper, chalkboard, or whiteboard	20
<b><i>Discussing the Read-Aloud</i></b>	<b>Comprehension Questions</b>	Image Card 30	15
	<b>Word Work: Mission</b>		5
 <b>Complete Remainder of the Lesson Later in the Day</b>			
<b><i>Extensions</i></b>	<b>Sayings and Phrases: A Feather In Your Cap</b>		15
	<b>Writing a Narrative: Draft/Revise</b>	Instructional Masters 8B-1, 9B-1, 10B-1, 10B-2; chart paper, chalkboard, or whiteboard	



# Mae Jemison

10<sub>A</sub>

## Introducing the Read-Aloud

10 minutes

### What Have We Already Learned?

Remind students that in the last lesson they heard about the first astronauts to walk on the moon. Have students describe what this experience was like for the astronauts Neil Armstrong and Buzz Aldrin. (scary, exciting, etc.) Have students describe what this experience was like for the people listening to the steps of their journey on Earth. (scary, exciting, joyous, etc.) Reread Armstrong's words, "That's one small step for [a] man, one giant leap for mankind!" Ask students, "What did his words mean when he said them? What do you think the importance of his words is to you today?"

### Essential Background Information or Terms

Review the term *astronaut* with students. Tell students that all astronauts in the United States train with NASA. Ask students if they remember what the letters in the acronym NASA stand for. (National Aeronautics and Space Administration) Share that NASA is an organization that was started to lead the scientific research and exploration of outer space. Tell students that it was NASA that coordinated the Apollo 11 trip to the moon, other manned flights into space, and many voyages of the spacecraft that have taken pictures of the distant planets in our solar system. Tell students that NASA was formed in 1958 and since then continues to change the way we think about the universe.

Tell students that a lot of people work for NASA to support its many missions. Explain that a mission is a specific task or job that a person, team, or piece of equipment is sent to perform. Ask students, "What kinds of missions have you heard about that involve learning about space?" (Answers may vary.) Ask students, "What kinds of things do you think scientists and other workers at NASA might do to help astronauts and spacecraft triumph in their missions?" Guide students to understand that it takes many kinds of workers to help astronauts and spacecraft to be successful in their missions to learn more about space.

## **Purpose for Listening**

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Show students Image Card 30 (Mae Jemison) and tell them that Jemison is a famous astronaut who worked for NASA. Tell students to find out why Jemison is famous and in what year she traveled into space. Ask students to listen for the many contributions Jemison has made during her life.



## Mae Jemison

### ← Show image 10A-1: Spacecraft

We have taken an imaginary adventure into space in our special classroom “spaceship,” but how would you like to *really* travel into space?

When Copernicus was born in the 1400s, space travel was an impossible dream. Copernicus didn’t even have a telescope, let alone a spacecraft! But thanks to the careful observations, logical thinking, and bold ideas of Copernicus and many other scientists before and after him, today we live in an amazing time when dreams of space travel really can come true. Advancements or improvements in technology have made it possible for human beings to travel into space. Ever since Apollo 11 first landed on the moon in 1969, more and more astronauts have flown into space. Would you like to be one of them?



### ← Show image 10A-2: Astronaut Mae Jemison

Mae Jemison’s answer to that question was definitely yes! She dreamed about going into space from the time she was a little girl. And when she grew up, that’s exactly what she did. In 1992 Mae Jemison blasted into space aboard the Space Shuttle *Endeavour*.<sup>1</sup> She lived on the *Endeavour* for eight days and **conducted**, or carried out, many experiments while she was there. In these experiments, she carefully collected information about how weightlessness in space affects animals and humans. One of the experiments involved frog eggs. Jemison wanted to see if they would develop into tadpoles normally while in orbit.<sup>2</sup>

Mae Jemison was the first African-American woman ever to go into space. In fact, she was the first African-American female astronaut in the history of the National **Aeronautics** and Space Administration.<sup>3</sup>

1 [Show Image Card 24 (Space Shuttle).] This space shuttle is similar to the *Endeavour* on which Jemison traveled. Who remembers what is special about space shuttles?

2 Do you think they did? Yes, they did!

3 If the word part *aero-* means having to do with air, and the word part *-nautics* is related to navigation, what do you think *aeronautics* means? (the science of flight, or navigating through the air)



← **Show image 10A-3: Mae Jemison as a child**

How did Mae Jemison make her childhood dreams of space travel come true? Part of the answer is that when she was young, she read—a lot—about the things she was interested in. Jemison was born in 1956 in Decatur, Alabama, but grew up in Chicago, Illinois.<sup>4</sup> As a child, Jemison was very interested in space. She was twelve years old when astronaut Neil Armstrong and his Apollo 11 **mission** landed on the moon. At age fourteen, Jemison was still interested in space, so she read many adult books about astronomy. At the age of only sixteen, she graduated from high school and went to college at Stanford University in Stanford, California.<sup>5</sup>

4 [Have a volunteer point to Alabama and Illinois on a U.S. map.]

5 [Have a volunteer point to California on a U.S. map.]



← **Show image 10A-4: Mae Jemison graduating from college**

Education was very important to Mae Jemison. Education is also very important to NASA in choosing who will become an astronaut. While Jemison was at Stanford University, she studied chemical **engineering**, which is the study of chemicals or substances and how they can be used to solve problems or make products.<sup>6</sup> While she was at college, Jemison also enjoyed theater, dancing, and playing football with her friends. She believed it was important to be a well-rounded person, which means to study and enjoy many different things. Jemison graduated from college with a degree in chemical engineering and Afro-American studies.

6 Plastic is just one of the many materials that we use every day developed through chemical engineering.



← **Show image 10A-5: Mae Jemison working in Africa**

Besides wanting to be an astronaut, Mae Jemison also wanted to be a biomedical engineer.<sup>7</sup> Biomedical engineers seek new ways to use technology to improve healthcare for people. When Jemison graduated from college, she thought about applying right away to NASA to become an astronaut, but decided to go to medical school first. In medical school she traveled around the world, providing medical care to people living in developing countries.<sup>8</sup> As a medical school student, Jemison traveled to Kenya in Africa where she helped with community medicine projects in a very difficult area.

7 An engineer is a person who uses the knowledge and tools of engineering to solve problems.

8 A developing country is a country where most people do not have a lot of money or resources, and many do not have all of the basic things they need to live a healthy life—such as adequate food, healthcare, clean water, and education.

9 [Have a volunteer point to Kenya, Thailand, and Cambodia on a world map or globe.] Refugees are people who have had to flee to another country to find safety.



10 Jemison certainly has many dreams that she has pursued!

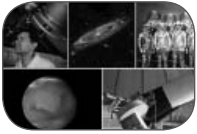
Jemison also traveled to Thailand in Asia to care for **refugees** from Cambodia.<sup>9</sup> After Jemison graduated from medical school, she worked for the Peace Corps for more than two years. The Peace Corps is a U.S. governmental organization that sends volunteers to assist people in developing countries. In the Peace Corps, Jemison was responsible for the health of Peace Corps volunteers working in West Africa.

← **Show image 10A-6: Mae Jemison at work on the space shuttle**

In 1985, Mae Jemison decided the time was right to **pursue** her dream of space travel.<sup>10</sup> She applied to NASA to become an astronaut. But soon afterward, in January 1986, NASA suffered a terrible **tragedy** in its Space Shuttle program. The Space Shuttle *Challenger* burst into flames a little over a minute after it was launched. After this tragedy, all astronaut **applications**—including Jemison’s—were postponed, meaning that NASA was not accepting any applications for new astronauts for a time. After NASA reopened the astronaut application program, Jemison found out she was chosen to be an astronaut in 1987.

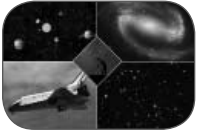
In 1992, after completing her Space Shuttle mission aboard the *Endeavour*, Jemison was famous. She was the first African-American woman to go into space. Jemison retired from NASA in 1993 to pursue some of her other dreams. Jemison has used her fame as a “launch pad” to bring important issues into the public spotlight. She founded an **international** science camp called The Earth We Share.<sup>11</sup> Students at the international camp work to help solve current global problems by using science and technology. She also started her own company, which seeks to develop technologies that benefit planet Earth and the people who live on it. But most of all, Jemison is a great example of how important it is to follow your many dreams. Mae Jemison is living proof that your dreams can literally take you “out of this world!”

11 [You may wish to write the word *international* on chart paper, a chalkboard, or a whiteboard.] What word parts do you see in this word? The prefix *inter-* means among or between and the word part *-national* means nations or countries. What do you think the word *international* means? (among or between two or more nations)



← **Show image 10A-7: Astronomy images**

Mae Jemison is just one of many astronomers who have added to our knowledge and understanding of space and the universe. For thousands of years, humans have been curious about the celestial bodies and what lies beyond the Earth. Even now, there are man-made satellites, spacecraft, and even scientists in space performing experiments, gathering information, and taking pictures.



← **Show image 10A-8: What discoveries are yet to come?**




As we come to the end of our space journey together, there is still one question: what's next? As we learn more and more about our world, there could be a thrilling discovery waiting right around the corner. Will you be the next great scientist to contribute to the work of other scientists who have come before you? Will you become an astronaut and set foot on another planet or moon? Will you discover a new celestial body, a new galaxy, or a new way of thinking about our world? What's next?


## ***Discussing the Read-Aloud***

**20** minutes



### **Comprehension Questions**

**15** minutes

1.  *Literal* [Show Image Card 30 (Mae Jemison).] Why is Mae Jemison famous? (In 1992, she was the first African-American woman to become an astronaut and travel into space.)
2.  *Inferential* Describe Jemison's mission as an astronaut. (She traveled into space and lived on the Space Shuttle *Endeavor* for eight days. She conducted many experiments about how weightlessness affects plants and animals.)
3. *Inferential* What are some of the achievements Jemison had before becoming an astronaut? (She graduated from school early, became a doctor and studied engineering, joined the Peace Corps, helped refugees, etc.)
4.  *Evaluative* NASA considers many applications for the astronaut program. What kinds of characteristics and skills do you think made Jemison a good candidate for NASA? (She had determination, strong academics, a love of reading and science, was a doctor and an engineer, had many degrees, etc.)

5. *Inferential* Why did NASA stop taking applications for new astronauts for a period of time when Jemison was interested in joining NASA? (There was a tragedy in the space program when the Space Shuttle *Challenger* burst into flames. NASA stopped taking applications for new astronauts for a while.)
6. *Inferential* What kind of international work did Jemison do to help people around the world? (Jemison helped with a community medicine project in Kenya; she helped care for Cambodian refugees in Thailand; she was responsible for the healthcare of Peace Corps volunteers in West Africa; she founded an international science camp to help students learn to solve global problems; she started a company to develop technologies to help planet Earth and the people who live on it.)
7.  *Evaluative* Compare and contrast the lives of Nicolaus Copernicus and Mae Jemison. (Answers may vary, but may include: Copernicus was a white man; Jemison is an African-American woman. Copernicus lived in the late 1400s and early 1500s; Jemison was born in the mid-1900s and is still living. Copernicus had little use of technology to make his observations; Jemison had the help of NASA and its technology to conduct her observations and experiments. Copernicus studied in Europe; Jemison traveled all over the world and into space.)

I am going to ask a question. I will give you a minute to think about the question, and then I will ask you to turn to your neighbor and discuss the question. Finally, I will call on several of you to share what you discussed with your partner.

8.  *Evaluative Think Pair Share:* Mae Jemison had many dreams she wanted to pursue. Think about your interests and passions. What do you want to pursue now or as you get older? (Answers may vary.)
  9. After hearing today's read-aloud and comprehension questions and answers, do you have any remaining questions?
-  You may wish to allow time for individual, group, or class research of the text and/or other resources to answer any remaining questions.



## Word Work: Mission

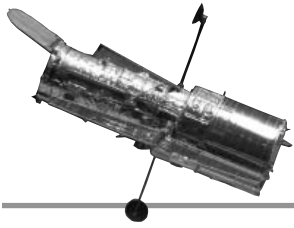
5 minutes

1. In the read-aloud, you heard, “[Jemison] was twelve years old when astronaut Neil Armstrong and his Apollo 11 *mission* landed on the moon.”
2. Say the word *mission* with me.
3. A mission is a special task or job that a person or a team is sent to do.
4. People on Earth watched with excitement as astronauts Aldrin, Armstrong, and Collins carried out their mission to the moon on Apollo 11.
5. Have you ever been on a mission or pretended to be on a mission? Has an adult you know ever been on a mission? Be sure to use the word *mission* when you tell about it. [Ask two or three students. If necessary, guide and/or rephrase the students’ responses to make complete sentences: “\_\_\_\_\_ was on a mission when . . .”]
6. What’s the word we’ve been talking about? What part of speech is the word *mission*?

Use a *Sharing* activity for follow-up. Directions: Turn to your partner and tell them about a time when you or someone you know was on a mission. What difficulties had to be overcome? What were the rewards for succeeding in the mission? Be sure to use the word *mission* in a complete sentence as you share.



### Complete Remainder of the Lesson Later in the Day



# Mae Jemison

10<sub>B</sub>

## Extensions

20 minutes

### Sayings and Phrases: A Feather In Your Cap

5 minutes

An idiom is an expression whose meaning goes beyond the literal meaning of its individual words. Idioms have been passed down orally or quoted in literature and other printed text. Idioms often use figurative language, meaning that what is stated is not literally taking place. It is important to help your students understand the difference between the literal meanings of the words and their implied or figurative meanings.

Ask students if they have ever heard someone say “a feather in your cap.” Have students repeat the idiom. Ask students what a cap is. (hat) Explain that this idiom refers to an accomplishment that is worthy of praise. Memorizing all of the multiplication tables, for example, can be a feather in your cap. This 17th-century idiom comes from an ancient Native American and Asian custom. Warriors placed a feather in their headgear for every enemy they defeated in battle.

Ask students, “In today’s read-aloud, which of Jemison’s accomplishments could be seen as a feather in her cap? (becoming a doctor and an engineer, serving in the Peace Corps, being the first African-American female astronaut, etc.)

When Mae Jemison became the first African-American female in space, someone could have told her, “That accomplishment is a feather in your cap!” It used to be that only men with backgrounds as jet pilots were considered for becoming astronauts with NASA, so Jemison broke many boundaries as an African-American woman who worked hard to develop herself as a scientist.

Ask students if they can think of a situation where they or someone else they know has achieved an accomplishment that is a feather in their cap. You may wish to share an example of your own. Try to find other opportunities to use this saying in the classroom.



## Writing a Narrative: Draft/Revise (Instructional Masters 8B-1, 9B-1, 10B-1, and 10B-2)

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Display the planning and drafting charts created as a class based on Instructional Masters 8B-1 and 9B-1. Remind students that they have completed the planning step of the writing process and that today they are going to continue working on the drafting step together.

Read the draft of the biography to the class. Have students share any additional ideas they may have for a title and/or subtitle and add these to the list. Have students also share any other ideas they may have for a new/different “hook.” Display this list of ideas.

Tell students that they are going to use a Revision Checklist to help them know what other changes need to be made to the biography, just as they did with their opinion and informational paragraphs. Remind students that the word *revise* means change and is a substep of the drafting step. Explain that writers often revise many, many times before they are able to call their final manuscript “finished.” Remind students that revising is different from editing: revising often includes making changes to the content and/or the order of the content, whereas editing often includes making corrections to grammar, punctuation, and spelling according to the rules of standard English. Tell students that they will complete the editing step the next time you meet to work on writing.

Copy Instructional Master 10B-1 onto chart paper, a chalkboard, or a whiteboard. Read the Revision Checklist to students. Remind students that in the opinion paragraph they wrote together in *Classic Tales: The Wind in the Willows*, their supporting example sentences were in chronological order because they followed the plot of the story. Tell students that many biographies follow the events of a person’s life in chronological order, but that sometimes a biography begins halfway through the person’s life and then flashes back to the past, or moves forward into the future.

✈ You may wish to introduce/review the terms *flashback* and *foreshadowing* if students grasp the concepts of the basic biography and are ready for this variety/challenge, writing the sentences onto strips and moving them around to see which order helps the narrative flow best.

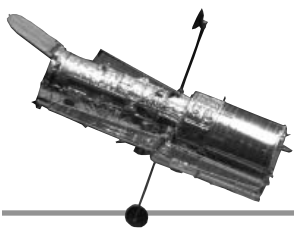
Once the class has decided upon the necessary revisions, tell students that the last substep of the drafting step is to write a second draft of the biography, incorporating the changes made during the revision

substep. Rewrite the sentences onto chart paper, a chalkboard, or a whiteboard, telling students once again that you are using capital letters at the beginning of sentences and appropriate punctuation at the end, quotation marks around any dialogue, and commas to introduce dialogue and to separate things in a list.

Read the final draft aloud to the class. Revisit the list of ideas for a title to see if one of them is a fitting choice. Encourage students to keep thinking about any other title ideas. Tell students that they will complete the next step of the writing process—editing—the next time you meet to work on writing together, and that you will decide on a final title then.

**Note:** You may wish to have some students use Instructional Masters 10B-1 and 10B-2 to complete this step of the writing process on their own, collecting their worksheets in their Space Notes notebooks or folders. Also, you may need to take more than one day to complete this step of the writing process, as the biography is longer than other genres previously taught.

This is the last read-aloud of this domain. The editing and publishing steps of the narrative writing piece have been placed at the beginning of Pausing Point 2. It is highly recommended that this first section of Pausing Point 2 be regarded as *required* in order to most accurately align with the writing requirements of the Common Core State Standards. Refer to the recommended schedule in the Introduction to guide you in planning the remaining days of this domain. During this time, some students may have the opportunity to write biographies on various key science figures.



## Pausing Point 2

PP<sub>2</sub>

### **Note to Teacher**

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Students have now heard all of the read-alouds in the *Astronomy: Our Solar System and Beyond* domain. It is highly recommended that you pause here and spend two days reviewing, reinforcing, or extending the material taught thus far.

You may have students do any combination of the activities listed below. The activities may be done in any order. You may wish to do one activity on successive days. You may also choose to do an activity with the whole class or with a small group of students who would benefit from the particular activity.

### **Core Content Addressed in This Domain**

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Students will:

- ✓ Identify the sun as a constant source of heat and light energy
- ✓ Classify the sun as a star
- ✓ Identify our planet Earth as the third planet from the sun and ideally suited for life
- ✓ Demonstrate how day and night on Earth are caused by Earth's rotation
- ✓ Explain why the sun seems to rise in the east and set in the west
- ✓ Explain what happens during a solar eclipse and lunar eclipse
- ✓ Explain the reasons for seasons
- ✓ Describe the eight planets of our solar system and their sequence from the sun
- ✓ Identify our solar system as the sun and all of the smaller bodies that orbit it, e.g., the planets, moons, asteroids, etc.
- ✓ Describe the characteristics of a planet
- ✓ Explain that Pluto has been reclassified as a dwarf planet
- ✓ Describe the asteroid belt

- ✓ Compare and contrast asteroids, meteoroids, and comets
- ✓ Describe stars as hot, distant, and made of gas
- ✓ Describe the characteristics of stars
- ✓ Compare and contrast our sun and other stars
- ✓ Describe a galaxy as a very large cluster of many stars
- ✓ Identify the Milky Way as our own galaxy and Andromeda as the closest spiral galaxy in our universe
- ✓ Describe the universe as a vast space that extends beyond the imagination
- ✓ Describe gravity
- ✓ Describe the effects gravity has on Earth, within the solar system, and in the universe
- ✓ Explain what constellations are and how they are useful
- ✓ Recognize and name important constellations
- ✓ Describe tools and methods used to study space and share information
- ✓ Identify and use vocabulary important to the process of science
- ✓ Explain the Big Bang Theory as an important scientific theory of the origin of the universe
- ✓ Describe the life and contributions of Copernicus
- ✓ Recall key details about the history of space exploration, e.g., Galileo's invention of the telescope, *Sputnik 1*, Apollo 11, and the Hubble Space Telescope
- ✓ Describe the life and contributions of astronaut Mae Jemison

## Activities

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### Writing a Narrative: Edit/Final Copy

#### **Materials: Instructional Masters 8B-1, 10B-2, PP2-1, and PP2-2**

Display the plan and drafts created as a class based on Instructional Masters 8B-1 and 10B-2. Remind students that they have completed the planning and drafting steps of the writing process together and that today they are going to complete the editing step. Tell students that this is also the time to decide on a final title.

Tell students that they are going to use an Editing Checklist to help them know if any further corrections are needed. Remind students that writers often edit their drafts many, many times before they are able to call their manuscripts “finished.” Remind students that editing is different from revising; revising often includes making changes to the content and/or order of content, whereas editing often includes making corrections to grammar, punctuation, and spelling to follow the rules of standard English.

Copy Instructional Master PP2-1 onto chart paper, a chalkboard, or a whiteboard. Read the Editing Checklist to the class. Have students refer to the most recent draft of the narrative and discuss any necessary edits to grammar, punctuation, or spelling. As you make corrections to the draft and check off the items on the checklist, you may wish to model basic proofreading marks for students.

Tell students that after editing and deciding on a title, the last substep before publishing the biography is to create a final copy. You may wish to type this final copy, modeling for students keyboarding skills, including spellcheck, dictionary, and thesaurus functions.

Tell students that they have now completed the editing step, including the substep of creating the final copy, and that they will complete the publishing step the next time they meet to work on writing. Explain that this means they are going to create a presentation of the final copy, possibly together with illustrations and/or other graphic aids, to display and share with others. Encourage students to be thinking of any illustrations they would like to include with this biography during the publishing step.

**Note:** You may wish to have some students use Instructional Masters PP2-1 and PP2-2 to complete this step of the writing process on their own, collecting their worksheets in their Space Notes notebooks or folders. Some students may have the opportunity to write their own biographies during this Pausing Point. You may need to take more than one day to complete this step of the writing process, as the biography is longer than other genres previously taught.



## Writing a Narrative: Publish

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### Materials: Instructional Master PP2-2

Remind students that they have completed the editing step of the writing process, including the substep of creating the final copy. Display this final

copy based on Instructional Master PP2-2, and tell students that they will now complete the publishing step of the writing process. Explain that this means they will create a presentation of their biography to share.

You may wish to provide groups of students with copies of the final biography they created as a class and allow them to create various ways to publish it. For example, some students may wish to use technology to add computer graphics such as illustrations, text boxes, and sidebars to aid in the presentation of information. Some students may wish to create a PowerPoint presentation. Other students may wish to create an artistic “book” format of the narrative, perhaps with handwritten text and/or handmade illustrations.

Encourage students to be creative. If you choose to have students work in groups, have them share their published narrative with the class. You may wish to share the class biography within the school and/or community.

**Note:** You may wish to have some students complete this step of the writing process on their own, collecting their worksheets in their Space Notes notebooks or folders.

### **Alternate Biographies**

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To expand upon Nicolaus Copernicus’s discoveries and on the section on gravity, you may wish to discuss the scientist Isaac Newton, who discovered the laws of gravity. Some students may wish to do their independent writing on Newton as well.

You may also wish to have students research one of the other astronauts, such as Buzz Aldrin or Neil Armstrong, and then write a biography about one of them.

### **Solar System Models**

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#### **Materials: Poster 1; drawing paper, drawing tools**

Tell students that before Copernicus discovered that Earth orbited the sun, many people believed a theory by a man named Ptolemy. Ptolemy said that Earth was at the center of the universe. Invite students to draw Ptolemy’s geocentric solar system (with Earth in the center). Show students Poster 1, and invite them to draw the solar system as we know it today—and as Copernicus described it—with the sun in the center.



## Image Review

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Show the Flip Book images from any read-aloud again, and have students retell the read-aloud using the images.

## Image Card Review

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### Materials: Image Cards 1–30

In your hand, hold Image Cards 1–30 fanned out like a deck of cards. Ask a student to choose a card but to not show it to anyone else in the class. The student must then perform an action or give a clue about the picture s/he is holding. For example, for Mae Jemison, a student may pretend to practice medicine or say, “I founded an international space camp to use science and technology to help solve world problems.” The rest of the class will guess what person is being described. Proceed to another card when the correct answer has been given.



## Domain-Related Trade Book or Student Choice

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### Materials: Trade book

Read an additional trade book to review a particular concept; refer to the books listed in the introduction. You may also choose to have the students select a read-aloud to be heard again.

If students listen to a read-aloud a second time, you may wish to have them take notes about a particular topic. Be sure to guide them in this important method of gathering information. You may wish to model how to take notes, construct an outline, etc.

## Key Vocabulary Brainstorming

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### Materials: Chart paper, chalkboard, or whiteboard

Give the students a key domain concept or vocabulary word such as *Big Bang Theory* or *stars*. Have them brainstorm everything that comes to mind when they hear the word, such as, *theory of the beginning of the universe, constellations, Orion*, etc. Record their responses on chart paper, a chalkboard, or a whiteboard for reference.

You may also wish to have students do this brainstorming activity individually or with a partner.

## Multiple-Meaning Word Activity: Conducted

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**Materials: Chart paper, chalkboard, or whiteboard; images depicting the various meanings of the word *conducted***

1. In the read-aloud “Mae Jemison,” you heard the word *conducted* in this sentence about Jemison: “She lived on the *Endeavour* for eight days and conducted many experiments while she was there.”
2. With your neighbor, think of and discuss as many meanings for the word *conducted* as you can. [Give students a few minutes to brainstorm and discuss. You may wish to encourage them to jot down their ideas.]
3. [Create three columns on chart paper, a chalkboard, or a whiteboard. Write the letter ‘A’ at the top of the first column. Now ask a volunteer to come up with a definition for the word *conducted* as it occurred in the read-aloud. Write “carried out or made something happen” next to the ‘A.’]
4. [Ask a volunteer to share a different meaning of *conducted* that may have emerged from their discussions; guide students to the second meaning for *conducted*. Write the letter ‘B’ at the top of the second column, and add the definition “directed or led” beside it.]
5. [Ask if anyone came up with a third different meaning for *conducted*; guide the discussion to the third meaning. Write the letter ‘C’ at the top of the third column, and add the definition “served as a route/path or direction for, as for electricity.”]
6. [Read the following sentences one at a time. At the end of each sentence, have students indicate which column the sentence belongs in according to the meaning for *conducted*, and write it on chart paper, a chalkboard, or whiteboard in the correct column.]
  - Terry Ann conducted the orchestra for her school’s spring musical. (B)
  - Electricity cannot be conducted through rubber, so a safe place during a lightning storm is in a car. (C)
  - Mr. Lee’s class conducted a survey to find out which piece of playground equipment was most commonly used. (A)
  - The mother duck conducted her ducklings through the rippling stream, seemingly to avoid the waterfall. (B)
  - The soapstone floor under Sandy’s wood stove conducted heat, which warmed the entire room. (C)

- The marching band played their instruments together beautifully as Minna conducted them with precision. (B)
- Judge Vance conducted the trial with fairness and compassion. (A)

## 10 Riddles for Core Content

Ask the students riddles such as the following to review core content:

- I theorized that the sun was at the center of the solar system. Who am I? (Nicolaus Copernicus)
- I was the first African-American woman to travel into space. Who am I? (Mae Jemison)
- I am the name of the mission during which astronauts Neil Armstrong and Buzz Aldrin first landed on the moon. What was I called? (Apollo 11)
- I am a picture that a group of stars appears to make in the night sky. What am I? (constellation)
- I am far from the sun and have been reclassified because of new scientific evidence. (Pluto)
- The axis of the earth points to me, and I show humans where to find a northern direction. (the North Star or Polaris)
- I was the first satellite made by humans to be sent into space. (*Sputnik 1*)
- I am a scientific explanation for how the universe began. (the Big Bang Theory)
- I improved upon the telescope and discovered the four moons nearest to Jupiter. (Galileo)
- I am a journey with a purpose, perhaps to the moon or Jupiter or Africa or even across town. (a mission)

## Class Book: *Astronomy: Our Solar System and Beyond*

### Materials: Drawing paper, drawing tools

Tell the class or a group of students that they are going to add to the class book to help them remember what they have learned in this domain. Have the students brainstorm important information about the Big Bang Theory, stars and constellations, space exploration, Nicolaus Copernicus, and Mae Jemison. Have each student choose one idea to draw a picture of and ask him or her to write a caption for the picture. Bind the pages to make a book to put in the class library for students to read again and again.

## Astronomy Bulletin Board

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### Materials: Drawing paper, drawing tools


Make a bulletin board to illustrate what students have learned in this domain. Have students draw pictures of planets and other celestial bodies, galaxies, eclipses, etc., or cut out images from magazines depicting these items. Have students write a fact about each illustration. As students create, encourage them to use complex vocabulary, including, if possible, any domain-related vocabulary.


## Constellations

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### Materials: Black paper; white chalk; hair spray; star stickers (optional)

Have students peruse the book tub for books about constellations. Have students draw a constellation of their choosing on black paper with white chalk. You may wish to spray the drawings with hair spray or a special fixative to keep the chalk from smearing. Post the drawings on a bulletin board where students can write a description of the constellation they found, and, if they were able to research any information on the name of the constellation, why it was given the name it was.

 You may wish to provide students with a page of star stickers. Instruct them to create their own constellations on black construction paper and write a paragraph that explains the name of the constellation and the myth or legend that created the name. Have students use the correct paragraph form.

 You may also wish to have students complete further research on the constellation and write an informational paragraph about the constellation (modeled in the *Classification of Animals* and *Light and Sound* domains).

## Stargazing Activity

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### Materials: Telescopes

Hold an optional evening session to give students a chance to look through a telescope. You may wish to invite a local astronomer as a guest speaker. Low-cost telescopes are available for schools, teachers, and students. There are two magazines, *Sky and Telescope* and *Astronomy*, available in many bookstores, with good information. A wide range of telescopes for purchase can be found there. Edmund Scientific ([www.edmundscientific.com](http://www.edmundscientific.com)).

com) also sells telescopes, eyepieces, and low-cost astronomy books. Also, check the website Telescopes.com for astronomy instruments and information about them. If your school can't afford to purchase a telescope, you may be able to locate an astronomy professor at a nearby college, or an amateur astronomer who would be willing to provide a telescope for an evening. Alternatively, if there is an observatory or planetarium in your area, you may wish to take a field trip so that students can experience stars and/or the solar system in a different setting.

Another option would be to ask students who live in an area with little light pollution to go stargazing with their parents or caregivers. [Check the weather to make sure that it is going to be a clear night.] Suggest students find the Big Dipper and Polaris, as well as any other constellations or celestial bodies you wish. Ask them to notice how stars in the eastern sky gradually get higher as time passes while stars in the western sky get gradually lower. Have students notice that Polaris doesn't seem to move during the night; it is the one fixed star around which all the others seem to move. The next day, ask students to share what they saw. Reinforce with the class that early explorers often used stars to guide their travels.

**Note:** This activity may be difficult to do in cities where there are a lot of nighttime lights that cause light pollution. Sometimes the outskirts of a city, or even a high point in the city, has less light pollution, making stars more visible. You may want to consider traveling to one of these areas to stargaze. You may also wish to visit a science museum or planetarium to observe constellations more closely.

## Galaxies

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### **Materials: Posters 2–4; drawing paper, drawing tools**

Have students create drawings of galaxies. Show students Posters 2–4, reviewing the possible shapes of galaxies. Have students create their own group of galaxies. As students create, encourage them to use complex vocabulary, including, if possible, any domain-related vocabulary. Tell students that they can include as many galaxies as they want in their group, but that they must include at least two different galaxy types. After students complete their drawings, have them describe what type of galaxies they have drawn, if there are solar systems in their galaxies, and if they think that any of these solar systems have planets with life. Ask students what things are needed to support life on Earth and if the same things would be needed to support life on their planets. Ask them

to describe their planets as they answer the questions. Have students share if their planets have any moons and, if so, how many. You may wish to have students record all of these ideas. Depending on your class, you may wish to have some students use these ideas to create a fictional story.

### **Research Activity: Space Programs**

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Some students may wish to research and learn more about one of the space programs, such as the Apollo missions, the Mars rovers, the *Voyager* probes, the space shuttle program, or the Hubble Space Telescope. Some may wish to create a poster sharing what they learn. Allow students the time to share their findings with a group or with the class.

### **Research Activity: The North Star**

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Some students may wish to research the North Star and learn more about how it has changed over long periods of time. Allow students the time to share their findings with a group or with the class.

### **Research Activity: Orienteering**

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Some students may wish to research the recreational competition called orienteering and learn more about its history and how one participates in a modern orienteering event. Allow students the time to share their findings with a group or with the class.

## **Venn Diagram**

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**Materials: Instructional Master PP2-3; chart paper, chalkboard, or whiteboard**

Tell students that together you are going to compare and contrast two things students have learned about during *Astronomy: Our Solar System and Beyond* by asking how they are similar and how they are different. Use Instructional Master PP2-3 to list two things at the top of the diagram and then to capture information provided by students. Choose from the following list or create a pair of your own:

- Galileo and Aristotle
- Aristarchus and Aristotle
- Jemison and Armstrong

- Jemison and Copernicus
- space rovers and probes
- a space shuttle and Apollo 11

You may wish to create several copies of the Venn diagram to compare and contrast several things. You may also wish to have students use these diagrams as brainstorming information for further writing.

- ✎ You may wish to have some students use Instructional Master PP2-3 to complete this activity independently.
- ✎ You may wish to have some students create a three-way Venn diagram to compare and contrast three things, e.g., the three modules of the Apollo 11 spacecraft; three missions, astronomers, or astronauts; etc.

## Star Colors and Temperatures

**Materials: Instructional Master PP2-4; Image Cards 2 (Sun) and 19 (Orion and His Hunting Dogs)**

Review with students what they have learned about the colors of stars. Show students Image Cards 2 and 9. Ask what stars they remember hearing about, and what they remember about the color and temperature of each star.

Have students color the circles in the diagram to correspond with the temperatures of yellow, red, white, and blue stars.

You may wish to reread excerpts from the read-aloud introductions, Guided Listening Supports, or read-alouds of Lessons 4 and 6. You may also wish to allow students to use other available online and text resources.

## ✎ Astronomy Poetry

Using the poem “Escape at Bedtime” and/or other astronomy-inspired poetry as models, have students create their own poems about stars and other aspects of space.

## First Landing on the Moon

**Materials: Computer with Internet access**



Using a computer with internet access, visit the following website: <http://www.nasa.gov/multimedia/hd/apollo11.html>. Show students clips of the first moon landing. Have students write about what it must have felt

like to stand on the moon and look back at Earth. You can create similar assignments for space shuttle launches.

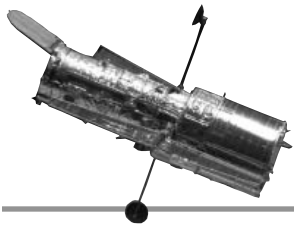
### **Writing Prompts**

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Students may be given an additional writing prompt such as the following:

- Nicolaus Copernicus’s theory was remarkable because . . .
  - The most interesting thing about Mae Jemison is . . .
  - Some of the ways that astronomers study space are . . .
  - If I were an astronomer, I would study \_\_\_\_\_ because . . .
-  Choose one of the constellations you have learned about. Write your own constellation story of how that constellation came to be in the night sky.
-  Describe an experiment you would like to perform if you had a chance to go to the moon or orbit the earth in a spaceship.





# Domain Assessment

# DA

This domain assessment evaluates each student's retention of the core content targeted in *Astronomy: Our Solar System and Beyond*.

## 10 Domain Assessment

**Note:** You may wish to have some students do the three parts of this assessment in two or three sittings. Some students may need help reading the questions. You may wish to allow some students to respond orally.

### *Part I (Instructional Master DA-1)*

Directions: Use the names in the box to fill in the names of some of the objects in our solar system.

1. Mercury
2. Venus
3. Earth
4. Mars
5. Asteroid Belt
6. Jupiter
7. Saturn
8. Uranus
9. Neptune

**Part II (Instructional Master DA-2)**

Directions: Read each question and the optional answers with your teacher. Circle the letter that best answers each question or completes each statement.

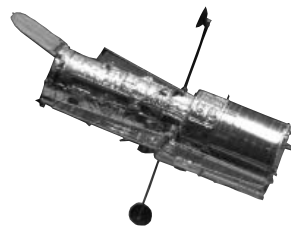
1. Why do the seasons change? (B)
2. Which is the name of our galaxy? (D)
3. Stars are \_\_\_\_\_. (C)
4. Which are objects found in our solar system? (D)
5. During a solar eclipse, the moon moves between the sun and Earth and \_\_\_\_\_. (A)
6. Which is **not** true of gravity? (C)

**Part III (Instructional Master DA-3)**

Directions: Write one or two sentences to answer each question.

1. Who was Nicolaus Copernicus, and how did he challenge how people thought about the universe?
2. Who was Mae Jemison? What are some words you can use to describe her and why?
3. How was the Apollo 11 mission important to astronomy and space exploration?
4. What is a theory? What is the Big Bang theory?
5. What are some ways that scientists study space? What are some questions you would like scientists to answer?

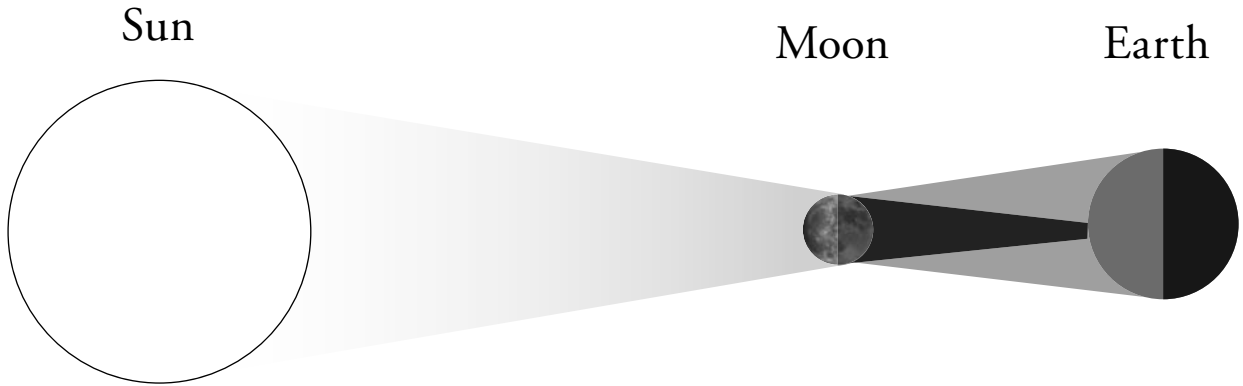
**For Teacher Reference Only:**  
Copies of *Tell It Again! Workbook*





Name: \_\_\_\_\_

## A Solar Eclipse

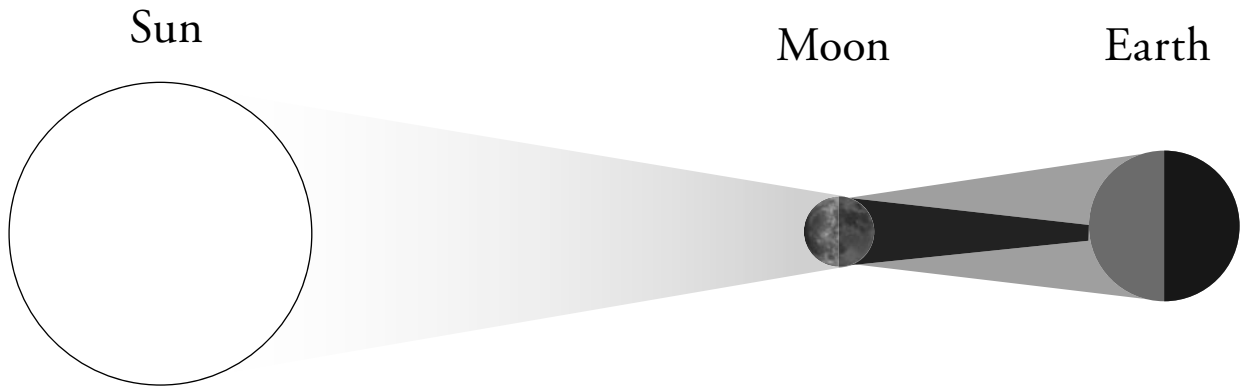


*Directions: Read the statements and look at the diagram. Sequence the events of a solar eclipse in the correct order.*

- \_\_\_ The moon's shadow falls somewhere on the surface of Earth.
- \_\_\_ In its orbit around Earth, the moon passes between the sun and Earth.
- \_\_\_ A shadow forms behind the moon.
- \_\_\_ The sun's light shines on half of Planet Earth.
- \_\_\_ The moon blocks some of the sunlight that is shining on Earth.



## A Solar Eclipse



*Directions: Read the statements and look at the diagram. Sequence the events of a solar eclipse in the correct order.*

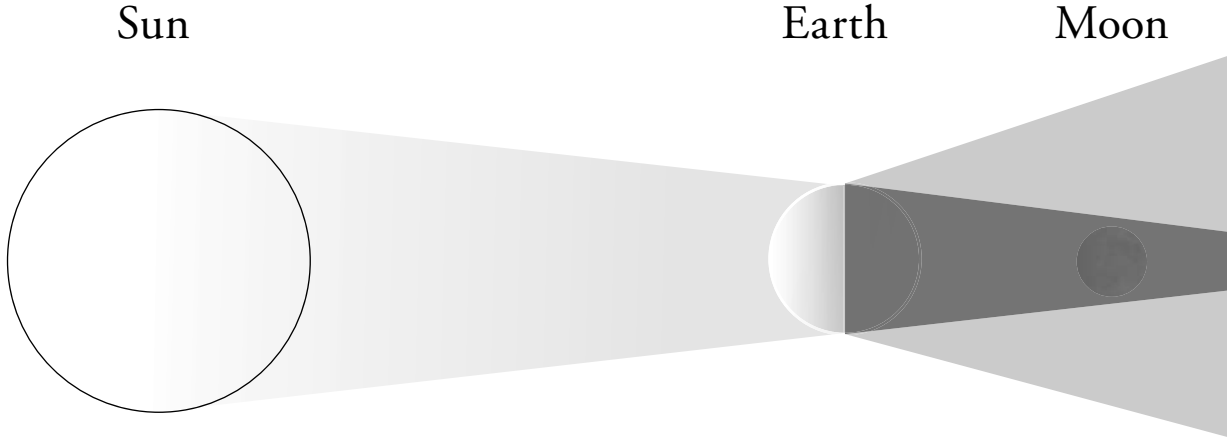
- 5 The moon's shadow falls somewhere on the surface of Earth.
- 2 In its orbit around Earth, the moon passes between the sun and Earth.
- 4 A shadow forms behind the moon.
- 1 The sun's light shines on half of Planet Earth.
- 3 The moon blocks some of the sunlight that is shining on Earth.





Name: \_\_\_\_\_

# A Lunar Eclipse

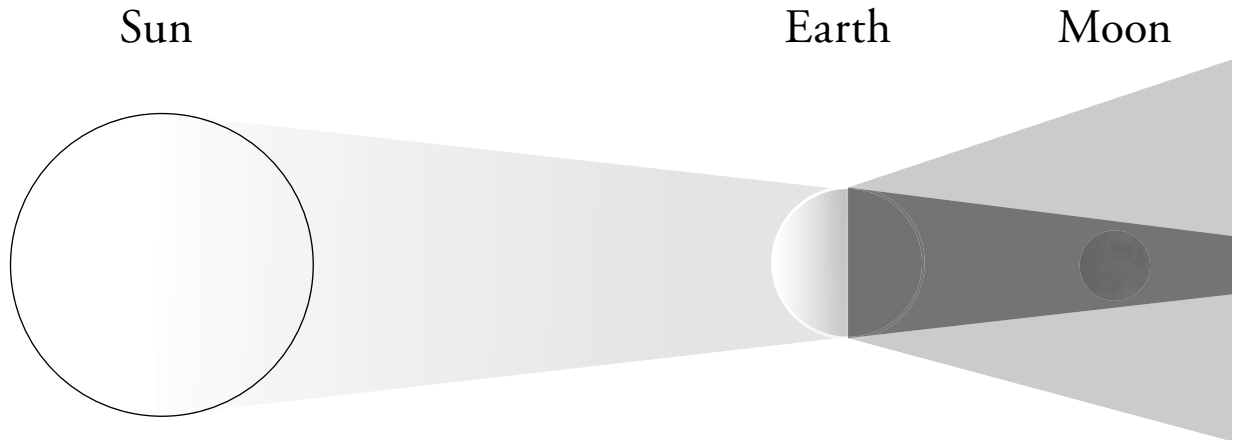


*Directions: Read the statements and look at the diagram. Sequence the events of a lunar eclipse in the correct order.*

- \_\_\_ Earth's shadow crosses the face of the moon, and the moon appears darkened as we view it from Earth.
- \_\_\_ The moon reflects the sunlight so that we see a bright moon from Earth.
- \_\_\_ Earth passes between the sun and the moon.
- \_\_\_ The sun's light shines on the moon.
- \_\_\_ Earth blocks some or all of the sunlight that is shining on the moon.



## A Lunar Eclipse



*Directions: Read the statements and look at the diagram. Sequence the events of a lunar eclipse in the correct order.*

- 5 Earth's shadow crosses the face of the moon, and the moon appears darkened as we view it from Earth.
- 2 The moon reflects the sunlight so that we see a bright moon from Earth.
- 3 Earth passes between the sun and the moon.
- 1 The sun's light shines on the moon.
- 4 Earth blocks some or all of the sunlight that is shining on the moon.



Name: \_\_\_\_\_



## Dear Family Members,

Over the next several days, your child will be learning about astronomy, the solar system, and galaxies. S/he will review the organization of the solar system, with the sun at the center and Earth and the other planets orbiting it. S/he will learn that gravity is an important force in the universe and will also learn about galaxies, specifically the Milky Way and Andromeda galaxies.

Below are some suggestions for activities that you may do at home to reinforce what your child is learning about astronomy.

### 1. Solar System Model

During this domain your child will be seeing images of the planets and their positions in the solar system. You may wish to reinforce this by working with him/her to make your own model of the solar system out of play dough, clay, or papier-mâché. You may wish to reference the diagram of our solar system at the end of this letter. In your model, be sure to include the sun, the eight planets, and the asteroid belt found between Mars and Jupiter. You may also wish to include Earth's moon, the moons of other planets, and/or the dwarf planets Pluto and Ceres. (Pluto is no longer grouped with the eight planets.) You may wish to try to recreate the colors of the planets as shown in photographs taken by the Hubble telescope. (As you create your models, you may wish to depict the orbits of the planets as well.)

### 2. Gravity, Forces, and Mass

Your child will be learning about a force called *gravity*. In this lesson, your child will be introduced to many new words, that you may want to review at home. Two of the words used are *force*, which is a pull or push on an object or system, and *mass*, which is the amount of material something is made of.

### 3. Out-of-This-World Images

Your child has learned that a great deal of what we know about space has been discovered through scientific observation. S/he has heard that scientists use telescopes to observe outer space and that the most famous of these is the Hubble

telescope. Your child has also learned about galaxies, what they are made of, and how they are shaped. Visit the Hubble gallery (<http://hubblesite.org/gallery/>) with your child to view photographs of the planets in our solar system, objects in the universe, and various galaxies. You may also wish to search for related television programs on Discovery, National Geographic, and PBS channels.

#### 4. Words to Use

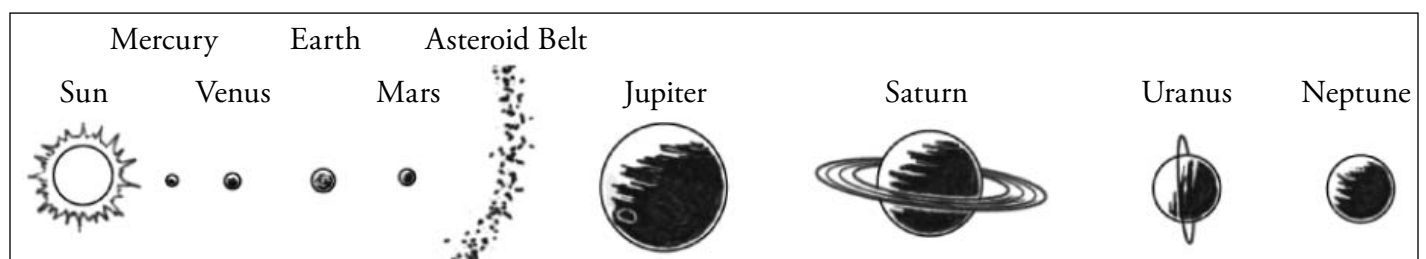
Below are several of the words that your child will be learning about and using. Try to use these words as they come up in everyday speech with your child.

- *satellite*—The moon is Earth’s only natural satellite; Jupiter, however, has more than sixty natural satellites.
- *rotates*—We experience daylight and the darkness of night because planet Earth rotates around its axis once each day and causes different parts of Earth to face the sun.
- *cluster*—Our Milky Way Galaxy is a cluster of billions of stars.
- *gravity*—Gravity is a force of attraction between two objects that pulls the object with less mass toward the object with greater mass.

#### 5. Read Aloud Each Day

It is very important that you read with your child every day. Set aside time to read to your child and to listen to your child read to you. I have attached a list of recommended trade books related to astronomy that may be found at the library, as well as a list of informational websites.

Be sure to praise your child whenever s/he shares what has been learned at school.





## ***Recommended Resources for Astronomy: Our Solar System and Beyond***

### **Trade Book List**

1. *13 Planets: The Latest View of the Solar System*, by David Aguilar (National Geographic Children's Books, 2011) ISBN 978-1426307706
2. *Astronaut Handbook*, by Meghan McCarthy (Alfred A. Knopf, 2008) ISBN 978-0375844591
3. *Astronomy (Amazing Science Discoveries)*, by Dr. Bryson Gore (Stargazer Books, 2009) ISBN 978-1596041998
4. *Astronomy (DK Eyewitness Books)*, by Kristen Lippincott (Dorling Kindersley Limited, 2009) ISBN 978-0756637675
5. *Basher Science: Astronomy: Out of this World!*, by Dan Green (Kingfisher, 2010) ISBN 978-0753466179
6. *The Best Book of Spaceships*, by Ian Graham (Kingfisher, 1998) ISBN 978-0753461679
7. *Big and Busy Space*, by Roger Priddy (St. Martin's Press, 2008) ISBN 978-0312506872
8. *The Big Dipper*, by Franklyn M. Branley (HarperCollins Publishers, 1991) ISBN 978-0064451000
9. *Black Holes*, by Dana Meachen Rau (Compass Point Books, 2007) ISBN 978-0756510954
10. *Black Holes (True Books)*, by Ker Than (Children's Press, 2010) ISBN 978-0531228012
11. *Born With a Bang: The Universe Tells Our Cosmic Story*, by Jennifer Morgan (Dawn Publications, 2002) ISBN 978-1584690320
12. *Boy, Were We Wrong About the Solar System*, by Kathleen Kudiniski (Dutton Juvenile, 2008) ISBN 978-0525469797
13. *Comets*, by Melanie Chrismer (Scholastic, Inc., 2008) ISBN 978-0531146941
14. *Comets, Meteors, and Asteroids*, by Seymour Simon (Mulberry Books, 1998) ISBN 978-0688158439
15. *Comets, Stars, the Moon, and Mars*, by Douglas Florian (Harcourt, Inc., 2007) ISBN 978-0152053727
16. *Constellations (True Books)*, by F.S. Kim (Children's Press, 2010) ISBN 978-0531228029
17. *Destination: Space*, by Seymour Simon (HarperCollins, 2006) ISBN 978-0060877231
18. *Discover Space*, by Cynthia Pratt Nicolson (Kids Can Press, Ltd., 2005) ISBN 978-1553378242
19. *Discover Space Rocks (Kids Can Read)*, by Cynthia Pratt Nicolson (Kids Can Press, 2006) ISBN 978-1553379010
20. *DK First Space Encyclopedia*, by Caroline Bingham (Dorling Kindersley Limited, 2008) ISBN 978-0756633660

21. *First Space Encyclopedia*, by DK Publishing (DK Children, 2008) ISBN 978-0756633660
22. *Floating in Space*, by Franklyn M. Branley (HarperCollins, 1998) ISBN 978-0064451420
23. *Forces Make Things Move*, by Kimberly Brubaker Bradley (HarperCollins, 2005) ISBN 978-0064452144
24. *Galaxies*, by Seymour Simon (HarperCollins, 1991) ISBN 978-0688109929
25. *Galaxies (True Books)*, by Howard K. Trammel (Children's Press, 2010) ISBN 978-0531228036
26. *Galaxies, Galaxies!*, by Gail Gibbons (Holiday House, 2007) ISBN 978-0823421923
27. *Galileo's Leaning Tower Experiment*, by Wendy Macdonald (Charlesbridge, 2009) ISBN 978-1570918704
28. *Glow in the Dark Constellations: A Field Guide for Young Stargazers*, by C.E. Thompson (Grosset & Dunlap, 1999) ISBN 978-0448412535
29. *Gravity is a Mystery*, by Franklyn M. Branley (HarperCollins Publishers, 2007) ISBN 978-0064452014
30. *The Hubble Space Telescope: Understanding and Representing Numbers in the Billions*, by Greg Roza (Rosen Publishing Group, 2005) ISBN 978-1404251298
31. *I Fall Down*, by Vicki Cobb (HarperCollins Publishers, 2004) ISBN 978-0688178420
32. *If You Decide to Go to the Moon*, by Faith McNulty (Scholastic Inc., 2005) ISBN 978-0590483599
33. *The International Space Station (Let's-Read-And-Find-Out Science: Stage 2)*, by Franklyn M. Branley (Perfection Learning, 2000) ISBN 978-0756901752
34. *Mae Jemison: Out of this World*, by Corinne J. Naden and Rose Blue (The Millbrook Press, Inc., 2003) ISBN 978-0761325703
35. *The Magic School Bus Blasts into Space (Scholastic Reader, Level 2)*, by Kristin Earhart (Scholastic, 2009) ISBN 978-0545086028
36. *The Magic School Bus Lost in the Solar System*, by Joanna Cole (Scholastic Audio Books, 2010) ISBN 978-054522337
37. *The Magic School Bus Sees Stars: A Book About Stars*, by Nancy White (Scholastic Inc., 1999) ISBN 978-0590187329
38. *The Magic School Bus Takes a Moonwalk (Scholastic Reader, Level 2)*, by Joanna Cole (Scholastic, 2007) ISBN 978-0439684002
39. *Messages from Mars*, by Andrew Schuerger and Loreen Leedy (Holiday House, 2006) ISBN 978-0823419548
40. *The Mighty Mars Rovers: The Incredible Adventures of Spirit and Opportunity*, by Elizabeth Rusch (Houghton Mifflin Books for Children, 2012) ISBN 978-0547478814
41. *The Milky Way*, by Gregory L. Vogt (Lerner Publications Company, 2010) ISBN 978-0761338758
42. *The Moon*, by Seymour Simon (Simon and Schuster Books for Young Readers, 2003) ISBN 978-0689835636



Name: \_\_\_\_\_



43. *Moonshot: The Flight of Apollo 11*, by Brian Floca (Atheneum Books for Young Readers, 2009) ISBN 978-1416950462
44. *Night Light (A Book About the Moon)*, by Dana Meachen Rau (Picture Window Books, 2006) ISBN 978-1404817319
45. *NightWatch: A Practical Guide to Viewing the Universe*, by Terence Dickinson (Firefly Books, 2006) ISBN 978-1554071470
46. *On Earth*, by G. Brian Karas (Puffin Books, 2005) ISBN 978-0142410639
47. *On the Moon*, by Anna Milbourne (Usborne Publishing Ltd., 2006) ISBN 978-0794506179
48. *Once Upon a Starry Night: A Book of Constellations*, by Jacqueline Mitton (National Geographic Society, 2009) ISBN 978-1426303913
49. *Our Solar System*, by Seymour Simon (HarperCollins, 2007) ISBN 978-0061140082
50. *The Planet Gods: Myths and Facts about the Solar System*, by Jacqueline Mitton (National Geographic Society, 2008) ISBN 978-1426304484
51. *Pluto: A Dwarf Planet*, by Ralph Winrich (Capstone Press, 2010) ISBN 978-1429645850
52. *Pluto: Dwarf Planet*, by Christine Taylor-Butler (Children's Press, 2008) ISBN 978-0531147665
53. *Roaring Rockets*, by Tony Mitton (Kingfisher, 2000) ISBN 978-0753453056
54. *Seven Wonders of the Rocky Planets and Their Moons*, by Ron Miller (Twenty First Century Books, 2011) ISBN 978-0761354482
55. *The Sky is Full of Stars*, by Franklyn M. Branley (HarperCollins, 1983) ISBN 978-0064450027
56. *Space Exploration*, by Carole Stott (DK Children, 2009) ISBN 978-0756658281
57. *Space, Stars, and the Beginning of Time: What the Hubble Telescope Saw*, by Elaine Scott (Clarion Books, 2011) ISBN 978-0547241890
58. *Stargazers*, by Gail Gibbons (Holiday House, 1999) ISBN 978-0823415076
59. *Stars*, by Seymour Simon (HarperCollins Publishers, 2006) ISBN 978-0060890018
60. *Stars (True Books)*, by Ker Than (Scholastic Inc., 2010) ISBN 978-0531228067
61. *Stars (Jump into Science: Stars)*, by Steve Tomecek (National Geographic Society, 2003) ISBN 978-0792255819
62. *The Sun (True Books)*, by Elaine Landau (Children's Press, 2008) ISBN 978-0531147962
63. *The Sun*, by Seymour Simon (Perfection Learning, 2001) ISBN 978-0688092368
64. *Sun, Moon and Stars*, by Stephanie Turnbull (Usborne Publishing Ltd., 2007) ISBN 978-0794513993
65. *The Sun is My Favorite Star*, by Frank Asch (Sandpiper, 2008) ISBN 978-0152063979
66. *Sun Up, Sun Down: The Story of Day and Night*, by Jacqui Bailey (Picture Window Books, 2006) ISBN 978-1404811287
67. *There's No Place Like Space!*, by Tish Rabe (Random House, Inc., 2009) ISBN 978-0679891154

68. *The Universe*, by Seymour Simon (HarperCollins, 2006) ISBN 978-0060877255
69. *Up, Down, All Around: A Story of Gravity*, by Jacqui Bailey (Picture Window Books, 2006) ISBN 978-1404819993
70. *What Makes Day and Night (Let's-Read-and-Find-Out Science 2)*, by Franklyn Branley (HarperCollins, 1999) ISBN 978-0064450508
71. *What the Moon Is Like*, by Franklyn M. Branley (HarperCollins Publishers, 2000) ISBN 978-0064451857
72. *When Is a Planet Not a Planet?: The Story of Pluto*, by Elaine Scott (Clarion Books, 2007) ISBN 978-0618898329
73. *Why Can't I Jump Very High?: A Book About Gravity*, by Kamal S. Prasad (Science Square Publishing, 2004) ISBN 978-0974086156
74. *Why Isn't Pluto a Planet?*, by Michael Portman (Gareth Stevens Publishing, 2013) ISBN 978-1433982835
75. *You Are the First Kid on Mars*, by Patrick O'Brien (G. P. Putnam's Sons, 2009) ISBN 978-0399246340
76. *Zoo in the Sky: A Book of Animal Constellations*, by Jacqueline Mitton (National Geographic Society, 2006) ISBN 978-0792259350

## Student Websites

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1. The European Space Agency for Kids  
<http://www.esa.int/esaKIDSen/index.html>
2. Games, Activities, Facts, and Resources  
<http://www.kidsastronomy.com/index.htm>
3. Kids NASA: Mars for Kids  
<http://mars.jpl.nasa.gov/participate/funzone/>
4. The Natural History Museum: Meteorites  
<http://www.nhm.ac.uk/kids-only/earth-space/meteorites>

Name: \_\_\_\_\_

Planet Name:

Position from the Sun:

Planetary Year:

Distance from the Sun:

Closest:

Farthest:

Day Length:

Mass of Planet:

Rings:

Diameter:

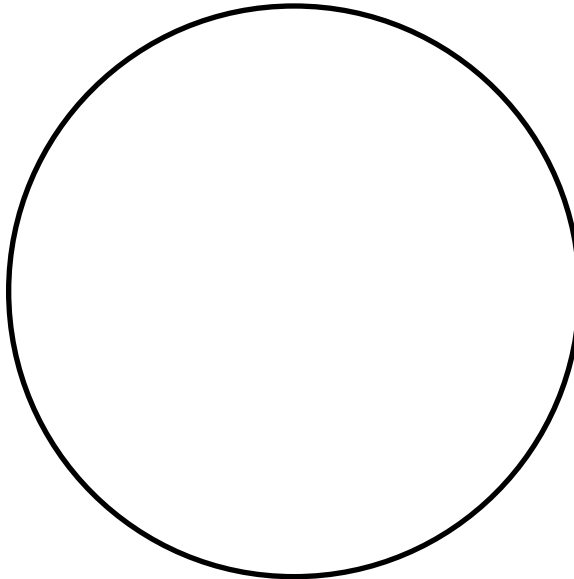
When Discovered:

Moons:

Who Discovered:

Temperature(s):

Origin of Name:



Directions: Use this graphic organizer to record the information you find in your research.



Name: \_\_\_\_\_

Planet Name:

Atmosphere:

Gravity (Compared to Earth):

Volume (Compared to Earth):

Speed or Velocity around Sun:

Spacecraft Visits:

Special Features:

Interesting Facts:

*Directions: Use this graphic organizer to record the information you find in your research.*



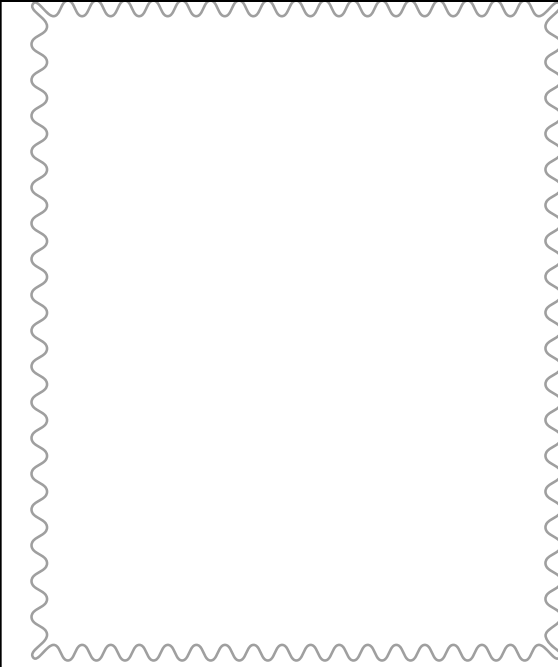
Name: \_\_\_\_\_

*Directions: Refer to the envelope your class addressed as you fill out the "space address" on your own envelope. Design and draw your own stamp.*

The form is a large rectangle. In the top-left corner, there is a smaller rectangle with a wavy, scalloped border, intended for a stamp. The bottom half of the main rectangle contains ten vertical lines, spaced evenly, for writing an address.







(School Name) \_\_\_\_\_

(Number and Street) \_\_\_\_\_

(Town or City) \_\_\_\_\_

(State and ZIP code) \_\_\_\_\_

(Country) \_\_\_\_\_

Planet Earth \_\_\_\_\_

Our Solar System \_\_\_\_\_

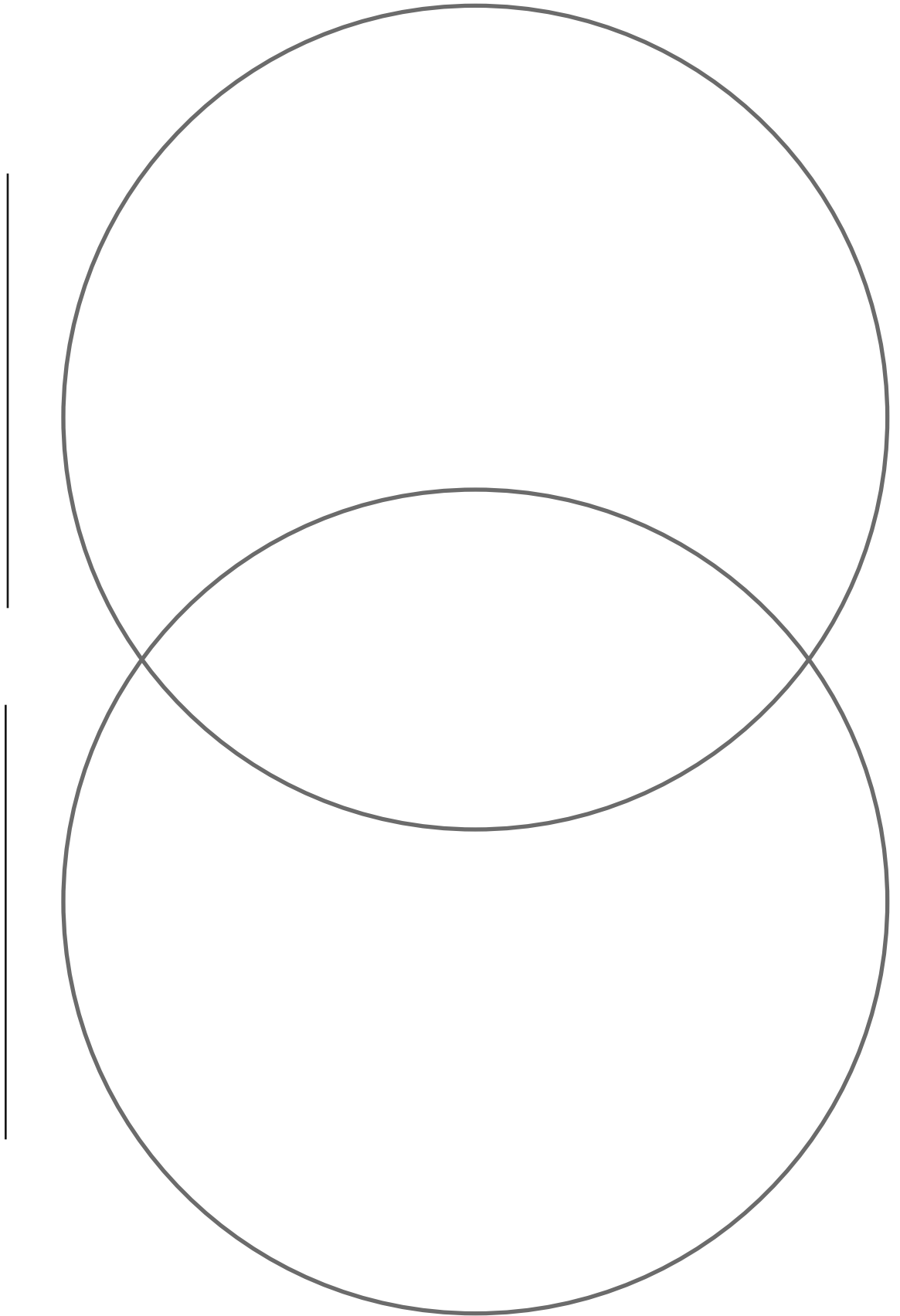
Milky Way Galaxy \_\_\_\_\_

The Universe \_\_\_\_\_



Name: \_\_\_\_\_

*Directions: Write the two things you are comparing and contrasting on the two blanks. In the overlapping part of the diagram, write words and/or phrases that describe how the two things are alike. In the non-overlapping parts of each circle, write words and/or phrases that describe how the two things are different.*





Name: \_\_\_\_\_



## Dear Family Members,

Over the next few days, your child will be learning more about the universe, one theory of its possible origins, and space exploration, focusing on key figures such as Nicolaus Copernicus and Mae Jemison.

Below are some suggestions for activities that you may do at home to reinforce what your child is learning about astronomy.

### 1. Space Exploration

Over the next few days, your child will be learning about NASA-led space exploration. You may want to review with your child that space exploration is one way astronomers learn more about the universe. Your child will hear about the Apollo 11 mission to the moon and the astronaut Mae Jemison. Ask your child to share what they remember about these two topics. (Neil Armstrong and Buzz Aldrin were the first to set foot on the moon; they traveled on a rocket; etc. Mae Jemison was the first female African American astronaut.) You may wish to supplement what your child has learned by visiting the website [www.NASA.gov](http://www.NASA.gov) to research current NASA endeavors and the most recent astronauts and space explorations.

### 2. Stargazing

Go outside one evening and stargaze with your child. Point out any constellations you know and have your child share with you any of the constellations s/he has learned. You may also wish to point out any of the planets visible in the night sky, like Venus or Mars. If you have access to technology, such as a computer tablet or smartphone, you may wish to use a stargazing application.

If you live in a city, it may be hard to see stars because light pollution will interfere with the light from the stars. Sometimes the outskirts of a city, or even a high point in the city, has less light pollution, making stars more visible. You may want to consider traveling to one of these areas to stargaze. You may also wish to visit a science museum or planetarium to observe constellations more closely.

### 3. Universe Theories

Your child will be hearing one theory of how the universe may have begun called the Big Bang theory. Share with your child that there are many theories of how the universe began. You may wish to research some of these different theories together, discussing what a theory is with your child.

### 4. Words to Use

Below are several of the words that your child will be learning about and using. Try to use these words as they come up in everyday speech with your child.

- *expanding*—The balloon is expanding with each breath I blow into it.
- *constellations*—Ancient peoples created stories about groups of stars that made patterns called constellations in the night sky in the shapes of people, animals, and other objects.
- *theory*—The Big Bang theory says that all matter in the universe was compressed in a small, hot, dense speck that suddenly expanded.
- *opposed*—In Copernicus’s time, many people opposed the idea that the sun was at the center of the solar system.

### 5. Read Aloud Each Day

It is very important that you read with your child every day. Set aside time to read to your child and to listen to your child read to you. Please refer back to the list of recommended resources related to astronomy that may be found at the library, as well as the list of informational websites.

Be sure to praise your child whenever s/he shares what has been learned at school.

Name: \_\_\_\_\_

*Directions: Read the statements. Sequence the events of the Big Bang in the correct order, according to the Big Bang theory.*

- \_\_\_ Brand new bits of matter formed, crashing into each other.
- \_\_\_ Stars, galaxies, and planets formed, and the universe kept growing and expanding.
- \_\_\_ There was a tiny, very hot, very dense speck.
- \_\_\_ The galaxy continues to expand today.
- \_\_\_ The speck suddenly expanded, becoming bigger and a little bit cooler.





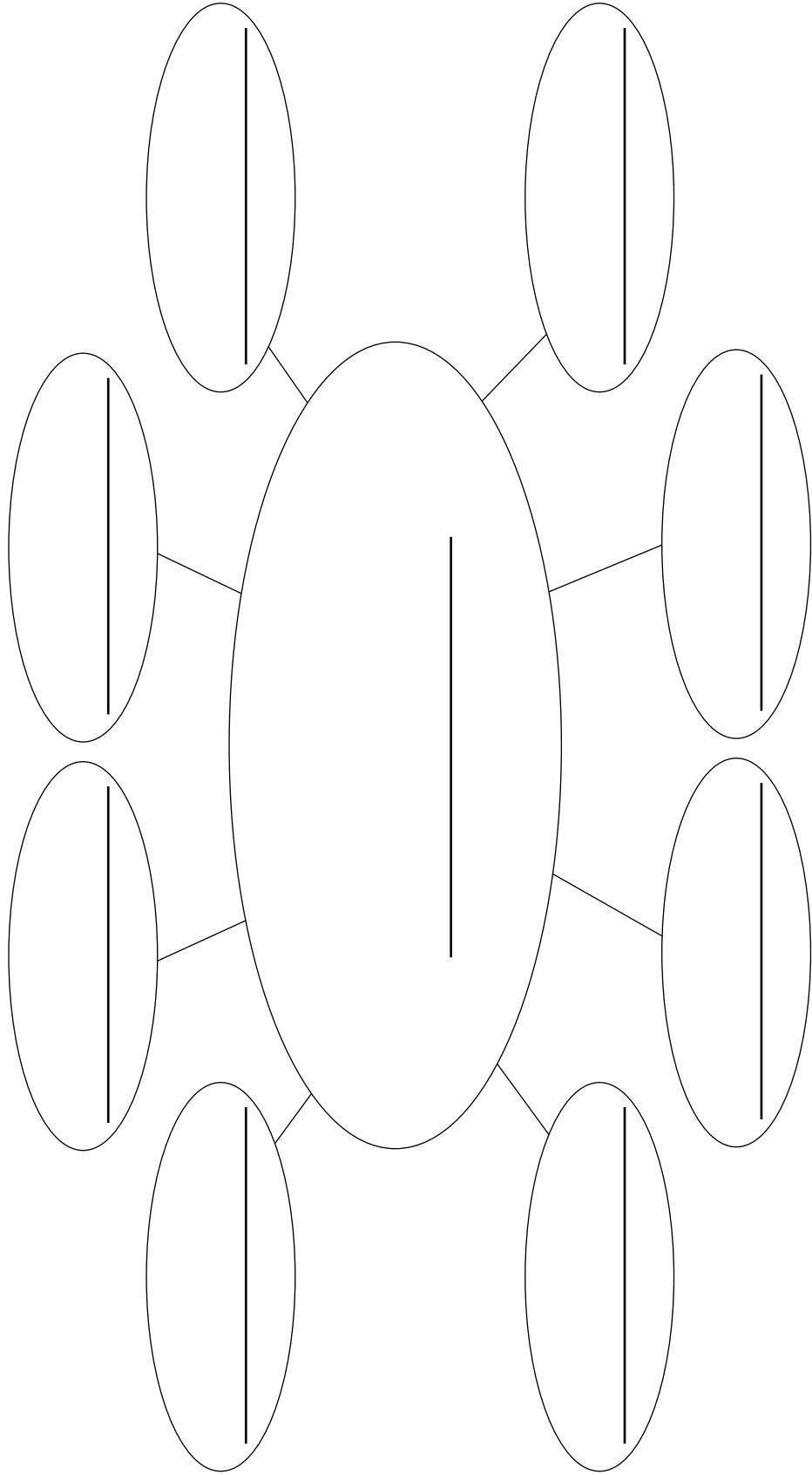
*Directions: Read the statements. Sequence the events of the Big Bang in the correct order, according to the Big Bang theory.*

- 3 Brand new bits of matter formed, crashing into each other.
- 4 Stars, galaxies, and planets formed, and the universe kept growing and expanding.
- 1 There was a tiny, very hot, very dense speck.
- 5 The galaxy continues to expand today.
- 2 The speck suddenly expanded, becoming bigger and a little bit cooler.



Name: \_\_\_\_\_

*Directions: In the center of the oval, write the name Nicolaus Copernicus. Record facts about Copernicus in the surrounding ovals.*





Name: \_\_\_\_\_

*Directions: Write your sentences in the first, second, and third rectangles about Copernicus's early life, achievements, and how he had an impact on society.*

**Paragraph 1: Early Life****Paragraph 2: Achievements****Paragraph 3: Impact on Society**



Name: \_\_\_\_\_

## Revision Checklist

Ask yourself these questions as you revise your paragraphs.

<b>1.</b>	<b>Do I have a good topic sentence?</b>	
<b>2.</b>	<b>Do I have a good concluding sentence?</b>	
<b>3.</b>	<b>Are there any parts that do not make sense?</b>	
<b>4.</b>	<b>Do my sentences flow well in this order?</b>	
<b>5.</b>	<b>Do I have a good variety of sentence structure?</b>	
<b>6.</b>	<b>Could I combine any of my sentences?</b>	
<b>7.</b>	<b>Do I have a good variety of descriptive words?</b>	
<b>8.</b>	<b>Are my paragraphs interesting?</b>	
<b>9.</b>	<b>Is this my best work?</b>	









Name: \_\_\_\_\_

## Editing Checklist

Ask yourself these questions as you edit your paragraphs.

<b>1.</b>	<b>Do I have a fitting title?</b>	
<b>2.</b>	<b>Do all of my sentences start with capital letters?</b>	
<b>3.</b>	<b>Do all of my sentences end with the correct punctuation?</b>	
<b>4.</b>	<b>Have I spelled all of my words correctly?</b>	
<b>5.</b>	<b>Have I used correct grammar?</b>	
<b>6.</b>	<b>Does each sentence provide a complete thought?</b>	

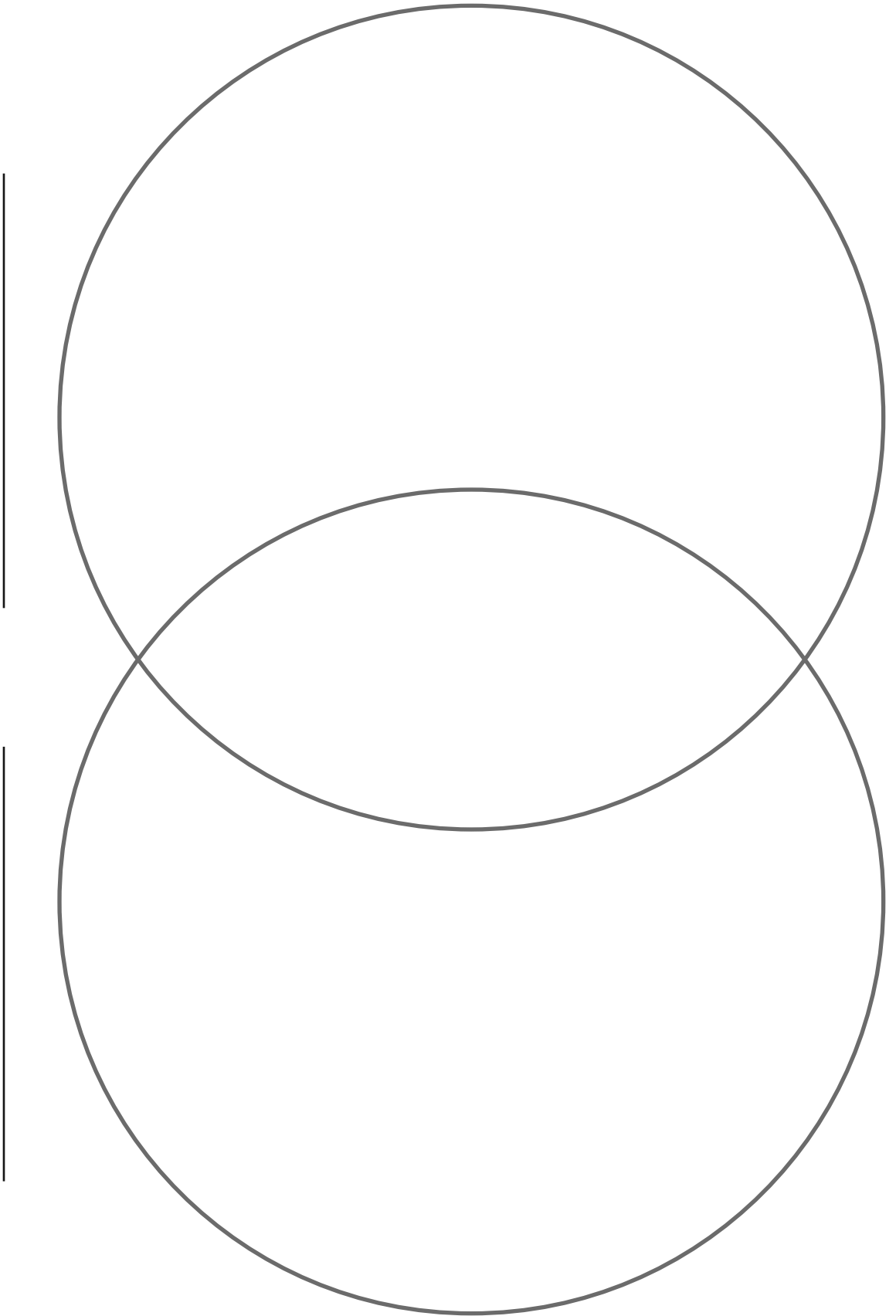






Name: \_\_\_\_\_

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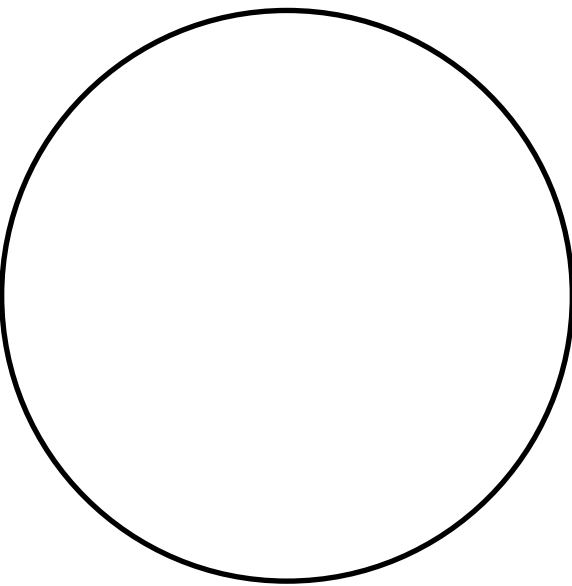
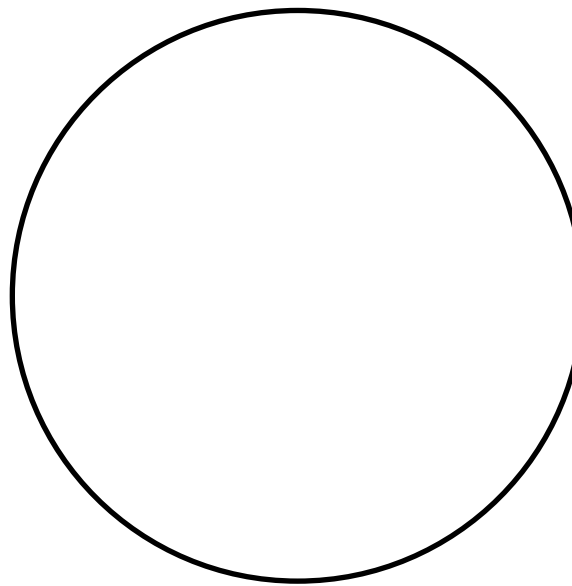
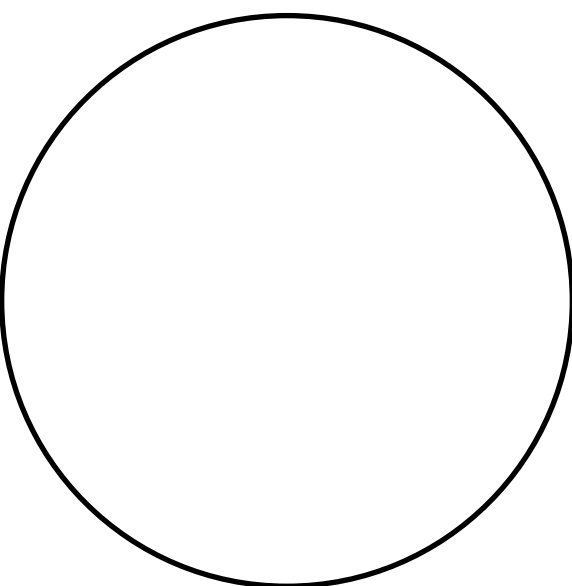
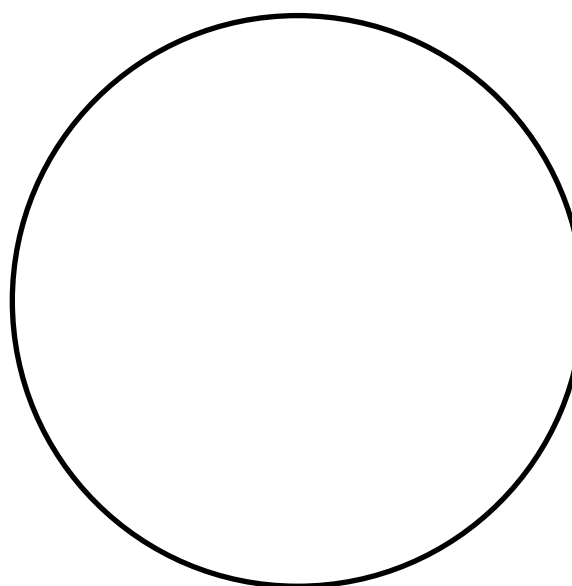






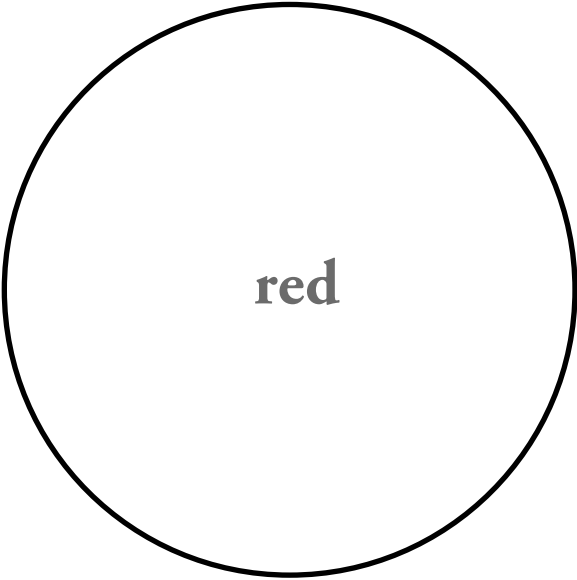
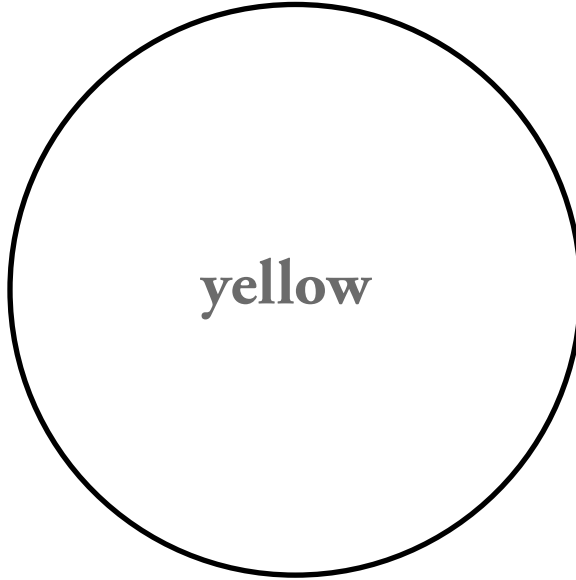
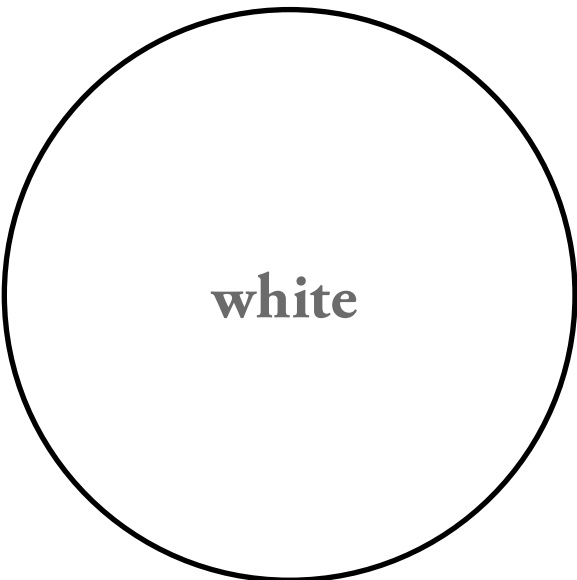
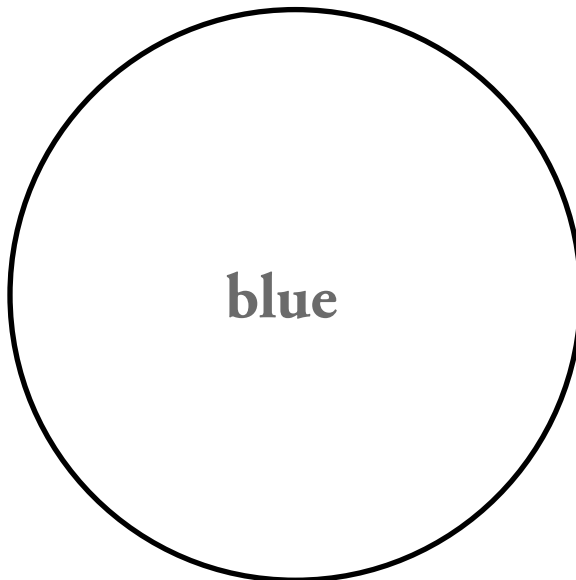
Name: \_\_\_\_\_

*Directions: Read the label below each circle, which represents a star. Color each star blue, yellow, red, or white to match the temperature listed.*

 <p>hot</p>	 <p>hotter</p>
 <p>very hot</p>	 <p>very, very hot</p>



*Directions: Read the label below each circle, which represents a star. Color each star blue, yellow, red, or white to match the temperature listed.*

 <p>red</p> <p>hot</p>	 <p>yellow</p> <p>hotter</p>
 <p>white</p> <p>very hot</p>	 <p>blue</p> <p>very, very hot</p>

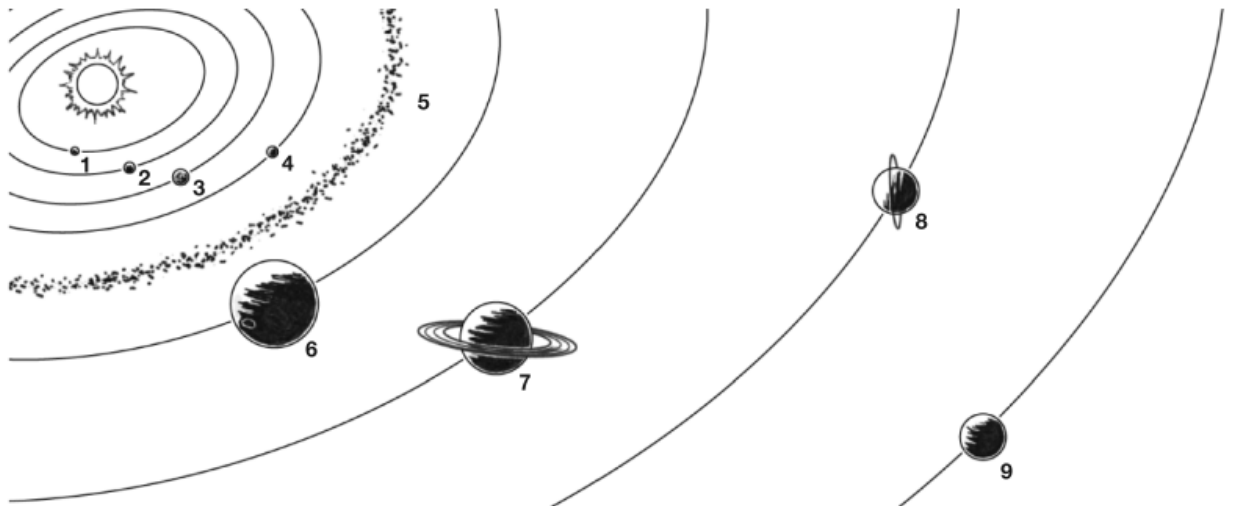


Name: \_\_\_\_\_

# Naming the Planets

Uranus	Earth	Mars
Jupiter	Neptune	Venus
Asteroid Belt	Mercury	Saturn

*Directions: Use the names in the box to fill in the names of some of the objects in our solar system.*



1. \_\_\_\_\_

6. \_\_\_\_\_

2. \_\_\_\_\_

7. \_\_\_\_\_

3. \_\_\_\_\_

8. \_\_\_\_\_

4. \_\_\_\_\_

9. \_\_\_\_\_

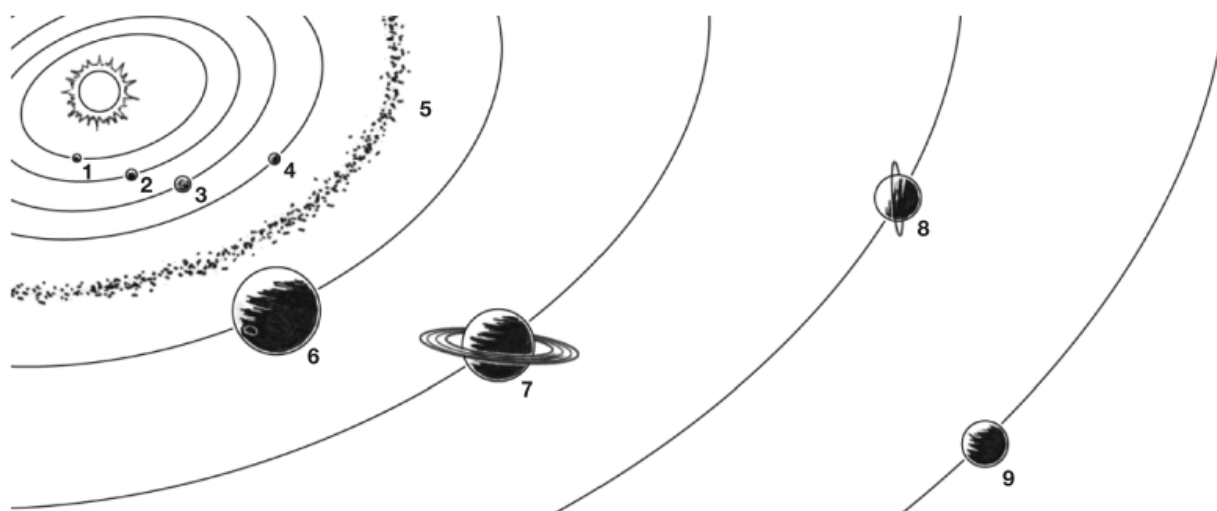
5. \_\_\_\_\_



## Naming the Planets

Uranus	Earth	Mars
Jupiter	Neptune	Venus
Asteroid Belt	Mercury	Saturn

Directions: Use the names in the box to fill in the names of some of the objects in our solar system.



1. Mercury

6. Jupiter

2. Venus

7. Saturn

3. Earth

8. Uranus

4. Mars

9. Neptune

5. Asteroid Belt





Name: \_\_\_\_\_

*Directions: Read each question and the optional answers with your teacher. Circle the letter that best answers each question or completes each statement.*

1. Why do the seasons change?
  - A. The sun gets hotter.
  - B. Earth is slightly tilted as it travels around the sun.
  - C. The sun is tilted.
  - D. Earth moves closer to the sun in its orbit.
  
2. Which is the name of our galaxy?
  - A. the asteroid belt
  - B. our solar system
  - C. the Andromeda Galaxy
  - D. the Milky Way
  
3. Stars are \_\_\_\_\_.
  - A. hot, near, and made of gas
  - B. hot, distant, and made of liquid
  - C. hot, distant, and made of gas
  - D. cold, distant, and made of gas

4. Which are objects found in our solar system?
- A. comets
  - B. asteroids
  - C. meteoroids
  - D. all of the above
5. During a solar eclipse, the moon moves between the sun and Earth and \_\_\_\_\_.
- A. blocks the sun's light from reaching Earth
  - B. blocks Earth's light from reaching the sun
  - C. blocks the sun's light from reaching the moon
  - D. none of the above
6. Which is **not** true of gravity?
- A. It is a force.
  - B. It keeps objects in orbit around the sun.
  - C. It is stronger if the objects are farther away from each other.
  - D. It keeps oxygen on Earth.

*Directions: Read each question and the optional answers with your teacher. Circle the letter that best answers each question or completes each statement.*

1. Why do the seasons change?
  - A. The sun gets hotter.
  - B. Earth is slightly tilted as it travels around the sun.
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  - C. It is stronger if the objects are farther away from each other.
  - D. It keeps oxygen on Earth.

Name: \_\_\_\_\_

1. Who was Nicolaus Copernicus and how did he challenge how people thought about the universe?

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2. Who was Mae Jemison? What are some words you can use to describe her and why?

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3. How was the Apollo 11 mission important to astronomy and space exploration?

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*Directions: Write one or two sentences to answer each question.*

4. What is a theory? What is the Big Bang theory?

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5. What are some ways that scientists study space? What are some questions you would like scientists to answer?

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# Tens Recording Chart

Use this grid to record Tens scores. Refer to the Tens Conversion Chart that follows.

Name														

# Tens Conversion Chart

## Number Correct

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	0	10																			
2	0	5	10																		
3	0	3	7	10																	
4	0	3	5	8	10																
5	0	2	4	6	8	10															
6	0	2	3	5	7	8	10														
7	0	1	3	4	6	7	9	10													
8	0	1	3	4	5	6	8	9	10												
9	0	1	2	3	4	6	7	8	9	10											
10	0	1	2	3	4	5	6	7	8	9	10										
11	0	1	2	3	4	5	5	6	7	8	9	10									
12	0	1	2	3	3	4	5	6	7	8	8	9	10								
13	0	1	2	2	3	4	5	5	6	7	8	8	9	10							
14	0	1	1	2	3	4	4	5	6	6	7	8	9	9	10						
15	0	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10					
16	0	1	1	2	3	3	4	4	5	6	6	7	8	8	9	9	10				
17	0	1	1	2	2	3	4	4	5	6	6	7	7	8	8	9	9	10			
18	0	1	1	2	2	3	3	4	4	5	6	6	7	7	8	8	9	9	10		
19	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	
20	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10

Simply find the number of correct answers the student produced along the top of the chart and the number of total questions on the worksheet or activity along the left side. Then find the cell where the column and the row converge. This indicates the Tens score. By using the Tens Conversion Chart, you can easily convert any raw score, from 0 to 20, into a Tens score.

Please note that the Tens Conversion Chart was created to be used with assessments that have a defined number of items (such as written assessments). However, teachers are encouraged to use the Tens system to record informal observations as well. Observational Tens scores are based on your observations during class. It is suggested that you use the following basic rubric for recording observational Tens scores.

9–10	Student appears to have excellent understanding
7–8	Student appears to have good understanding
5–6	Student appears to have basic understanding
3–4	Student appears to be having difficulty understanding
1–2	Student appears to be having great difficulty understanding
0	Student appears to have no understanding/does not participate



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