Student handouts are at the back of the Teacher Guide.

Correlation to Standards ............................................................................................................................ 3-4

Sally Ride Science Teacher Guides .............................................................................................................. 5

Space Exploration: About the Book ........................................................................................................... 6

Getting Started: In Your World .................................................................................................................... 7

Preview Space Exploration, read the introduction, and discuss key concepts.

Chapter 1: Solar System Tour .................................................................................................................... 8

Model summarizing with a two-column chart, read Chapter 1, and discuss key concepts in the chapter.

Students: Chapter 1 handout

Science Writing ........................................................................................................................................... 9

Write about what you would see on a tour of the solar system.

Students: Science Writing handout

Chapter 2: Exploring Our Solar System ....................................................................................................... 10-11

Model asking questions as you read, read Chapter 2, and discuss key concepts in the chapter.

Students: Chapter 2 handout

Thinking Like a Scientist ............................................................................................................................ 12-13

Calculate distances between planets in our solar system.

Students: Thinking Like a Scientist handout

Chapter 3: What We Have Learned .......................................................................................................... 14

Model summarizing with a concept map, read Chapter 3, and create a class concept map.

Students: Chapter 3 handout

How Do We Know?

> Read How Do We Know? .......................................................................................................................... 15

Read about geophysicist Maria Zuber and answer the questions.

Students: How Do We Know? handout

> Math Connection .................................................................................................................................... 16

Make calculations about satellites orbiting the Moon.

Students: Math Connection handout

Create a Science Poster ............................................................................................................................. 17

Research a NASA mission and make a poster about it.

Students: Create a Science Poster handout

Study Guide: Hey, I Know That! .................................................................................................................. 18

Complete the study guide questions.

Students: Hey, I Know That! handout
Correlation to Science Standards
For information on alignment to state science standards and NGSS, visit

Correlation to Common Core
Sally Ride Science’s Key Concepts and Cool Careers book series provide students with authentic literacy experiences aligned to Common Core in the areas of Reading (informational text), Writing, Speaking and Listening, and Language as outlined in Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects. Space Exploration: Journeys of Discovery and the accompanying activities align to the following standards:

Reading Standards for Literacy in Science and Technical Subjects 6-12 (RST), Grades 6-8
Key Ideas and Details
1. Cite specific textual evidence to support analysis of science and technical texts.
2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
Integration of Knowledge and Ideas
7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
Range of Reading and Level of Text Complexity
10. By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12 (WHST), Grades 6-8
Text Types and Purposes
1. Write arguments focused on discipline-specific content. a.-e.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. b., d., f.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge
7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
8. Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
10. Write routinely over extended time frames (time for 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.

Speaking and Listening Standards 6-12 (SL), Grades 6-8

Comprehension and Collaboration
1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6, grade 7, and grade 8 topics, texts, and issues, building on others’ ideas and expressing their own clearly. a.-d.

Presentation of Knowledge and Ideas
4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
   Grade 6
   Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation. Grade 7
   Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. Grade 8

Language Standards 6-12 (L), Grades 6-8

Vocabulary Acquisition and Use
4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 6, grade 7, and grade 8 reading and content, choosing flexibly from a range of strategies. a.-d.
6. Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

*Book pages pictured in the Teacher Guides are from eBook editions. Some pages in the print books have different images or layouts.

Cool Careers
Cool Careers in Biotechnology
Cool Careers in Earth Sciences
Cool Careers in Engineering (Upper Elementary)
Cool Careers in Engineering (Middle School)
Cool Careers in Environmental Sciences (Upper Elementary)
Cool Careers in Environmental Sciences (Middle School)
Cool Careers in Green Chemistry
Cool Careers in Information Sciences
Cool Careers in Math
Cool Careers in Medical Sciences
Cool Careers in Physics
Cool Careers in Space Sciences

Key Concepts in Science
Adaptations
Biodiversity
The Biosphere
Cells
Earth’s Air
Earth’s Climate
Earth’s Energy
Earth’s Natural Resources
Earth’s Water
Elements and Compounds
Energy Basics
Energy Transformations
Flowering Plants
Food Webs
Forces
Genetics
Geologic Time
Gravity
Heat
Life Cycles
Light
Motion
Organic Molecules
Photosynthesis and Respiration
Physical Properties of Matter
Plant and Animal Systems
Plate Tectonics
The Rock Cycle
Solids, Liquids, and Gases
Sound
Space Exploration
Sun, Earth, and Moon
Units of Measurement
Vertebrates
The Water Cycle
Weathering and Erosion

Sally Ride Science provides professional development and classroom tools to build students’ passion for STEM fields and careers. Founded by Dr. Sally Ride, America’s first woman in space, the company brings science to life for upper-elementary and middle school students.

Visit us at SallyRideScience.com for more information.
**Space Exploration: Journeys of Discovery** explains what humans have learned by exploring our solar system and beyond. Students learn that the Sun is at the center of our solar system, and all other objects in the solar system are held in orbit by its gravity. The book recounts how humans have developed technologies that have helped them explore our solar system and describes milestones in the history of space exploration. At the end of each two-page spread, a brief statement called *The Bottom Line* reinforces students’ understanding by summing up the key ideas covered in those pages.

**In Your World** explains that the Sun is at the center of our solar system. Its gravity holds the solar system together, and its energy provides light and heat for all the planets. Students learn that there are eight planets in our solar system and that Earth is the only one with liquid water on its surface and the only one where we know there is life. Students learn that our solar system is home not only to the planets and their moons, but to dwarf planets, asteroids, and comets.

**Chapter 1** explains that the Sun is at the center of our solar system. Its gravity holds the solar system together, and its energy provides light and heat for all the planets. Students learn that there are eight planets in our solar system and that Earth is the only one with liquid water on its surface and the only one where we know there is life. Students learn that our solar system is home not only to the planets and their moons, but to dwarf planets, asteroids, and comets.

**Chapter 2** explains how gravity determines the motion of the planets. Students learn that this motion is so predictable that it’s possible to calculate where any planet will be in its orbit at any time in the future. The chapter explains that spacecraft are designed to be as reliable as possible so they can work on their own far from Earth and that spacecraft can fly past, orbit, or land on the planets they explore.

**Thinking Like a Scientist** describes how scientists are able to measure distances in the vast expanse of our solar system. Students get a chance to make calculations and draw conclusions using a table of interplanetary distances.

**Chapter 3** explains that in recent years, robotic rovers and orbiting spacecraft have found evidence that Mars has frozen water at its poles and underground, which could nurture microscopic life. Students learn that the atmosphere of one of Saturn’s moons, Titan, resembles the atmosphere of early Earth before life began. Students also learn how engineers are designing spacecraft to explore the Moon so scientists can learn more about it and prepare for astronauts to return.

**How Do We Know?** focuses on Maria Zuber, a geophysicist who has devoted herself to exploring the planets and moons of our solar system in new ways. She has pioneered the use of lasers to map their surfaces with unprecedented accuracy. Then, in *Math Connection*, students make calculations to figure out how far the GRAIL spacecraft—Maria’s mission to map the Moon’s interior—traveled around the Moon on each orbit.

**Hey, I Know That!** allows students to assess their own learning through a variety of assessment tasks related to the key concepts covered in *Space Exploration*. 
Preview the book

Ask students to browse through *Space Exploration*. Encourage them to look at the cover, table of contents, chapter titles, special features, photographs, and diagrams. Explain that paying attention to these features will give them clues about the text.

Read *In Your World* (pages 4 and 5) and discuss key concepts

Tell students to read *In Your World*. Then begin a class discussion by asking,

*Why do you think people are so interested in exploring our solar system?* [Sample answers: Human beings have always been explorers—we are curious about our world and the other worlds in our solar system. People explore the solar system to understand how it formed, what it is like, and whether water and life exist any other place besides Earth.]

*The text mentions that you can have a rainy day on Earth but not on any other planet in our solar system. Why is it important that Earth has rain?* [The fact that Earth has liquid water on its surface means that the planet can sustain life. Scientists look for signs of liquid water on other planets to see if those planets could support life.]

*Why do you think scientists use robotic spacecraft to explore space instead of sending astronauts?* [Many of the technologies needed for sending humans into deep space to other planets have not yet been developed. It is also safer and less expensive to send robotic spacecraft than it is to send people.]

Ask two or three students to share their ideas with the class.
SPACE EXPLORATION: CHAPTER 1
Solar System Tour

Read Chapter 1: Solar System Tour

Before reading: Model summarizing with a two-column chart

Before students begin reading Chapter 1, have them turn to page 8. Point out that pages 8 and 9 tell about the planets in our solar system. Say,

*One way to summarize the information about the planets is to make a two-column chart.*

Give students the Chapter 1 handout and point out that it has a space to make a two-column chart about the planets. Get students started by drawing a two-column chart on the board. At the top of the left-hand column, write *Planet*. At the top of the right-hand column, write *Features*. Then in the left-hand column, write *Mercury*. Say,

*What are some features of Mercury I could write in my chart?*

Listen to students’ responses. In the right-hand column, write information about Mercury, such as: *Smallest planet* and *Barren, cratered world*. Tell students to copy the chart on their handouts and complete it as they read Chapter 1.

Read Chapter 1: Solar System Tour (pages 6-11)

Ask students to read Chapter 1: Solar System Tour, taking notes on their handouts and completing the two-column chart of the planets as they read.

After reading: Discuss key concepts

Have pairs of students share their notes, discuss the main ideas of Chapter 1, and refine their notes if they wish. Then ask students:

*What role does the Sun play in our solar system?* [The Sun lies at the center of our solar system. It is by far the largest object in our solar system, and it is a shining star, so it plays two major roles in our solar system. The gravitational attraction between the Sun and the other objects in our solar system causes them to circle the Sun. So everything in the solar system—planets, dwarf planets, asteroids, and comets—travels in predictable paths, or orbits, around the Sun. The Sun also provides light and heat for Earth and all the rest of the solar system.]

*What other objects can be found in our solar system?* [Eight planets, hundreds of moons, at least four dwarf planets, hundreds of thousands of asteroids, and millions of comets can all be found in our solar system.]

Call on students to share their ideas and respond to other students’ answers.

SCIENCE BACKGROUND

Our solar system is made up of the Sun and all the bodies that orbit it, including planets—Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune—and their moons; dwarf planets such as Pluto and their moons; asteroids; and comets.

Pluto used to be many people’s favorite planet—it’s so tiny, so far away, and has such a weird orbit. Pluto was “the little planet that could.” But once other ice balls were discovered in the Kuiper Belt—one bigger than Pluto—a great debate took place. In 2006, astronomers came up with the first real definition of a planet. A planet must be round; orbit the Sun, not another planet; and be large enough to clear its path of other objects. Pluto failed the third part of the definition. So astronomers created a new category—dwarf planet—and our solar system got a makeover.
A guided tour of the solar system

Give students the Science Writing handout. It asks them to write two paragraphs based on this prompt:

*Imagine you are the guide for a tour of the solar system. You have a special spacecraft that can fly at high speed and protect you from the Sun’s heat and other hazards. What you would tell your passengers as you zoom through the solar system?*

The first paragraph should describe the Sun and the inner planets. The second paragraph should describe the outer planets. Encourage students to be creative as they write about the sights they would see at each point along the tour.

**ANSWER KEY**

*Sample paragraphs:

Our tour of the solar system starts at the Sun. It’s enormous, and the first thing we see is a solar flare exploding from the Sun’s surface. Flying away from the Sun, we encounter Mercury, the planet nearest to the Sun. Look, it’s pockmarked with craters. Now we are zipping past a cloud-covered Venus. And on your right, you will see a beautiful blue and white marble, Earth, against the blackness of space. Please take a moment to notice Earth’s closest companion, the Moon. It’s covered in craters with splotches of dark maria and light highlands. Now we are flying over the Red Planet, Mars. See its giant volcanoes and icy poles?

Okay, we’re leaving the inner planets and heading toward the outer planets. Keep your seatbelts fastened as we dodge asteroids in the Asteroid Belt. See that huge planet? It’s Jupiter, the largest planet in the solar system. You will notice dozens of moons circling Jupiter like a miniature solar system. Next we are passing through Saturn’s thin sheet of rings, made of chunks of ice racing around Saturn in the same direction. As we keep moving, you can see Uranus and Neptune, similar blue-green worlds with thin rings and many moons. Finally, we are passing the dwarf planet Pluto. After we zoom through a swarm of icy comets in the fringes of the solar system, it’s time to turn around and head home.*
Read Chapter 2: Exploring Our Solar System

Before reading: Model asking questions while reading

Have students turn to page 12 in Space Exploration. Read aloud the title and subtitle of Chapter 2—Exploring Our Solar System: Moons, Rings, and Other Worlds. Have students look at the diagram on page 13, shown here.

Then read aloud the caption: Voyager 1 took nearly two years to get to Jupiter, then another two years to get to Saturn. Engineers had to aim the spacecraft toward the places where the planets would be. Say,

This makes me wonder—How do engineers know where the planets will be in the future?

Write the question on the board. Then call on a student to read aloud the text on page 13. Say,

That answers my question—the force of gravity is so predictable that scientists can calculate where a planet will be at any point in the future. But what other challenges do scientists face in designing a mission? That’s another question.

Tell students that asking questions as they read is an effective way to increase their understanding of what they read.

Read Chapter 2: Exploring Our Solar System (pages 12-17)

Ask students to read Chapter 2: Exploring Our Solar System. Give them the Chapter 2 handout and tell them to use it to write down any questions that occur to them as they read and any answers they find. Note that the handout also has a chart to complete about how scientists deal with the challenges they face in designing a space mission.

After reading: Discuss key concepts

After students read Chapter 2, begin a discussion by returning to the subject that you asked about after students read the book’s introduction:

*Why do you think scientists have relied on robotic spacecraft rather than humans to explore our solar system?*

[Putting people into space is much more complicated and expensive than putting robotic spacecraft into space. It requires a larger, more sophisticated spacecraft with advanced life-support systems (for example, protection from the harsh environment of space such as temperature extremes and radiation; air to breathe, water to drink, and food to eat; exercise equipment to maintain muscle strength and bone mass in low gravity; ways to overcome the isolation away from family and friends). In addition, the spacecraft would need to be very reliable and able to get astronauts back to Earth.]

Call on three or four students to share their thoughts about why sending robotic spacecraft, rather than humans, to space is safer, cheaper, and easier.
Students may mistakenly believe that most spacecraft that are launched into space have astronauts aboard. Explain to students that because of the expense, time, distance, and danger involved in exploring space, the majority of space missions are carried out remotely, and humans only rarely travel into space. In fact, humans have only traveled as far as our own Moon. A human mission to Mars, for example, would take about two years round trip. The life-support systems needed for people to make this trip are still being developed and tested and would be very expensive.
Read *Thinking Like a Scientist* (pages 18-19) and answer the questions

Ask students to read *Thinking Like a Scientist*. Give them the *Thinking Like a Scientist* handout and have them use it to answer the questions on page 19. Have students work in small groups to discuss the questions and come to agreement on the answers. Then ask each group to present to the class—go through one question and show how they arrived at their answer.

**Interpreting Data**

Scientists use tables to organize, analyze, and compare data. This table uses the average distance from Earth to the Sun—149,597,870 kilometers (about 93 million miles)—as a unit of measurement. The Earth-Sun distance is set at 1, and the average distance between each of the other planets and the Sun is relative to this unit of length.

*Your turn!* Use the information on pages 18 and 19 and in the table to answer these questions. Be sure to show your work.

**ANSWER KEY**

1. How would you use the information in the table to calculate the average distance from Earth to each of the other planets? [To find the average distance from Earth to any one of the other planets, first use the table to look up the distance from Earth to the Sun and the distance from the other planet to the Sun. Then subtract the smaller of the two distances from the other. For example, to find the average distance from Earth to Mercury, subtract Mercury’s average distance from the Sun from Earth’s average distance from the Sun, or 1 – 0.4 = 0.6. To express that distance in kilometers (miles), multiply 0.6 by the Earth-Sun distance, or 149,597,870 kilometers (93 million miles).]

2. Now calculate the average distance between Mars and Earth and the average distance between Jupiter and Earth. [First, to find the average distance from Earth to Mars, subtract the average Earth-Sun distance from the average Mars-Sun distance, or 1.5 – 1 = 0.5. So the average Earth-Mars distance is 0.5 times the average Earth-Sun distance. To express that distance in kilometers (miles), next multiply 0.5 by the average Earth-Sun distance, or 149,597,870 kilometers (93 million miles), which is 74,798,935 kilometers (46 million miles).

   Then, to find the average distance from Earth to Jupiter, subtract the average Earth-Sun distance from the average Jupiter-Sun distance, or 5 – 1 = 4. So the average Earth-Jupiter distance is 4 times the average Earth-Sun distance. To express that distance in kilometers (miles), multiply 4 by the average Earth-Sun distance, or 149,597,870 kilometers (93 million miles), which is 598,391,480 kilometers (372 million miles).]

3. How many times farther from Earth is Jupiter than Mars is from Earth? [Using the average Earth-Sun distance as a measuring stick, we already know the average Earth-Jupiter distance is 4 times larger than the average Earth-Sun distance and the average Earth-Mars distance is just 0.5 times as large. To calculate how many times farther from Earth Jupiter is than Mars, divide Jupiter’s average distance from Earth by Mars’ average distance from Earth, or 4 ÷ 0.5 = 8. On average, Jupiter is 8 times farther from Earth than Mars is from Earth.]
4. How many minutes would it take on average for a command to travel at the speed of light from Earth to a spacecraft as distant as Mars? To a spacecraft as distant as Jupiter? [We already know it takes about 8 minutes for a command to travel the average Earth-Sun distance at the speed of light. To calculate how long it would take a command to travel the average Earth-Mars distance, multiply that distance by the number of minutes required to travel the average Earth-Sun distance, or 0.5 x 8 = 4. So it would take 4 minutes to travel that distance. For Jupiter, multiply the average Earth-Jupiter distance by the number of minutes required to travel the average Earth-Sun distance, or 4 x 8 = 32. So on average, a command would take 32 minutes to travel that distance.]

ADDRESS MISCONCEPTIONS

Students may mistakenly believe that our solar system is a crowded place, with each planet having “neighbors” nearby. To help students comprehend the vast distances between objects in the solar system, point out that to travel around Earth, you would travel almost 13,000 kilometers (8,080 miles), a very long distance. Tell students that Venus, our closest neighbor, is about 42,000,000 kilometers (26,097,600 miles) away from Earth. That’s more than 3,000 times the distance it would take to go around Earth (42,000,000 ÷ 3,000). This means you’d have to travel around Earth more than 3,000 times to equal the distance it would take to reach our nearest neighbor. The other planets are even farther away than that!
Read Chapter 3: *What We Have Learned*

**Before reading: Model summarizing with a concept map**

Tell students that as they read Chapter 3 of *Space Exploration*, they will summarize the main ideas by making a concept map. Then model how to make a concept map based on the key concepts in Chapter 2. Tell students to review their notes for Chapter 2. Draw a circle in the middle of the board and ask,

*What was the main idea of Chapter 2?*

Listen to students’ responses and agree on a main idea, such as *How do we explore our solar system?* Write that in the circle. Then draw the second level of circles, connecting them with lines to the first circle. Tell students that each level provides more detail for the level above. Ask,

*What are the key concepts in Chapter 2?*

In the second level of circles, write down students’ answers, such as, *Exploring space requires planning* and *Most spacecraft do not carry astronauts*. Draw a third level of circles with lines connecting them to the second level. Ask students to look at their notes again. Point to a circle in the second level and ask,

*What ideas add to your understanding of this concept?*

For the circles connecting to *Exploring space requires planning*, students might suggest, *It is challenging to figure out where to send a spacecraft*, and, *Technology is used to plan space missions*. Write their answers in the appropriate circles.

When the class has filled in the map, ask students to look it over and suggest any additions or changes so that the map reflects the key concepts in Chapter 2.

**Read Chapter 3: *What We Have Learned* (pages 20-25)**

Ask students to read Chapter 3: *What We Have Learned*. Give them the Chapter 3 handout and tell them to use it to take notes. Also, point out that there is a space on the handout for them to make a concept map of Chapter 3.

**After reading: Create a class concept map**

After students read Chapter 3, discuss their concept maps of the chapter. Tell them that there are many ways to map the same set of concepts. Have students share their concept maps and discuss the key concepts in Chapter 3. Tell students they may refine their concept maps if they wish.

Then, as a class, generate a concept map on the board of the big ideas in Chapter 3. Begin with a central circle, labeled *What we have learned*. Then draw the next level of circles connected by lines to the central circle.

Invite students to suggest what should be put inside each circle. These should be the big ideas covered in this chapter, not the details about an idea. Then draw the next level of circles, connecting one or two circles to each of the big-idea circles. (Depending on the number of details, you may need to draw additional circles connected to a big-idea circle.)

Encourage students to suggest ways to rearrange the contents of the circle if they have compelling reasons for doing so.
Read *How Do We Know?* (pages 26-29)

Give students the *How Do We Know?* handout for *Space Exploration*. Have them look at the questions on the handout for the first section, *The Issue* (page 26). Then have them read that section and answer the questions. Have them complete the rest of the sections (*The Expert*, page 27; *In the Field*, page 28; *Technology*, page 29) in the same way. Then go over each question as a class. Call on two or three students to share their answers to each question.

**ANSWER KEY**

1. How did the science writer help you understand the topic? *Sample answer: The science writer helped me understand that there are many forces that shape the surfaces of planets. The writer also helped me understand that robotic spacecraft are used to help explore and learn about planets and other objects in the solar system.]*

2. How did the science writer capture your interest? *Sample answer: The science writer helped me think about some of the questions I have about objects in the solar system, such as, Why are some planets rocky and others made of gas?]*

3. What is the focus of Maria Zuber’s work? *Maria Zuber studies the surfaces and interiors of other planets in the solar system, and recently she has been investigating the Moon.*

4. Why must Maria Zuber sometimes wear goggles and a special suit when she is working? *Maria wears goggles to protect her eyes from the laser that she uses while working; she wears a protective suit to keep the telescopes and lasers she uses to study the Moon clean.*

5. Describe how the GRAIL spacecraft sensed variations in the Moon’s interior. *The two spacecraft orbited above the Moon’s surface with one following the other. The gravitational pull from different parts of the Moon changes depending on the Moon’s density in that location. This gravitational pull affected the speed at which the spacecraft moved. When the first spacecraft changed speed, the second one moved either closer or farther away. The changes in the distance between the two spacecraft told researchers about the density of the area the satellites were traveling over.*
Answer the Math Connection questions

Give students the Math Connection handout and have them use it to answer the Math Connection questions on page 29 of Space Exploration.

Math Connection: Moon Pi

Want to find the circumference of a circle? Multiply its diameter by pi, or 3.14. (Pi is the ratio between a circle’s circumference and diameter.) The Moon’s diameter is 3,476 kilometers (2,160 miles).

ANSWER KEY

1. What is the Moon’s circumference? [To find the circumference of the Moon, multiply its diameter by pi: 3,476 km x 3.14 = 10,900 km. The circumference of the Moon is 10,900 kilometers (6,770 miles).]

2. If the GRAIL spacecraft circled the Moon 50 kilometers (31 miles) above its surface, how far did they travel around the Moon on each orbit? [To find the distance GRAIL traveled during each orbit, add 50 kilometers twice to the Moon’s diameter. Then, multiply this number by pi:

   $3,476 \text{ km} + 50 \text{ km} + 50 \text{ km} = 3,576 \text{ km}$

   $3,576 \text{ km} \times 3.14 = 11,200 \text{ km}$

   The distance GRAIL traveled during each orbit of the Moon was 11,200 kilometers (6,960 miles).]
Profile a NASA mission

Give students the *Create a Science Poster* handout. It calls on students to choose a NASA mission, research it, and make a poster.

Have students visit NASA’s website and select a past, current, or future mission.

**Popular missions include:**

- *The International Space Station*
- *Apollo 11*
- *Cassini*
- *Mars Curiosity Rover*
- *Hubble Space Telescope*

Ask students to create a science poster that highlights key features of the mission. The handout has a place for students to design their posters. Give them poster board and colored pencils or markers to create their final posters.

**Remind students to:**

- come up with a fun title for their poster.
- include drawings or images printed from the Internet.
- describe the goal of the mission, the people involved, the technology involved, and any other interesting details about the mission.

The poster should have a title, captions or labels, and photos or diagrams. The handout has a space for students to design their poster. Give them poster board and markers or colored pencils to create their final posters.
Complete the *Hey, I Know That!* study guide (page 30)

Give students the *Hey, I Know That!* handout and ask them to use it to answer the questions on page 30 of *Space Exploration*. When students have finished answering the questions, have pairs of students exchange and discuss their work. Encourage students to discuss any answers about which they do not agree. Finally, as a class, go over the answers to the questions.

**ANSWER KEY**

1. This picture shows a planet passing between Earth and the Sun. Which planet? There are only two possibilities! What are they and why? (page 8)  *The planet must be either Mercury or Venus. They are the only two planets that follow orbits that pass between the Sun and the Earth. So this planet has to be one of those two. It just happens to be Venus.*

2. *Cassini* captured this flash of sunlight off a lake on Saturn’s moon Titan. What fills that lake? (page 23)  *The hydrocarbon called methane likely fills this enormous lake near Titan’s north pole.*

3. What created these tracks, and where are they? (page 21)  *The robotic rover Opportunity created these tracks as it rolled across the dusty red surface of Mars.*

4. Where was the astronaut who snapped this picture? (page 17)  *The astronaut who took this photo was in orbit around Earth’s Moon. Here, the astronaut photographed the brilliant blue of Earth as it rose above the Moon’s horizon.*

5. Flying past Jupiter’s moon Europa, the *Galileo* spacecraft took this image of huge cracked blocks of . . . what? (page 10)  *These are cracked blocks of ice. A frozen crust of water ice covers the surface of Europa.*
Solar System Tour: Notes for Chapter 1

As you read Chapter 1, write down the most important information you come across. Resist the urge to write down everything that you read. Instead, focus on the big ideas, or gist, of what you are reading.

THE SUN AND ALL THAT ORBITS IT

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__________________________________________________________________________________________
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SPACE ATTRACTION

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THE INNER PLANETS

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__________________________________________________________________________________________

THE OUTER PLANETS

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__________________________________________________________________________________________
__________________________________________________________________________________________

MANY, MANY MOONS

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DWARF PLANETS, ASTEROIDS, AND COMETS

__________________________________________________________________________________________
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__________________________________________________________________________________________
**PICTURE THIS**

Review your notes for Chapter 1. Summarize the information about the planets by making a two-column chart. In the left-hand column, write the names of the planets. In the right-hand column, write information about the features of each planet.

<table>
<thead>
<tr>
<th>Planet</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**PUT IT ALL TOGETHER**

Use your notes and two-column chart to help you identify and list the most important ideas—the key concepts—in Chapter 1.

__________________________________________________________________________________________
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__________________________________________________________________________________________
__________________________________________________________________________________________
Science Writing: A Guided Tour of the Solar System

Imagine you are the guide for a tour of the solar system. You have a special spacecraft that can fly at high speed and protect you from the Sun’s heat and other hazards. What will you tell your passengers as you zoom through the solar system?

Write two paragraphs
In the first paragraph, describe the Sun and the inner planets. In the second paragraph, tell about the outer planets. Describe the sights you would see at each point along the tour.

Welcome to a Solar System Tour

The Sun and inner planets:

_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________

The outer planets:

_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
_________________________________________________________________________________________
Exploring Our Solar System: Notes for Chapter 2

As you read each section of Chapter 2, write down any questions that occur to you. Also write down any answers to your questions that you find.

MOONS, RINGS, AND OTHER WORLDS

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

READY, AIM . . .

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

HI, TECH

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

BETTER PACK EVERYTHING

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

ROBOTIC EXPLORERS

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

OUR FIRST STEPS BEYOND EARTH

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
**PICTURE THIS**

Summarize Chapter 2 by completing the chart about the challenges scientists face in designing space missions and the approaches they take to solve those problems.

<table>
<thead>
<tr>
<th>Engineering challenge</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planets and other objects to be studied are always moving.</td>
<td></td>
</tr>
<tr>
<td>There are no power outlets in space.</td>
<td></td>
</tr>
<tr>
<td>Spacecraft are exposed to scorching heat, freezing cold, and intense radiation.</td>
<td></td>
</tr>
<tr>
<td>Spacecraft need to gather information and send it back to Earth.</td>
<td></td>
</tr>
</tbody>
</table>

**PUT IT ALL TOGETHER**

Use your notes and chart to help you identify and list the most important ideas—the key concepts—in Chapter 2.

__________________________________________________________________________________________
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Thinking Like a Scientist:  
Calculating Solar System Distances

Read Thinking Like a Scientist on pages 18 and 19 of Space Exploration. Then use the information on pages 18 and 19 and in the table to answer these questions. Be sure to show your work.

Interpreting Data
Scientists use tables to organize, analyze, and compare data. This table uses the average distance from Earth to the Sun—149,597,870 kilometers (about 93 million miles)—as a unit of measurement. The Earth-Sun distance is set at 1, and the average distance between each of the other planets and the Sun is relative to this unit of length.

<table>
<thead>
<tr>
<th>Planet</th>
<th>Average distance from Sun compared to Earth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>0.4</td>
</tr>
<tr>
<td>Venus</td>
<td>0.7</td>
</tr>
<tr>
<td>Earth</td>
<td>1</td>
</tr>
<tr>
<td>Mars</td>
<td>1.5</td>
</tr>
<tr>
<td>Jupiter</td>
<td>5</td>
</tr>
<tr>
<td>Saturn</td>
<td>10</td>
</tr>
<tr>
<td>Uranus</td>
<td>19</td>
</tr>
<tr>
<td>Neptune</td>
<td>30</td>
</tr>
</tbody>
</table>

1. How would you use the information in the table to calculate the average distance from Earth to each of the other planets?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

2. Now calculate the average distance between Mars and Earth and the average distance between Jupiter and Earth.

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
3. How many times farther from Earth is Jupiter than Mars is from Earth?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
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_______________________________________________________________________________________

4. How many minutes would it take on average for a command to travel at the speed of light from Earth to a spacecraft as distant as Mars? To a spacecraft as distant as Jupiter?

_______________________________________________________________________________________
_______________________________________________________________________________________
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_______________________________________________________________________________________
What We Have Learned: Notes for Chapter 3

As you read Chapter 3, write down the most important information you come across. Resist the urge to write down everything that you read. Instead, focus on the big ideas, or gist, of what you are reading.

DECADES OF DISCOVERY

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

PHASE IN . . . AND OUT

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

A THING FOR RINGS

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

FROZEN IN TIME

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

ASTRONAUTS ON THE MOON

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

BACK TO THE MOON

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
PICTURE THIS

Review your notes for Chapter 3. Summarize your notes by creating a concept map of the main ideas in the chapter. You might start with a central circle labeled *What we have learned*. Then draw a second level of circles connected by lines to the main circle. In those circles, write key ideas in the chapter. Add a third level of circles with details about the concepts in the second level.

PUT IT ALL TOGETHER

Use your notes and concept map to help you identify and list the most important ideas—the key concepts—in Chapter 3.

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________

________________________________________________________________________________________
Review the questions below for each section of *How Do We Know?* Then read each section in the book and answer the questions.

**THE ISSUE**

1. How did the science writer help you understand the topic?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

2. How did the science writer capture your interest?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

**THE EXPERT**

3. What is the focus of Maria Zuber’s work?

_______________________________________________________________________________________
_______________________________________________________________________________________

**IN THE FIELD**

4. Why must Maria Zuber sometimes wear goggles and a special suit when she is working?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

**TECHNOLOGY**

5. Describe how the GRAIL spacecraft sensed variations in the Moon’s interior.

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
Math Connection: Moon Pi

Want to find the circumference of a circle? Multiply its diameter by pi, or 3.14. (Pi is the ratio between a circle’s circumference and diameter.) The Moon’s diameter is 3,476 kilometers (2,160 miles).

Show your work as you answer the questions.

1. What is the Moon’s circumference?

_______________________________________________________________________________________
_______________________________________________________________________________________
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2. If the GRAIL spacecraft circled the Moon 50 kilometers (31 miles) above its surface, how far did they travel around the Moon on each orbit?

_______________________________________________________________________________________
_______________________________________________________________________________________
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_______________________________________________________________________________________
Create a Science Poster: Profile a NASA Mission

Visit NASA’s website and select a current, past, or future mission to research.

**Popular missions include:**
- The International Space Station
- Apollo 11
- Cassini
- Mars Curiosity Rover
- Hubble Space Telescope

Use the NASA website to research the mission you select. On this worksheet, design a science poster highlighting key features of the mission. Then make your final poster on poster board.

**Remember to:**
- come up with a fun title for your poster.
- include drawings or images printed from the Internet.
- describe the goal of the mission, the people involved, the technology involved, and other interesting details about the mission.
Hey, I Know That! Study Guide

Use this sheet to answer the *Hey, I Know That!* questions on page 30 of *Space Exploration*.

1. This picture shows a planet passing between Earth and the Sun. Which planet? There are only two possibilities! What are they and why? (page 8)

________________________________________________________________________
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2. *Cassini* captured this flash of sunlight off a lake on Saturn’s moon Titan. What fills that lake? (page 23)

________________________________________________________________________
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3. What created these tracks, and where are they? (page 21)

________________________________________________________________________
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________________________________________________________________________

4. Where was the astronaut who snapped this picture? (page 17)

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________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

5. Flying past Jupiter’s moon Europa, the *Galileo* spacecraft took this image of huge cracked blocks of . . . what? (page 10)

________________________________________________________________________
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