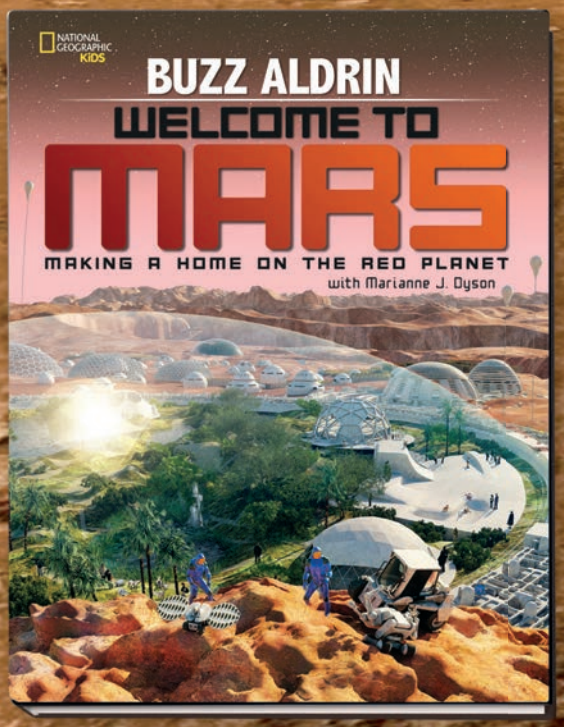
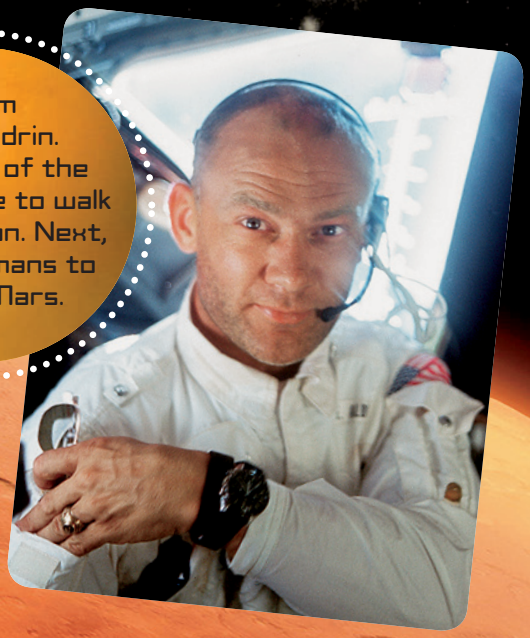
NATIONAL GEOGRAPHIC KIDS

EDUCATOR'S GUIDE

Next Generation Science Standards and Classroom Activities



In this fascinating book, hero-astronaut Buzz Aldrin challenges you to think about Mars as not just a faraway red planet but as a future home for Earthlings!! What will your new home be like? How will you get there? What type of job can you get? What will your bedroom look like? What will you eat for breakfast? Find out what life might be like far from Earth as you navigate your way through this fun book.



Hi! I'm Buzz Aldrin. I was one of the first people to walk on the moon. Next, I want humans to settle Mars.

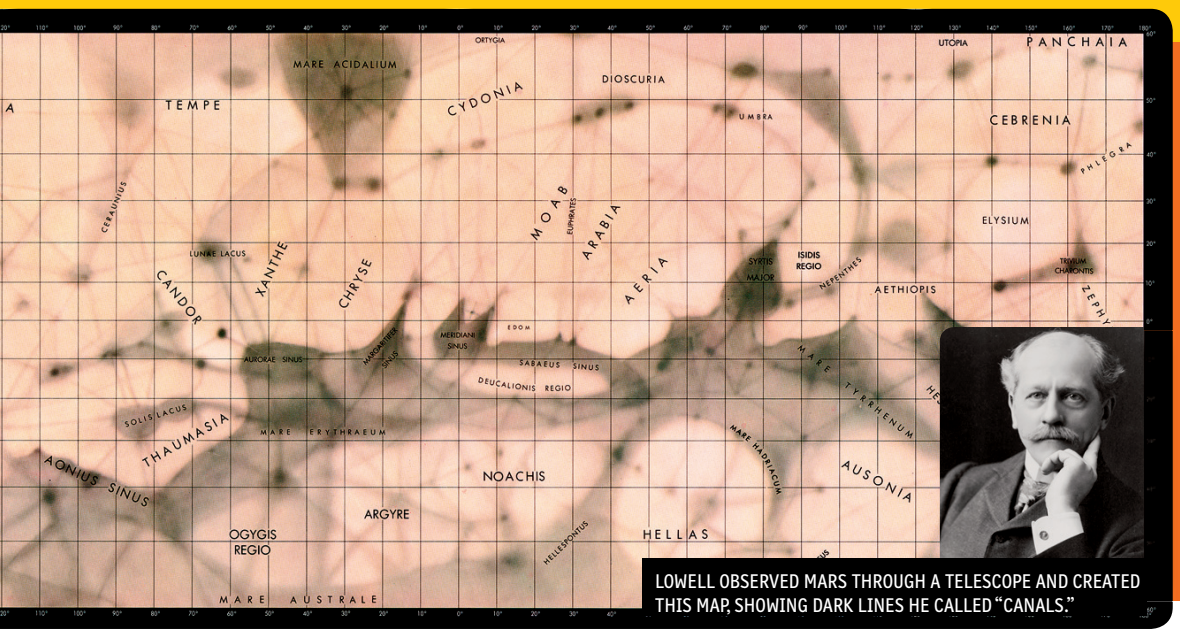
Instructional Note:

The Next Generation Science Standards (NGSS) are built on the Core Disciplinary Ideas (CDIs) of the Framework for K-12 Science Education. In this Educator's Guide, activities introduce, review, or otherwise address one or more of the CDIs used as the basis for the NGSS performance expectations for each grade level.

THIS ART SHOWS THE MARS SCIENCE LABORATORY ENTERING MARS'S ATMOSPHERE.

Grade 2

ESS2.B: Plate Tectonics and Large-Scale System Interactions • Maps show where things are located. One can map the shapes and kinds of land and water in any area.



LOWELL OBSERVED MARS THROUGH A TELESCOPE AND CREATED THIS MAP, SHOWING DARK LINES HE CALLED "CANALS."

MATERIALS

- A topographical globe
- Two large pieces of thick cardboard
- Art supplies, including tape, glue, scissors, markers, modeling clay, paper sacks, plastic sacks, cardboard tubes, construction paper, pipe cleaners, tissue paper, newspapers, and egg cartons [You may wish to have students bring material from home.]
- Graph paper

Interpreting Maps

Read aloud Chapter 2, "Off to Mars." As you read, pause to discuss relationships among the text, photos, captions, and illustrations.

After reading the chapter, return to the section "Canals on Mars" on pages 28-29. Guide students to recognize that Percival Lowell created this map after observing Mars through a telescope. Invite students to identify different features they see.

Display the globe. Encourage students to compare the globe with the map. Invite students to feel the globe. Guide them to recognize that raised areas represent mountains. Flat areas represent plains. Challenge students to explain how Lowell most likely used what he knew of features on Earth when he created his map of Mars.

Divide the class into two groups. Give each group a large piece of thick cardboard. Invite groups to use the art supplies to create a landscape with a variety of different topographical features, using the cardboard as a base. Encourage them to give each group member a chance to contribute to the design. Discourage them from viewing the other group's work.

Display the finished landscapes on desks at the far end of the room. Give each student a piece of graph paper. Instruct students to draw a basic eye-level map of the other group's landscape. Collect the finished maps.

Give students a second sheet of graph paper. Encourage them to view the landscapes from above and draw a new map of the same landscape. Collect the finished maps.

Display each map. Invite students to identify each map as eye-level or an aerial view. Challenge them to match each map with the correct landscape. Encourage them to identify features that helped them make their decisions. Post each map above the correct landscape.

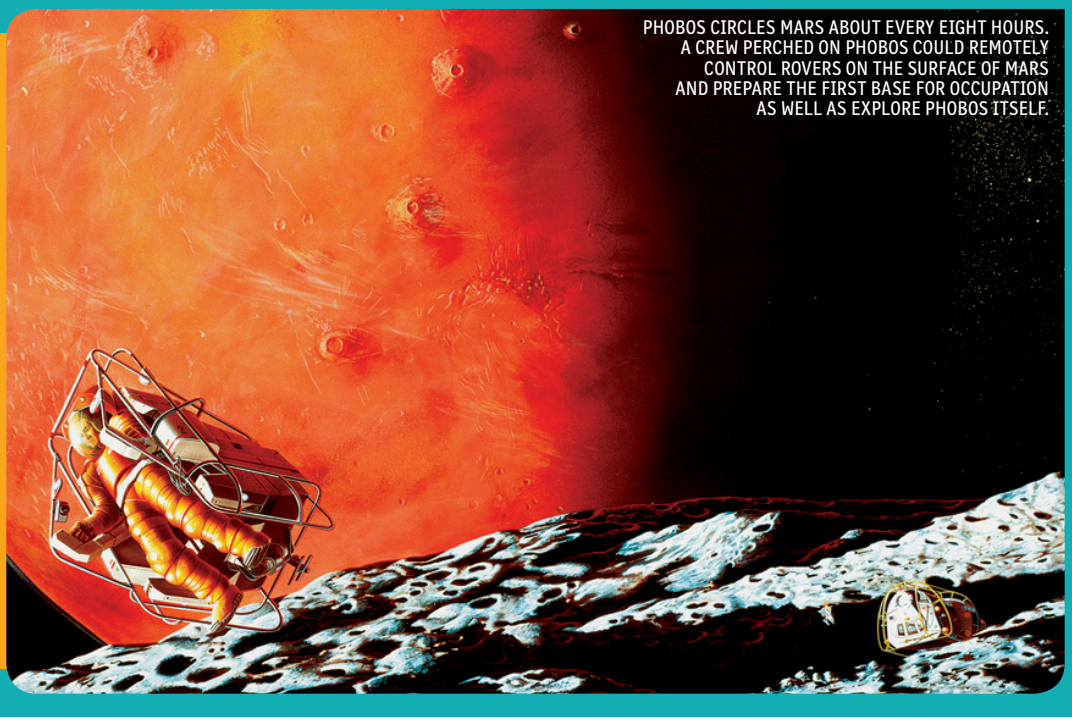
Have students compare the drawings. Discuss how distance and perspective can affect what people see. Discuss how prior knowledge of features can affect what people THINK they see. Guide students to recognize how these factors—and limited technology—influenced Percival Lowell's ideas about Mars.

Grade 3

PS2.A: Forces and Motion • The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it.

MATERIALS

- A piece of cardboard that is 8 inches [20 cm] square
- A marker or pen
- A tape measure or yardstick [meterstick]
- Two small toy cars, preferably blue for Earth and red for Mars!
- Two pieces of string or yarn, one about 20 inches [50 cm] long, and one about 25 inches [63.5 cm] long
- A round pencil, preferably not sharpened
- Tape



PHOBOS CIRCLES MARS ABOUT EVERY EIGHT HOURS. A CREW PERCHED ON PHOBOS COULD REMOTELY CONTROL ROVERS ON THE SURFACE OF MARS AND PREPARE THE FIRST BASE FOR OCCUPATION AS WELL AS EXPLORE PHOBOS ITSELF.

Patterns of Motion

Read aloud Chapter 1, "All Aboard!" As you read, pause to discuss relationships among the text, photos, diagrams, and illustrations.

After reading, guide students as they complete the "Race Around the Clock" activity on pages 18-19. If you want students to conduct this activity in small groups, gather multiple quantities of each supply.

After completing the activity, review the section "The Aldrin Cycler" on pages 20-21. Point out to the class that in the activity, Earth and Mars moved clockwise. Challenge students to explain why the planets are moving counter-clockwise in this diagram. If necessary, prompt students to review the note in Step 1 on page 19. (Answer: In the activity, students viewed the planets from "below," looking "up" at the solar system. In the illustration, they are viewing the planets from "above," looking "down.")

Remind the class that NASA's goal is to build a city on Mars. Invite students to predict how many years they think this might take. Then explain that the Aldrin cycler—like any train—will have a schedule and limited seating. Review the chapter to identify the best time to go to Mars (every two years and two months) and how many people can go on each trip (six).

Based on these limitations, challenge students to calculate how long it would take to build a city of more than 100 people. (36 years, 10 months; Every 13 years, ships can complete 6 trips, carrying 6 people each. So every 13 years, 36 people could arrive on Mars. In 26 years, the population would double to 72. It would take five more trips, or 10.10 years, to send more than 100 people to Mars.)

Encourage students to explain in their own words how patterns of planetary motion determine how and when people from Earth could settle on Mars.

Grade 4

ESS3.A: Natural Resources • Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

EARLY GREENHOUSES ON MARS MAY GROW PLANTS IN SOIL OR WATER WITH NUTRIENTS FROM EARTH, OR LATER SUPPLIED BY ROCKS FOUND ON MARS.

SKIING ON FROST AND GAS MIGHT BE A POPULAR SPORT ON MARS.

MATERIALS

- Art supplies, including poster board
- 1 digital video camera per group

Natural Resources

Brainstorm with students to identify natural resources that people on Earth need to survive. Then give each student a Venn diagram. Instruct students to label one side "Earth," the other side "Mars," and the middle section as "Both."

Invite students to read Chapter 4, "Riches of Mars," in pairs, small groups, or on their own. As they read, challenge students to identify and record information about natural resources in their Venn diagrams.

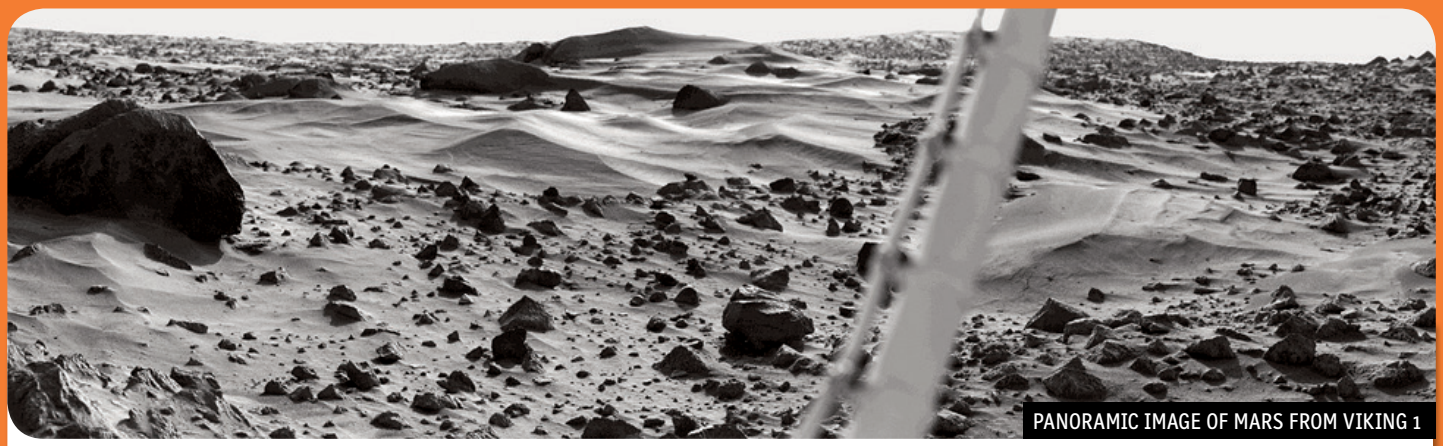
After reading, divide the class into small groups. Instruct group members that their job is to create an instructional "Welcome to Mars" video that people will watch as they prepare to live on the red planet.

Inform students that all scripts should address survival, recreation, and at least one other topic as it relates to natural resources found on Mars. Encourage groups to be thorough yet creative in how they deliver the information.

Give students time to write their scripts, create backgrounds and props, and film their instructional videos. Then have groups share their videos with the class. Encourage students to discuss how the change in natural resources will impact the lifestyle of people moving from Earth to Mars.

Grade 5

ESS2.B: The Roles of Water in Earth's Surface Processes • Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.



PANORAMIC IMAGE OF MARS FROM VIKING 1

The Search for Water

Give each student several small sticky notes. Invite students to read Chapter 3, "Approaching Mars," in pairs, in small groups, or on their own. As they read, encourage students to insert a sticky note each time the text makes a reference to water.

After reading, divide the class into small groups. Instruct group members to compile their findings into a bulleted list of facts about the search for water on Mars. Then brainstorm with students to create a list of important questions related to water on Mars. For example:

- Why is it important to know if Mars had water in the past?
- What have people done to search for water on Mars?
- Where have people found water on Mars?

Instruct each group to select one question. Using their notes from the chapter as a foundation, give groups time to conduct research to learn more about their topic. Encourage students to gather facts, photos, and other items to support their findings. Challenge them to make valid connections between their topic and knowledge of water on Earth.

Rejoin as a class. Explain to students that communication plays an important role in scientific progress. Scientists often specialize in very specific fields, so they participate in conferences to share what they know.

Guide the class in a scientific conference about water on Mars. After groups present their findings, encourage classmates to ask questions. Challenge experts to provide scientifically valid answers. To wrap up the conference, challenge groups to explain why knowledge of water on Earth is essential to finding water on Mars.

MATERIALS

- Small sticky notes
- Access to online research materials

Middle School

LS2.C: Ecosystem Dynamics, Functioning, and Resilience • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.

Martian Timeline

Invite students to read Chapter 5, "Martian Home," in pairs, small groups, or on their own. As students read, encourage them to pause to discuss relationships among the text, photos, and illustrations.

After students finish reading and discussing the chapter, have them read and review the book's conclusion, "Green Mars," on pages 88-89. Guide students to recognize that Chapter 5 describes life in the first Martian settlement. The time line describes how changing environmental conditions on Mars affect people's lives over a 1,000-year period.

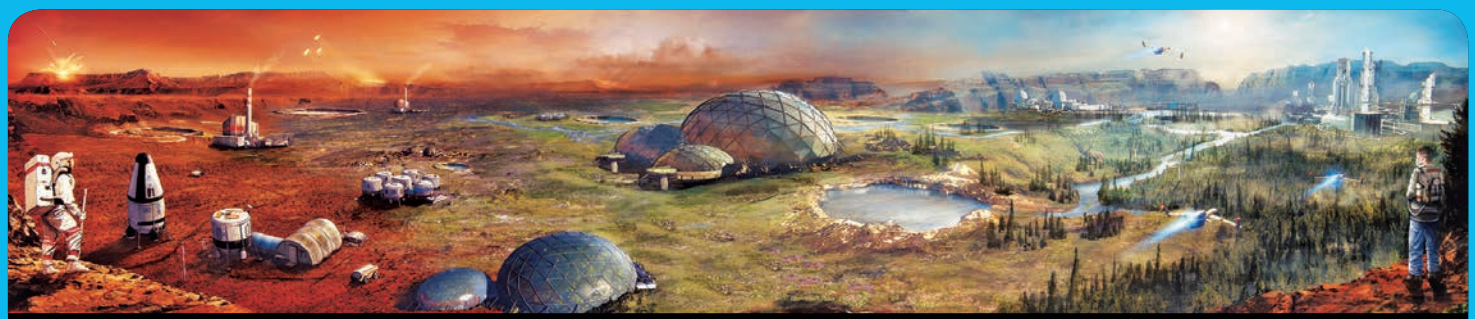
Divide the class into six groups. Assign each group one section of the time line. Using Chapter 5 as an example, instruct groups to write a new chapter for the book describing life on Mars during their assigned time periods.

Provide access to colored pencils, markers, and paper. Encourage groups to write about and create illustrations showing people's homes, food, and daily activities. Challenge students to include scientific reasons to explain how changes in the Martian ecosystem impact people's daily lives during that time period.

Give students time to complete their chapters. When all groups are finished, invite them to share their chapters with the class. Then discuss how changing the characteristics of Mars can make it a more suitable environment for human populations over time.

MATERIALS

- Colored pencils
- Markers
- Paper



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When we first arrive on Mars, the air will be too thin and the radiation level too high for people or plants to survive on the surface. People will live inside pressurized domes or cylinders covered by dirt or with filtered glass to block radiation.

During our first **100 years** on Mars, human factories will release gases. We may also crash comets into Mars to release ammonia and heat, and use space mirrors to melt the ice at the south pole. All these things will help thicken the air and warm Mars.

After about **200 years,** the air may be thick and warm enough to thaw the ice trapped in soil, and also block harmful radiation. Then microbes, algae, and lichens can grow on the surface. Clouds might get thick enough to produce snow or freezing rain.

Within about **600 years,** the simple plants would have produced enough oxygen and prepared the soil enough that more complex plants like evergreens might take root. Enough ice will melt to create lakes and rivers.

Between **600 years and 1,000 years,** Mars's atmosphere and surface will continue to change. More lakes and rivers will be filled with liquid water. More plants will begin to take root, creating more oxygen and using more carbon dioxide.

About **1,000 years** after humans begin terraforming Mars, the air may be thick enough that they can go outdoors without a space suit. People may still require breathing masks depending on the levels of oxygen and other gases.

Standards

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Grade 3

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The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it.

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Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

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