The NASA SCI Files™

The Case of the Great Space Exploration

Segment 4

Bianca is wrapping up Space Camp and feels like she is ready to blast off for worlds unknown. She's not the only one who's excited. Back in the tree house, the detectives learn about the X-Prize, a $10 million prize awarded to the first privately funded spacecraft that can carry three people to space and back. Tony definitely needs to know more! The tree house detectives dial up Mr. Erik Lindberg, grandson of Charles Lindberg, to learn about the importance of contests in developing aviation and space innovations. Still excited about the possibility of being tourists in space someday, the tree house detectives receive a report from Corrinne, a NASA SCI Files™ Kids' Club member, who is in Utah at the Mars Analog Research Station operated by the Mars Society. Dr. Tony Muscatello explains the Mars habitat and the importance of simulating working and living on Mars. Finally, Dr. D and Bianca meet to practice their satellite repair simulation and help the detectives wrap up what they have learned. The detectives are certainly glad they took Mr. Gregory's (NASA's deputy administrator) advice and are excited about the possibility of being next generation explorers who might actually walk on the surface of Mars!

Objectives

Students will

- understand that science and technology advance through the contributions of different people.
- predict a scientific fact for the future.
- investigate alternative sources of energy.
- measure reaction time.
- understand why reaction time is important.
- compare a rover and a lander.
- demonstrate how scientists gather data on distant planets.

Vocabulary

altitude – height above the Earth's surface

extremophile – microscopic life forms that can survive in extreme environments

geology – the science or study of the Earth, including rocks, water, and layers of the Earth

habitat – a sealed, controlled environment in which people can live, for example, to do research

X-Prize – a $10 million dollar prize to be awarded to the first team who can build and launch a plane that can carry three people 100 kilometers (km) into space, return to Earth safely, and repeat the launch in the same ship within two weeks

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 4 of *The Case of the Great Space Exploration*, discuss the previous segment to review the problem and what the tree house detectives have learned thus far. Download a copy of the **Problem Board** from the NASA SCI Files™ web site, select **Educators**, and click on the **Tools** section. The **Problem Board** can also be found in the **Problem-Solving Tools** section of the latest online investigation. Have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 3 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 3. Use tools located on the Web, as was previously mentioned in Segment 1.
4. Review the list of ideas and additional questions that were created after viewing Segment 3.
5. Read the overview for Segment 4 and have students add any questions to their lists that will help them better understand the problem.
6. **Focus Questions**—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program to answer the questions. An icon will appear when the answer is near.

View Segment 4 of the Video

For optimal educational benefit, view *The Case of the Great Space Exploration* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. At the end of Segment 4, lead students in a discussion of the Focus Questions for Segment 4.
2. Have students discuss and reflect upon the process that the tree house detectives used to learn more about the future of space exploration. The following instructional tools located in the **Educators** area of the web site may aid in the discussion: **Experimental Inquiry Process Flowchart** and/or **Scientific Method Flowchart**.
3. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
4. For related activities from previous programs, download the **Educator Guide**. On the NASA SCI Files™ home page, select Educators. Click on **Episodes in** the menu bar at the top. Scroll down to the 2000–2001 Season and click on *The Case of the Challenging Flight*. In the green box, click on **Download the Educator Guide**.

a. In the **Educator Guide** you will find

   1. **Segment 1** – *Lucky Lindy and the Spirit of St. Louis*
   2. **Segment 2** – *Thinking Out of the Box*

3. **Segment 4** – *The Eggs-tra-ordinary Airplane*

Close the PDF window and return to the Educator Guide page. Click on **Episodes** in the menu bar at the top. Scroll down to the 2001–2002 Season and click on *The Case of the Phenomenal Weather.* In the green box, click on **Download the Educator Guide**.

a. In the **Educator Guide** you will find

a. **Segment 3** – *3-2-1 Blast Off*

Close the PDF window and return to the **Educator Guide** page. Click on **Episodes** in the menu bar at the top. Scroll down to the 2001–2002 Season and click on *The Case of the Galactic Vacation*. In the green box, click on **Download the Educator Guide**.

a. In the **Educator Guide** you will find

a. **Segment 2** – *Mission to Mars*

Close the PDF window and return to the **Educator Guide** page. Click on **Episodes** in the menu bar at the top. Scroll down to the 2001–2002 Season and click on *The Case of the Inhabitable Habitat*. In the green box, click on **Activities/Worksheets**.

a. On the web site in the Activities/Worksheets section you will find

1. *Wish You Were Here!*

Close the PDF window and return to the **Educator Guide** page. Click on **Episodes** in the menu bar at the top. Scroll down to the 2001–2002 Season and click on *The Case of the Wright Invention*. In the green box, click on **Download the Educator Guide.**

b. In the **Educator Guide** you will find

1. **Segment 4** – *Testing 1,2,3*

5. Wrap up the featured online PBL investigation. Evaluate the students' or teams' final product, generated to represent the online PBL investigation. Sample evaluation tools can be found in the **Educators** area of the web site under the main menu topic **Tools** by clicking on **Instructional Tools**.
6. Have students write in their journals what they have learned about sand, minerals, rocks, plate tectonics, weathering and erosion, and beach erosion so that they can share their entry with a partner or the class.

Careers

airplane design engineer
geologist

Resources *(additional resources located on web site)*

Books

Becklake, Sue and Bond, Peter: *100 Things You Should Know About Space*. Barnes and Noble Books, 2004, ISBN: 0760753954.

Benford, Gregory: *Martian Race.* Warner Books, Inc., 2000, ISBN: 0446608904.

Bridgman, Roger: *Eyewitness Books: Robot*. DK Publishing, Inc., 2004, ISBN: 0756602548.

Dyson, Marianne: *Home on the Moon: Living on a Space Frontier.* National Geographic Society, 2003, ISBN: 0792271939.

George, Michael: *Space Exploration.* The Creative Company, 1991, ISBN: 0886824818.

Holland, Simon: *Space*. DK Publishing, Inc., 2001, ISBN: 0789478544.

Seuss, Dr.: *Bartholomew and the Oobleck.* Random House, 1976, ISBN: 0394800753.

Sneider, Cary I.: *Oobleck: What Do Scientists Do?* Lawrence Hall of Science, 1998, ISBN: 0924886099.

Willett, Edward: *Careers in Outer Space: New Business Opportunities.* Rosen Publishing Group, 2002, ISBN: 082393358X.

Video

Discovery Channel School: *Technology at Work*
Grades 3–6

FASE Productions: *Living and Working in Space: The Countdown Has Begun*
Grades 3–6

Holiday Space and Science: *History of Spaceflight: Reaching for the Stars*
Grades 6–adult

Just the Facts Learning Series: *Space Facts II*
Grades 6–adult

Universal: *October Sky*
Grades 5–adult

Web Sites

ANSARI X Prize
The ANSARI X PRIZE is a $10 million dollar prize to jumpstart the space tourism industry through competition among the most talented entrepreneurs and rocket experts in the world. The $10 million cash prize will be awarded to the first team that privately finances, builds, and launches a space ship able to carry three people 100 kilometers (km) (62.5 miles (mi)), returns safely to Earth, and repeats the launch with the same ship within 2 weeks.
http://www.xprize.org/

The Mars Society
The Mars Society web site has a great deal of information on the mission of the Mars Society. There are links to current research, news, and education-related topics. There is also a link to the Mars Desert Station, or Mars Habitat.
http://www.marssociety.org/

The Mars Millennium Project
Compare the geology and weather of Mars and Earth. Each analogy has two levels designed for a beginning or advanced learner.
http://www.lpi.usra.edu/education/MarsMillennium/earth_mars.html

Athena Mars Exploration Rovers
Visit this web site to learn about RATs (Rock Abrasion Tools), Mars facts, and Mars rovers.
http://athena.cornell.edu/

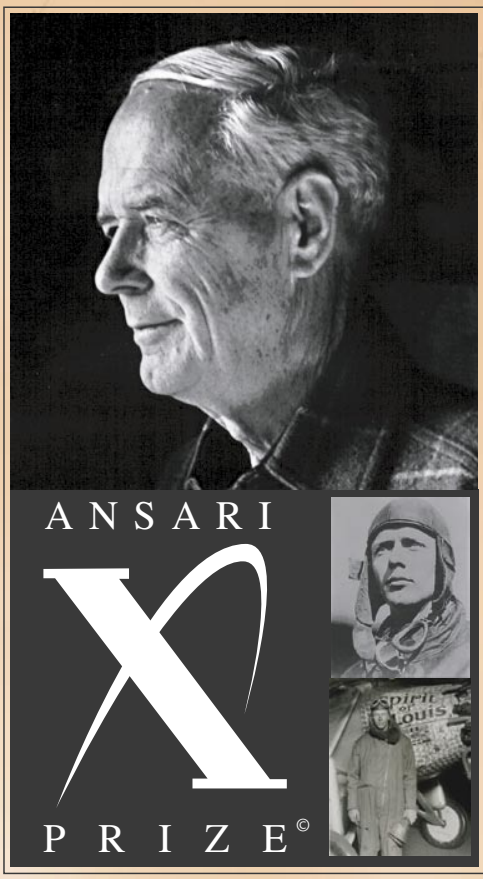
NASA: Mars Exploration Program
Come to this web site to explore the red planet Mars. Play games, do some activities, and learn about special events coming to a planet near you.
http://marsprogram.jpl.nasa.gov/funzone_flash.html

Activities and Worksheets

What's Your Prize?

Segment 4

Research various prizes, such as the Orteig prize won by Charles Lindberg, that have been awarded throughout history. Brainstorm for ideas of possible new prizes and the inventions or innovations that would win them. Determine the criteria for winning and design a trophy or other award for the winner.



www.xprize.org

In the space below, write a description of your contest and the prize and explain the criteria for winning. Justify why contests are important to inspiring innovations and inventions.

There's a RAT on the Rover!

Segment 4

Purpose

To demonstrate how scientists gather data on distant planets and to make scientific observations

Materials

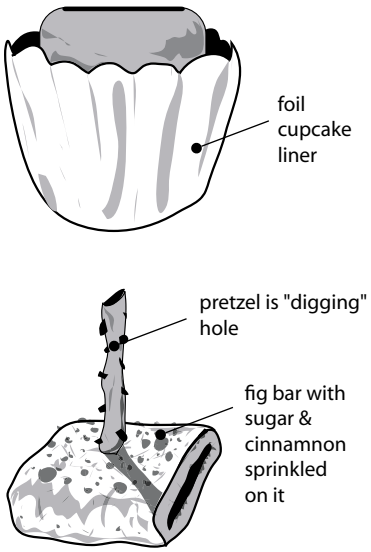
foil cupcake liners
different flavors of fig cookie bars
cinnamon
sugar
stick pretzels
metric ruler

Background

NASA uses robotic rovers to study the geology of planets far away. To observe rock samples on Earth, geologists would break the rock open with a rock hammer and carefully examine the pieces of rock with a hand lens or microscope. Instead of breaking the rock with a hammer, the Mars Exploration Rover has a special tool called the Rock Abrasion Tool (RAT) to remove the outer layers of rock and expose the underlying material. The RAT can dig approximately 5 mm into the rock and drill a diameter of approximately 4 cm. The abrasion tool, which is the size of a soda can, will shave away the top layers of the rock. This process may take anywhere from 30 minutes to 3 hours. A Microscopic Imager on the Rover, which is like a geologist's hand lens, and the Pancam, or Rover camera, will then be used to examine the materials the RAT uncovers.

Teacher Prep

1. Make a mixture of 1 part cinnamon to 3 parts sugar.
2. Sprinkle the mixture into the bottom of a cupcake liner.
3. Press each side of the fig bar into the cinnamon sugar mixture to cover the filling on the sides of the cookie. Note: Do not prepare too far in advance as the cookies will dry out quickly.
4. Repeat with all flavors of fig cookies, being careful to not mark the cookies in any way.
5. Set each cookie in a cupcake liner.
6. Sprinkle the tops of the fig bars with more of the cinnamon sugar mixture so the top surfaces of the cookies are also covered. The cinnamon sugar mixture represents Mars dust.



Procedure

1. Collect a "rock sample" from your teacher.
2. Observe the rock and in your science journal, record any observations about color, texture, size, and surface.
3. Measure the length, width, and height of the rock sample.
4. Using a pretzel as your RAT, gently begin rotating it a few times on the surface of the sample.
5. Observe the Mars dust (cinnamon sugar) as it begins to erode away, exposing the surface of the sample.
6. Observe the newly exposed region and record your observations.
7. Notice how the "dust" builds up along the edge of the drilled area, along with some of the rock surface.
8. Apply slightly more pressure to the RAT and rotate several more times to dig slightly deeper into the sample.
9. Remove the RAT and observe the interior of the rock (the filling).
10. Measure the depth and diameter of the hole left behind by the RAT.

There's a RAT on the Rover!

Segment 4

11. Conduct research to learn more about rocks and the rock cycle.
12. Using what you learned, make a hypothesis about the kind of rock you have uncovered and how it was formed.

Conclusion

1. What is a RAT?
2. What can scientists learn about a planet by studying data the RAT collects?

Extension

1. Using this formula: volume = length x width x height, calculate the volume of your rock sample. Now measure the size of the hole your RAT left. Estimate the volume of the material removed from the RAT hole.
2. Collect rocks in your area. Record the location where you found them. If possible, take a photograph or digital picture of the area. Examine the rocks. Using reference materials, classify the rocks. Every rock tells a story. What story does your rock tell about our Earth? Write and illustrate your story.

The Quickest Hand in the West

Segment 4

Purpose

To measure reaction time and to understand why reaction time is important when working in space

Materials

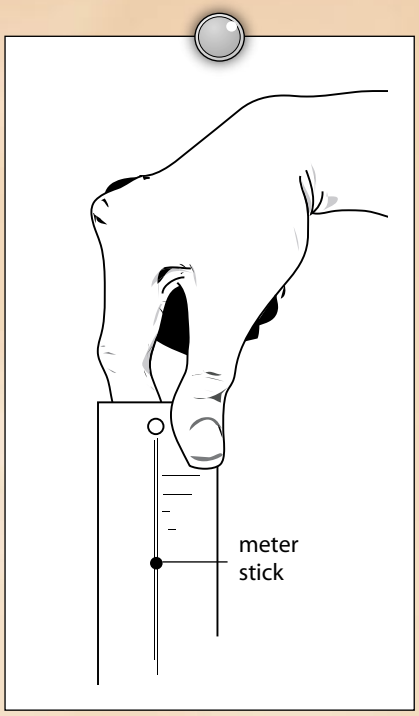
centimeter ruler
scissors
pen or pencil
meter stick
"Reaction Time" worksheet

Background

Reaction time is the time it takes the body to respond to the presentation of a stimulus. For example, pretend you are at a park. You are walking away from a baseball field and suddenly you hear, "Heads up!" Reaction time is how long it takes your body to react to the call to watch out. A quick reaction time is ideal, especially in the previous scenario. Reaction time can vary among individuals and can also vary for the same individual. The more tired a person is, the greater or slower his or her reaction time. Reaction time is especially important in space. Astronauts face many challenges while they are in such a harsh environment. They must have quick reaction times to ensure safety and to complete their missions. Adequate rest is necessary to keep astronaut reaction times quick. A Reaction Time Test can determine a person's reaction time. The test must be given several times, and an average must be taken to determine an individual's reaction time.

Procedure

1. Have your partner hold (with thumb and forefinger) a centimeter ruler vertically at the 30-cm mark with the 0-cm mark toward the floor. See diagram.
2. Place your thumb and forefinger at the end of the ruler at the 0-cm mark.
3. Your partner should be ready to catch the ruler between his/her thumb and forefinger but should not be touching the ruler yet.
4. Drop the ruler and have your partner try to catch the ruler as soon as he/she can.
5. Place your fingers where the ruler stopped and your partner caught it.
6. Observe the number on the ruler.
7. If the number is less than 5 cm, disregard the results and try again.
8. Record the number on the "Reaction Time" worksheet (page 83) next to trial number 1.
9. Repeat the process 19 more times, each time recording the number next to the corresponding trial number.
10. Change places with your partner and repeat the process 20 times.
11. Find the average for your reaction time by adding all the numbers together and dividing by 20.
12. Record your answer on the "Reaction Time" worksheet under average.
13. Make a line graph of your reaction times. Be sure to include a title and label the x axis and y axis on the graph.



The Quickest Hand in the West

Segment 4

Reaction Times for _____ (name)		***Reaction Times for*** _____ (name)	
Trial 1		*Trial 1*	
2		*2*	
3		*3*	
4		*4*	
5		*5*	
6		*6*	
7		*7*	
8		*8*	
9		*9*	
10		*10*	
11		*11*	
12		*12*	
13		*13*	
14		*14*	
15		*15*	
16		*16*	
17		*17*	
18		*18*	
19		*19*	
20		*20*	
Average Reaction Time: _____		***Average Reaction Time:*** _____	

Conclusion

1. Why do you think it was important to discard the results that were less than 5 cm?
2. Why did you have to do so many trials?
3. Why is it important to use the average from your trials to determine your reaction time?
4. Do you think your reaction time would change if you had more or less sleep? Why or why not?

Extension

On a weekend, ask for permission to stay up 1 or 2 hours later than usual. You must be feeling tired before starting the experiment. Remember, you will need a partner. Repeat the experiment at home. Was your average reaction time the same as at school? Why? Try the experiment again after you have had a good night's sleep. Was there a difference? Why?

To the Moon, Mars, and Beyond

Segment 4

Use the word bank, locate each word, and circle or highlight the word when you find it.

Phoenix Lander	rover	RAT
nutrition	Calorie	Food Pyramid
exercise	radiation	visible light
Mars	X-Prize	habitat
planet	ferrofluid	robot
solar sail	Space Camp	propulsion
nanotubes	water ice	astronaut

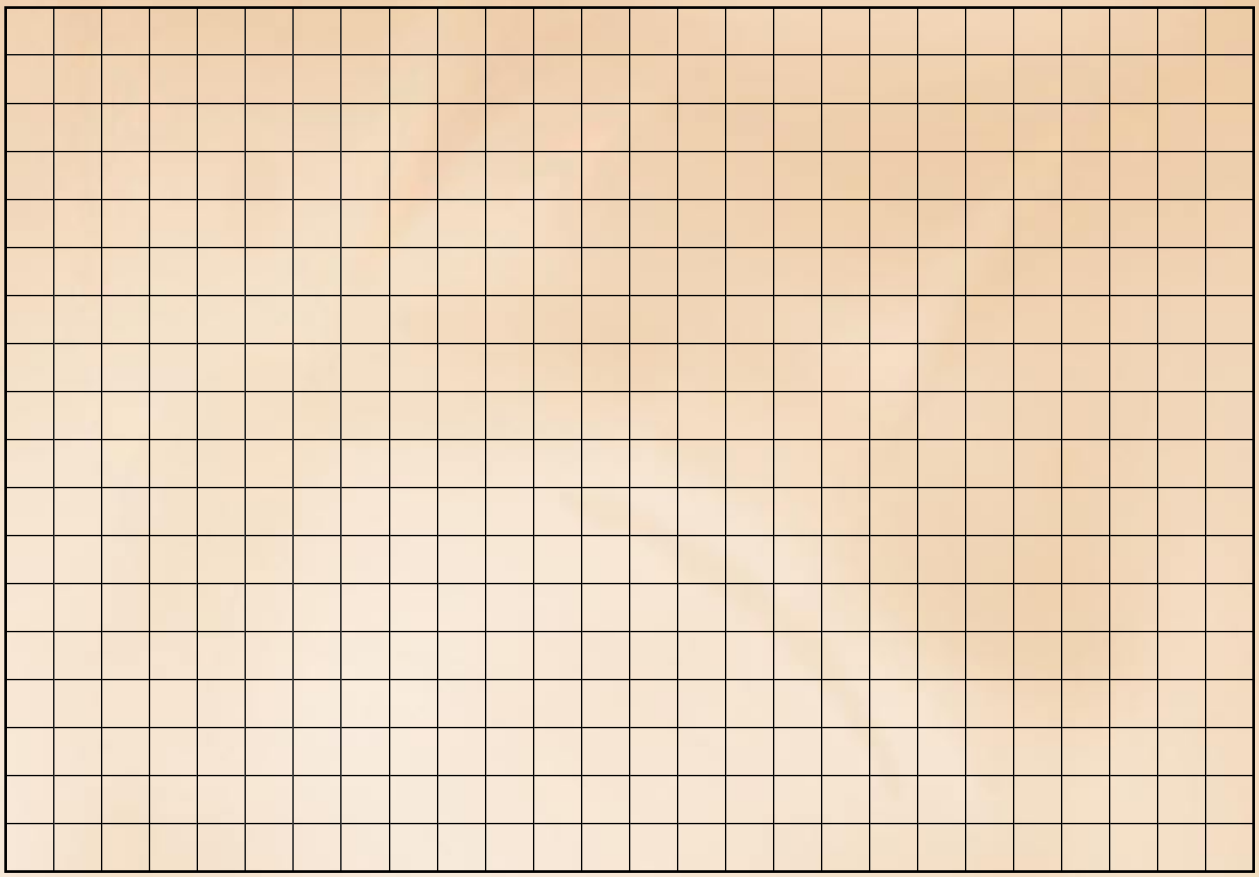
S P A C E C A M P R Y N E A P T A M O O N S
T N M O M A R S I N B A B E T U G U Y I O I
N A C A M O R P M E T S Y O H T R A E L D G
O O R D X P E R I A K M B I C L I P A O N N
I N M A P I O M B N G O M S T O N R H T A E
T H E E R T I U A I R A P X R Y S I S H N O
A K A I I O R K N K I N R Y V A I O I Y O U
I J I L Z E S N M D C C O T I L L E R D T E
D L P L E T E T E C T O P L S S A G O R U S
A A I E E E R G E H Z N U N I T E V A I B I
R S M W R T I O E I T V L U B R R A R E E C
T Z Q U I C L I V T O E S M L I O E P U S R
C N L D S A I N D E R R I M E A S A E A H E
A G E A R S Z A I E R G O O L T P E N D A X
L I V E R T S S N G P T N C I I A N O I B E
O S P A C E S T A T I O N T G O C L I M I H
R E D N A L X I N E O H P R H N E I T A T E
I E N E I G P L A N E T K O T S A C I R A R
E E R C P G S I C I Z U A P T E S T R Y T I
A K A T I I T G U D T B I R B I L L T P I N
F E R R O F L U I D R I R I O Y T I U D R G
G A E M O H S O B I T E R A T I V E N O U E
A S T R O N A U T C S N I K K I N Y N O P V
M F A E B Z X R S W W A T E R I C E S F R E

The Next Generation

Segment 4

Create a crossword puzzle with the following terms and the grid below.

astronaut
nutrition
propulsion
water ice
habitat
spacecraft
exercise
gravity
lander
Mars
crew
radiation
robot
nanotechnology



Across

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Down

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Answer Key

Segment 4

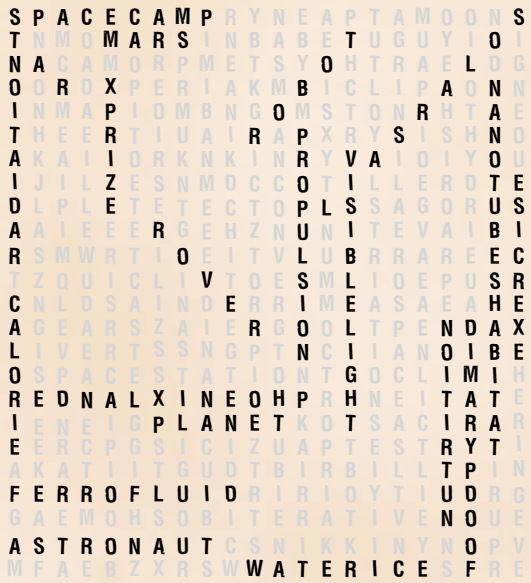
There's a RAT on the Rover

1. A RAT is a Rock Abrasion Tool used by scientists to study rocks on other planets.
2. Answers will vary but might include that they could learn the geology of a rock, which might help scientists understand how the planet was formed and learn whether life might have existed.

The Quickest Hand in the West

1. The average human brain is unable to respond that quickly to a stimulus, so a response distance of less than 5 cm would only be possible if directions were not accurately followed.
2. The greater the number of trials, the more statistically accurate the average becomes.
3. The human brain does not respond exactly the same way in the same time to identical responses. Factors such as how tired a person is, attention level, and outside distractions may all affect a response time.
4. Answers will vary, but students should understand that each person needs a particular amount of sleep so the body can rest and repair itself. However, too much sleep can slow reaction times and can be unhealthy for the human body.

To the Moon, Mars, and Beyond



On the Web

Edible Rover/Lander

1. Many destinations in space are too far or too harsh for human exploration at our current levels of technology.
2. A lander is designed to simply land at a given location on a planet and collect data from a stationary position. A rover is designed to move from one location to another to collect and transmit data.
3. Scientists choose spots that will best match the specific purpose of the mission. The spacecraft are designed to collect the kinds of data the scientists will need from that specific location to complete the mission.