

Lesson 12: The Phoenix Mission: Uncovering Martian Water

Purpose: To increase student knowledge about the Phoenix Mars Lander’s science mission to use robotic technology to uncover water on Mars.

Standards

NCTE/IRA Standards for English Language Arts

Standard 12- Students use spoken, written, and visual information to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

National Science Education Standards

Science as Inquiry – Content Standard A

1. Abilities necessary to do scientific inquiry.
2. Understanding about scientific inquiry.

Physical Science- Content Standard B

1. Properties of objects and materials – objects have many observable properties, such as size, that can be measured using tools.
2. Properties of objects and materials – materials can exist in different states—solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating and cooling.

Earth and Space Science – Content Standard D

1. Properties of Earth materials – soils have properties of color and texture, and capacity to retain water.

Overview

What is in the Martian arctic soil? That is what Phoenix is going to investigate. Using a robotic arm and a suite of instruments, the Phoenix Lander will dig down to (1) study the history of water in all its phases and (2) search for evidence of a habitable zone and evaluate the biological potential of the ice-soil boundary. Like other robots sent to study Mars, the Phoenix lander is designed to perform certain tasks unique to the mission. In this activity, students will be introduced to the mission and conduct some simple experiments to learn about the important properties of water and water-ice.

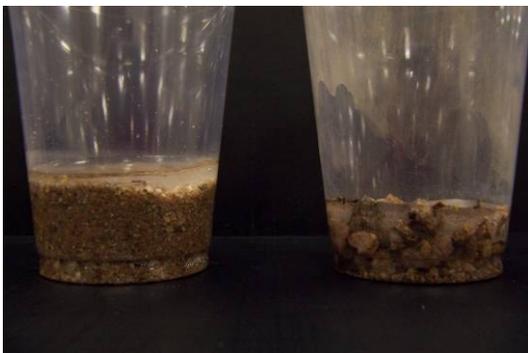
Understandings

1. Water is a special compound, which is essential to life on Earth and may be the key to discovering life beyond Earth.
2. Robots gather different information (data) depending on their design and use.
3. Combining the information (data) gathered by a variety of robots gives us a broader and more in-depth understanding of our Earth and Solar System.

Materials

1. *Where Can NASA Find Water on Mars and Is Water Important for All Living Things*, NASA Kids Science News Network (KSNN)[™] episodes (1-minute videos)*
2. Hand lens or magnifying glass (1 per student)
3. Paper plates (1 per student)
4. Copies of the Soil and Ice Observations sheets (included)
5. Two different types of soil samples labeled Sample A and Sample B, *Sand or small grain gravel are good types of soil samples that can be analyzed with small hand lenses. Pick one type of soil for Sample A and another type of soil for Sample B. Soil samples can be dug up from the local school yard or surrounding area. Try to avoid getting large amounts of biological material (i.e., leaves and roots) in the soil samples.*

6. Soil/Water icicles (1 per group), *Make the Soil/Water Icicles at least one day prior to the lesson by saturating the soil samples with water in small clear plastic cups and freezing the mixtures. Mark each tray of icicles Sample A or Sample B but do not label the cups. The students will be determining which soil sample is in their group's icicle.*



7. Icicle scraping tools: wooden craft or popsicle sticks, metal paperclip or other small metal object, plastic comb or paperclip, and any other readily available materials to scrap the icicles (1 of each per group)

*Videos can be downloaded from the MarsBots Material section of the Phoenix Mission Website (<http://phoenix.lpl.arizona.edu>) ***note: we will make the specific address available as we make final preparations on the learning module.

Time

Ten to Fifteen minutes to prepare the soil/water icicles

Ten minutes to watch the video clips and discuss the Phoenix Mission

Fifty minutes to make the observations and conduct experiment

Fifteen to twenty minutes for discussion

Directions

Part One: Dry Soil Observations

1. Watch the two 1-minute NASA KSNN™ segments and discuss the Phoenix Mission with the students. *The Phoenix Mars Lander is designed to measure volatiles (especially water) and organic molecules in the arctic plains of Mars, where the Mars Odyssey orbiter has discovered evidence of ice-rich soil very near the surface (see background section). More information about the mission can be obtained at <http://phoenix.lpl.arizona.edu>.*
2. Distribute a paper plate to each student. Instruct the students to divide the paper plate into halves, marking one half "A" and one half "B."
3. For this experiment, students will be using a hand lens to make observations. Distribute the hand lenses and have the students practice using a hand lens. *If hand lenses are limited the students can form the groups and share a single lens within their group.*
4. Give each student a small scoop (approx. 1 teaspoon) of both Sample A and Sample B. Have the students individually observe the small soil samples they receive using their hand lens. *Allow the students to use all their senses in observing: sight, touch, and smell (for safety purposes students should waft when smelling and not smell the sample directly. Also, under no circumstances should the students taste the soil.) Consider using terms such as*

grainy, gritty, smooth, rough, wet, dry, musty, and so on.

5. Have students record their observations in the data chart. *When recording their observations have the students consider the following questions. How do the soils compare? How do the textures compare? Which particles are larger? How do the colors compare?*
6. Discuss the students' findings and relate their observations to Phoenix. *The Phoenix Lander will use a very sophisticated suite of scientific instruments to examine the Martian arctic soil. A microscope will be examining the texture of the soil to try and understand the history of the arctic soils. By examining the grain size and texture, scientists can determine if the soils were ever affected by liquid water. Today, there is no liquid water on Mars and liquid water is necessary for life, as we know it. Understanding the history of the soil will help determine if the Martian arctic environment could have supported life in the past (see the background information).*
8. Divide students into observation groups (3-4 students per group) and give each group one icicle sample. *Do not let them know if it is made with Sample A or Sample B soil. At this point have the students remove the dry soil samples from their work stations (they will use their observation sheets for this section) but keep them available for the students to refer back to throughout the remainder of the lesson.*
9. Have the students examine the icicle and record their observations in the data chart. *Student can peel away the wax paper cup so they can observe the sample from all angles. Students should consider the following questions as they record their observations. Does the icicle contain Sample A or Sample B soil? How can you tell? (Textures, grain size, color...)*
10. Discuss the difference between dry soil and icy soil. *Which is easier to get small samples of soil from to analyze? How could you get small amounts of the icy soil into science instruments? Explain that Phoenix needs to dig into the very hard icy-soil and bring small amounts of the icy soil to the lander deck for analysis by the science instruments.*

Part Two: Icy Soil Observations

7. Discuss with the class how there is no liquid water on Mars but there is water in the form of ice in the planet's polar regions. *Reemphasize that Phoenix is looking for evidence of past liquid water by examining both the dry soil on top of the Martian surface and the icy soil below the surface.*
11. Distribute the icicle scraping tools and have each group make a single motion scrape across the icicle surface with each tool. Have the students record their observations. *Size of savings. Soil removal. Which tool worked best to remove icy soil samples? Why?*



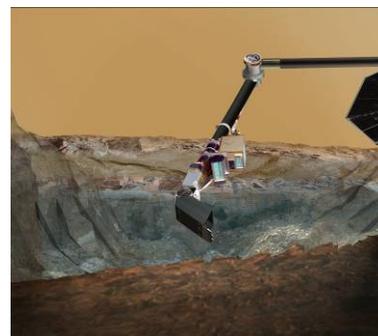
12. Then have each group make five quick scraping motions across the surface to simulate a motorized brush. *Now which tool worked best to remove icy-soil samples? Which method is better at*

scraping the hard ice samples: a single scooping motion or a “motorized” tool? Which would use more energy?

13. Discuss what the Phoenix engineers had to think about when designing a tool to dig into the hard icy-soils of Mars’ northern arctic plains. *Talk about the different materials (metal, plastic, wood) and methods used to scrape at the ice (dig, scoop, drill) and get enough of a sample that can go to the lander deck instruments for analysis.*

Soil and Icicle Observations

The Phoenix Mars Lander will use a robotic arm to dig into the icy-soils of the Martian arctic to study the soil and water history. Life, as we know it, requires liquid water. However, today there is no liquid water on Mars. Understanding if the Martian arctic ever had liquid water will help determine if it ever had an environment that could have supported life.



Phoenix will study the grain size, texture, color and chemical make-up of the icy-soil. In this exercise, you will get two soil samples to examine and compare. Then you will get a mystery icicle sample, similar to what Phoenix expects to find on Mars. Use the tools provided to examine the mystery sample and determine what type of soil is in your icicle and what type of tool is best for examining the sample.

Traits	Sample A	Sample B	Icicle Sample
Texture			
Color			
Particle Size			
Smell			
Other?			
Compare Samples A and B. How are they similar? Different?			Was the soil A or B? How do you know?
Wooden tool	Metal tool	Plastic tool	Other tool