National Aeronautics and Space Administration

MOON MINING

Student Section   Student Name _____

Lesson Objective

This lesson simulates the locating and the mining of ilmenite for oxygen on the moon.

During this lesson, you will

- gather data by spectroscopically locating the simulated ilmenite.
- collect simulated ilmenite by mining the simulated lunar surface.
- gather data by using observations while extracting oxygen from the simulated ilmenite over time.
- develop a conclusion based upon the results of this simulation.
- compare individual results to class results to look for patterns.

Problem

How can I find and mine valuable resources from a simulated moon surface?

Observation

Many things were learned about the moon during the Apollo flights to the moon. Much of this knowledge comes from the rock samples that the astronauts brought back with them from the moon. These samples were one of the greatest benefits of sending humans to the lunar surface. Before their missions, the astronauts went through training, to recognize different types of rocks and their significance.

NASA's Vision for Space Exploration calls for a return to the moon before going to Mars, and beyond. We'll learn how to "live off the land" by making oxygen and rocket propellants from the local materials, and we'll be testing new technologies and operations. Living and working on the moon will be a test run for living and working on Mars and beyond.

In this lesson, you will locate and simulate the mining of ilmentite for it's oxygen from the surface of the moon. The mineral ilmenite is Iron Titanium Oxide. After mining, you will then collect the oxygen that is extracted from the ilmenite.

Use the first column of this KWL chart to organize your observations about mining.

Brainstorm with your group what you want to know about mining, then list in the second column of this KWL chart.

KNOW	WANT TO KNOW	LEARNED

Hypothesis
Based on your observations, answer the "problem question" with your best guess. (How can I find and mine valuable resources from a simulated moon surface?) Your hypothesis should be written as a statement.

My hypothesis: _____

Materials
Per group
- 1 disposable plate moon prepared by your instructor before class
- 1 - 8.5" x 11" red transparency
- 1 - 8.5" x 11" blue transparency
- 1 quart size, freezer, zipper seal bag
- 1 spoon
- centimeter ruler
- stopwatch, watch or clock

Per student
- 1 pair of safety glasses
- graph paper

Safety
Review your classroom and lab safety rules. Put on safety glasses when instructed.

Test Procedure
1. Put on your safety glasses.
2. Observe your disposable plate moon with your partner.
3. Draw a line to divide the graph paper in half. Sketch your disposable plate moon on one half of the graph paper. Label your drawing. Title the drawing "Before Mining".
4. Place red transparency on half of the plate, and blue transparency on the other half.
5. Look for ilmenite (effervescent tablets) by moving the transparencies around the plate. What color can you see the ilmenite through? What color hid the ilmenite? NASA researchers use colors to locate certain items on the surface of other bodies. This is called "spectroscopically" locating the ilmenite.

6. When the ilmenite is located, extract the section it is in from the disposable plate (take it off of the plate with the spoon) and place it into the zipper seal bag. Zip the bag, making sure all air is locked outside the bag.

7. Place the bag in a sunny location. This represents the solar energy that may be used to power the machinery that extracts the oxygen from the ilmenite.

8. Evenly flatten out the contents of the bag by pushing it down with your palms. This will allow you to see the profile, or side, of the bag.

9. Observe the bag. Sketch what it looks like on your Moon Mining Data Sheet.

10. Measure from the tabletop to the top of the bag, using the profile, or side, of the bag. Record data on your Moon Mining Data Sheet at zero minutes. (See diagram.)

Measure from the tabletop to the top of the bag, using the profile, or side of the bag.
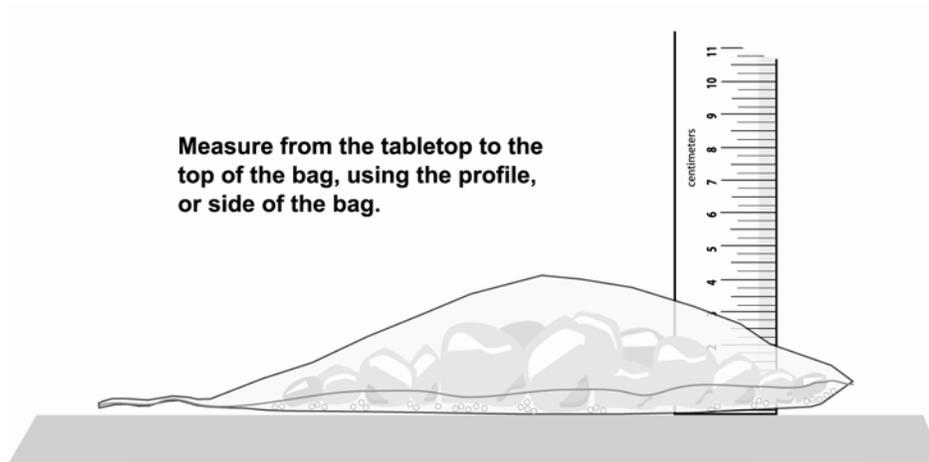
11. Predict how the bag will change over time, and record your prediction on your Moon Mining Data Sheet.

12. Guess what is inside the bag. Record on your Moon Mining Data Sheet.

13. Every 3 minutes for the next 12 minutes, repeat steps 9-12. Do not disturb the ilmenite sample.

14. Discuss what you see happening to your zipper sealed bag with your group. Why is the ice melting?

15. Sketch your disposable plate moon on the other half of the graph paper. Make sure you label where the ilmenite was found. Label your drawing. Title your drawing "After Mining". What are these deep places on the moon called?

16. After taking all measurements, study the data and draw conclusions by answering the questions following the Moon Mining Data Sheet.

Record Data

Moon Mining Data Sheet

	0 minutes	3 minutes		6 minutes		9 minutes		12 minutes	
Sketch the outline of the bag profile									
Measure in cm from the table to the top of the zipper bag (laying flat)		Predict	Actual	Predict	Actual	Predict	Actual	Predict	Actual
What do you think is inside the bag?									
Other observations									

Study Data

1. What do you think the ilmenite is doing in the bag as it is warmed to room temperature by solar energy?

2. What do we need to mine ilmenite from the surface of the moon?

3. Where is ilmenite found on the moon?

4. How do we locate ilmenite on the moon?

5. Does this data support your hypothesis? Why or why not?

6. How do your results compare to class results?

Conclusion
- Update the LEARNED column in your KWL chart.
- Restate your hypothesis and explain what happened during testing.