



MOON MINING

Student Section _____

Student Name _____

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

During this lesson, you will

- collect data by spectroscopically locating the simulated ilmenite.
- collect simulated ilmenite by mining the simulated lunar surface.
- collect 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 United States Space Exploration Policy 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 ilmenite for its oxygen from the surface of the moon. The mineral ilmenite is Iron Titanium Oxide. After mining, you will then collect the simulated 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.

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

- eye protection
- graph paper
- colored pencils or markers
- stopwatch, watch or clock
- hand protection, as needed

Safety

- Review classroom rules.
- Review lab safety rules.
 - Wear eye and hand protection.
 - Pull hair back.
 - Wear closed toe shoes.
 - Clean up work area.
 - Dispose of waste properly.
 - Wash hands after lab clean up.

KNOW	WANT TO KNOW	LEARNED

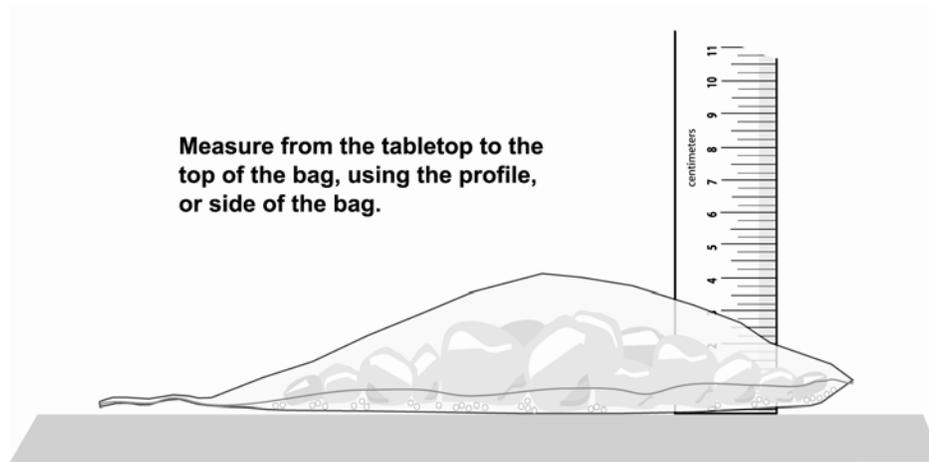
Hypothesis

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

My hypothesis: _____

Test

1. Put on your eye and hand protection.
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. Hold the red transparency over half of the plate, and the blue transparency over the other half.
5. Look for ilmenite (effervescent tablets) by moving the transparencies over the ice on the paper plate moon. What does the ice represent? What color transparency can you see the ilmenite through? What color transparency 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, use the spoon to extract, or scoop, the entire contents of the section of the plate.
7. Place the ilmenite into the zipper seal bag, continuing to use the spoon.
8. Zip the bag, making sure all air is locked outside the bag.
9. Place the bag in a sunny location or under an alternative heat source such as a lamp. This heat source represents the solar energy that may be used to power the machinery that extracts the oxygen from the ilmenite.
10. 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.
11. Observe the bag. Sketch what it looks like on your Moon Mining Data Sheet.
12. 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.)



13. Predict how the bag will change over time, and record your prediction on your Moon Mining Data Sheet.
14. Guess what is inside the bag. **Record** on your Moon Mining Data Sheet.
15. Every 3 minutes for the next 12 minutes, repeat steps 9-12. Do not disturb the ilmenite sample.
16. Discuss what you see happening to your zipper sealed bag with your group. Why is the ice melting?
17. 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?

Study Data

After taking all measurements and recording the data on the Moon Mining Data Sheet, study the data by answering the following questions.

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 how the results do, or do not, support your hypothesis.

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									

Scientific Investigation Rubric

Activity: MOON MINING

Student Name _____

Date _____

Performance Indicator	0	1	2	3	4
The student developed a clear and complete hypothesis.					
The student followed all lab safety rules and directions.					
The student followed the scientific method.					
The student recorded all data on the data sheet and drew a conclusion based on the data.					
The student asked engaging questions related to the study.					
The student mined simulated ilmenite and collected oxygen from the ilmenite.					
Point Total					

Point total from above: _____ / (24 possible)

Grade for this investigation _____

Grading Scale:

A = 22 - 24 points

B = 19 - 21 points

C = 16 - 18 points

D = 13 - 15 points

F = 0 - 12 points

