

# Lesson 4: Remote Sensing Mars

## Summary

This learning module and related laboratory exercise exposes students to remote sensing techniques utilized on Mars.

## Learning Goals

### Students will be able to:

- Apply the concepts of scale and context in remote sensing imagery.
- View THEMIS and HiRISE images and interpret major geomorphic features using Google Mars and associated homework activities.
- Understand how MOLA generates its image data by applying the fundamental equations in an experiment.

## Context for Use

This learning module is meant for adaptation in an introductory earth science course and/or planetary science course. It is advised that the teacher compare Earth-based remote sensing instrumentation for context/reference such as LandSat 7.

## Description and Teaching Materials

### *In-Class Activity*

In-Class Activity 1: Scale and Context

In-Class Activity 2: MOLA simulation

### *Homework/Lab*

Homework 1: Google Mars-Following Opportunity

Homework 2: Mars Image Analysis

3. We advise instructors to compare Earth-based remote sensing packages such as Landsat 7 for context.
4. In preparation for the MOLA simulation *In-Class Activity* instructors must gather a few materials (see the *MOLA simulation* for further clarification).

## Teaching Notes and Tips

1. The *In-Class Activities* can be utilized as homework as well. Students will have a lab-write up associated with the *MOLA simulation*.
2. For a large class size >20 you may either have a separate lab time/class for different sections or demonstrate the lab with the entire class and employ student participation.

## Assessment

- The *MOLA simulation* Lab write-up will assess the student's understanding of the MOLA instrument and MOLA's utility.
- The *Google Mars* homework will assess whether or not students can successfully navigate the Google Mars software and begin to interpret the data provided by Google Mars.

## Mars for Earthlings

### References and Resources

1. THEMIS images url: <http://themis.asu.edu/>
2. LANDSAT 7 images url: <http://landsat.gsfc.nasa.gov/images/>
3. HiRISE 13 April 2011 YouTube video: <http://www.youtube.com/watch?v=-U6-uYDtuSg>
4. MRO/HiRISE All HiClips revisited (Feb 2012) YouTube Video:  
<http://www.youtube.com/watch?v=YVDUQjJbjyc>
5. MOLA images url: <http://mola.gsfc.nasa.gov/index.html>
6. Ping-Pong Lab (NASA): <http://mola.gsfc.nasa.gov/pingpong.html>



## Mars for Earthlings

**Homework 2**

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*Mars Image Analysis*

**Directions:** View the following THEMIS image and answer the questions about the image. As students view the image, think about how this image might support one or more of NASA's main exploration goals:

1. Determine if life ever existed on Mars
2. Characterize the climate of Mars
3. Characterize the geology of Mars
4. Prepare for future human exploration of Mars

Go to: <http://themis.asu.edu/>

**Questions:**

*Getting to know THEMIS imagery (click on the "about")*

1. In a few sentences explain what THEMIS detects and how it works.
2. Go to THEMIS image: <http://themis.asu.edu/node/5765>  
What is the title of the THEMIS image?
3. Study the THEMIS image. List at least two features you observe.
  - a.
  - b.
4. If the sun is illuminating from the left, are the features expressing positive (hill) or negative (valley) relief? If features differ from another (i.e. one has positive relief and the other negative) describe their relief separately.
5. What is the Lat/Long of the center of THEMIS image?  
Lat \_\_\_\_\_ Long \_\_\_\_\_



## Mars for Earthlings

6. Explain how this image meets or does not meet NASA's exploration goals of Mars.
7. If students were to lead a lander mission to an area located within the image, where would they land and why?

### *More THEMIS Imagery*

8. Go to the THEMIS image gallery by Topic: <http://themis.asu.edu/gallery>  
Have the students choose an image they like and report the following:
  - a. What is the image ID or the image url?
  - b. Why did the students choose this image?
  - c. Where is the image located?
  - d. Near what major Mars geographic region is it located (South/North pole, Victoria Crater, Endurance Crater, Meridiani Planum, Hellas Basin, etc.)? Use the *View this image on Map* link at the bottom of the image data column to see a map view of Mars.
  - e. Why might this location be important to science?





## Mars for Earthlings

*HiRISE Imagery*

9. Navigate to the HiRISE website: <http://hirise.lpl.arizona.edu/>
  - a. Scroll to the bottom of the page (gray box) and click on the link “Science Themes”. Click on the *Aeolian Processes* file of images. Under the main image click “View Images in this Theme.” Find image titled “Dunes in the Western Nereidum Montes.” If students cannot find the image type ESP\_013046\_1390 into the search box.
  - b. Define the term *Aeolian*. (also known as eolian)
  - c. Why might an image of *aeolian* processes on Mars be of interest to us on Earth?
  - d. Have students sketch what they see below. Label appropriate parts (high and low areas). Can they identify the direction of the wind if North on Mars is up? If so, what direction (cardinal direction) is it?

