Educator Guide

Science Activity 5: Cliffs and Craters: Exploring Topography on Mars

Educator Preview

Activity Snapshot

Learners interpret topographic maps of Mars to identify safe and interesting landing sites.

Timing | 45 minutes

Get Ready and Team Up	10 min.
Analyze Landing Sites	25 min.
Reflect	10 min.
Total	**45 min.**

Level Up Activities 5–45 min. each

Prep Snapshot*

Prep Time **30 min.**

Print resources for the Activity.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Critical Thinking

Science Practices

- Analyzing & Interpreting Data
- Planning Investigations

Guiding Question

How can topographic maps help us choose a safe and interesting landing site on Mars?

Learners Will Do

Interpret topographic maps of Mars to identify flat areas and landforms.

Learners Will Know

Scientists use topographic maps to make decisions.

Connecting Across Activities

Activity 4: Introducing Topography	Activity 5: Exploring Topography on Mars	Activity 6: Introducing Spectroscopy
Last time, learners deepened their understanding of landforms by considering topography.	**Today**, learners interpret topographic maps of Mars to locate interesting landforms and to determine the safest place for a rover to land. These maps are the second set of data they will use to choose a landing site.	**Next time**, they will learn how to interpret spectra of light reflected from various objects, which will later help them identify minerals from a distance.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction, pgs. iii-xxvi. Access more PLANETS units, research, and pathways at https://planets-stem.org/.

QR Code for Activity Resources

weblink: https://hov.to/175aa080

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) in Prep & Setup Guide (PDF) Examples | Templates
- Play Doh or clay (optional)

For each learner

- Science Notebook (PDF)

For each group of four

- Science Activity 3 Landforms on Mars Data Packet (PDF)
- Science Activity 5 Mars Landing Site Topography Data Packet (PDF) (in page protectors, if possible)
- 1 Landing Site Oval (PDF) from Science Activity 3
- 1 dry-erase marker, fine point (optional, if using page protectors)

Activity 5 Materials Preparation (10 min.)

Ahead of Time

1. Review the *Our Ideas* poster *"In-Use Example"* in the Prep & Setup Guide - Examples (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this activity.
2. Make copies of Science Activity 5 Mars Landing Site Topography Data Packet (PDF) for each group of four. Note: Data Packets are large files and should be downloaded and printed ahead of time. Consider laminating the pages of *Science Activity 5 Mars Landing Site Topography Data Packet* or placing them into plastic page protectors to prevent them from getting damaged.
3. Optional: Print the images in *Science Activity 5 Mars Landing Site Topography Data Packet* on swell paper with these printable files (weblink).

4. Optional: Create a clay model of each of the landing sites in Science Activity 5 Mars Landing Site Topography Data Packet (PDF) to provide a tactile version of the data. The models can be estimations based on the color changes; they do not need to follow the lines exactly.

An example tactile clay model of Gale Crater

In Your Space

5. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally. Add a section divided into two columns. Title one column "Gale Crater" and the other "Jezero Crater."

Level Up!

If you are using the advanced version of this pathway with four possible landing sites, use the advanced version of the Science Activity 5 Mars Landing Site Topography Data Packet with Level Up (PDF) and add columns titled "Nili Fossae" and "Iani Chaos" to the *Our Ideas* poster.

Activity Guide

Get Ready and Team Up (10 min.)

1. Ask: **If you did the last activity, what did you do and why?** (*We built 3D models of topography and turned them into 2D maps. We learned how to interpret topographic maps*). Indicate the information about topography on the *Our Ideas* poster.

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. iii-xxvi).

2. Say: **Our challenge is to choose the best landing site to search for past liquid water.**
3. Say: **Today, we'll continue to focus on choosing a safe landing site.** Share the Guiding Question or a similar question from the *Our Ideas* poster with learners aloud and in writing (using multiple languages as needed): **How can topographic maps help us choose a safe and interesting landing site on Mars?**
4. Organize learners into groups of four and distribute Science Notebooks.

Analyze Mars Landing Sites (25 min.)

5. Say: **Now that you understand how to read a topographic map, you are ready to explore topographic maps of Mars. To help scientists study the topography of Mars, engineers developed an instrument that gathers information about the size and height of landforms by bouncing a laser off them and measuring how long it takes the light to come back. By measuring the height of millions of different points on the surface using this laser, scientists know the topography of the entire surface of Mars.The technology is called *Li*ght *D*etection *a*nd *R*anging, or LiDAR.** Record the term *LiDAR* on the *Our Ideas* poster.
6. Provide a *Science Activity 3 Landforms On Mars Data Packet* and a *Science Activity 5 Mars Landing Site Topography Data Packet* to each group. Demonstrate as you say: **Examine the topography data packet and compare it to the landforms data packet**. After a few minutes, ask questions to ensure learners notice the following:
   - These topographic maps show the same area of interest as the Context Camera images for each of the landing sites they explored earlier.
   - The colors match the color scale on the topographic maps they made in Activity 4 (if they followed the suggested key).

Support Thinking

To help learners understand LiDAR, show the videos Using Light to Measure Distance (LiDAR Theory) and Using Light to Map Surfaces (LiDAR Uses).

Level Up!

Although this activity lists two possible landing sites, if you have time, the activity is more interesting and enriching with four choices. If you choose this option, make sure to reference the two additional options as you go.

7. Say: **Turn to *Jezero Crater: Topography, pg. 5,* in the *Science Activity 5 Mars Landing Site Topography Data Packet.* What do you think the color scale, or the difference in color and shading, means?** *(The colors represent height. Yellow represents high areas and blue represents low areas. [If printed in grayscale, brighter represents high areas and darker represents low areas.] The color scale shows the direction of the slope.)* **What do you think the lines mean?** *(As on the topographic maps earlier, each line represents a particular height.)*

Level Up!

The Engineering Pathway, Worlds Apart: Engineering Remote Sensing Devices (PDF), goes into detail on how LiDAR works and challenges learners to engineer a model LiDAR device to capture the topography of a surface.

8. Say: **Your task is to determine the safest and most interesting areas to land a rover. Examine the data to understand the topography of each location. Remember, your goal is to find evidence of past liquid water, to see if Mars was once habitable, so you will need to use your data about landforms from the** *Our Ideas* **poster as well.**

9. As groups investigate, ensure they are interpreting the data correctly. Indicate different parts of the crater. Ask: **How steep is this area?** *(Where lines are close together and color varies quickly, the slope is steep, such as on a mountain. Where lines are far apart and color varies slowly, the slope is shallower, such as on a field.)* **What makes a good landing site, and which areas of the map are good landing sites?** *(A safe landing site should be in a flat area. Interesting landing sites include landforms that may have formed in water.)*

10. As they investigate, have learners fill out *Topography We Notice, pg. 7,* in the Science Notebook.

Level Up!

Tell learners that scientists often like to explore areas with steep slopes or rugged topography, where layers of rock might be exposed. Have them think about why these areas are interesting. (5 min.)

11. Have groups share their observations of the topography of each site with the whole group and record them on the *Our Ideas* poster.

12. Pass out a *Landing Site Oval* from Science Activity 3 and a dry erase marker, if you are using page protectors, to each small group. Say: **A safe landing site should be as flat as possible, while a scientifically interesting landing site should be on or near landforms that indicate past water. At each of the possible landing sites in the data packet, trace one oval showing where you think it might be safe and scientifically interesting to land.**

Reflect (10 min.)

13. Ask: **Did your choice of landing site change when you got topographic maps? How or why?** *(We rated flat areas that are safe to land more highly than before, etc.)*

14. Revisit the Guiding Question on the *Our Ideas* poster**.** Ask: **How did topographic maps help us choose a safe and interesting landing site on Mars?** *(They helped us locate a safe, flat landing site near interesting landforms.)* Remind learners of the term *LiDAR*.

15. Ask: **When might it be important to find a flat location on Earth?** (*Pitching a tent, playing soccer, constructing a building, etc.*) Consider returning to learners' ideas at the start of the next activity.

16. Say: **Good job working as scientists today! Next time, you will explore a different type of remotely sensed data that relies on light. These data will help you answer questions about what Mars is made of. The process you are following is similar to the process NASA uses to choose landing sites.**

Support Learner Differences / Level Up!

Invite a family or community member to come in as a special guest and share their knowledge about topography-related topics. See the flyers and ideas on the Remote Sensing Family and Community Connections (weblink) (45 min.)

After the Activity

1. Clean up:
   - Keep the *Our Ideas* poster for Activity 6.
   - Collect the Science Notebooks, *Science Activity 3 Mars Landforms Data Packets, Science Activity 5 Mars Landing Site Topography Data Packets,* and *Landing Site Ovals* from Science Activity 3.
2. Plan ahead for Science Activity 6. See Activity 6 Materials Preparation on pg. 70. The tactile graphs will take time to dry.
3. Take time to reflect on the following educator prompt: **How did you help learners apply what they learned about topographic maps in the previous activity?**

Remote Sensing Additional Resources

QR code leads to resources available for this unit.

weblink: https://hov.to/248cf0d9