Science Activity 1: Introducing Mars and Remote Sensing

Educator Preview

Activity Overview

Youth explore how different landforms are formed by wind and water, then examine images of landforms on Mars and Earth to find evidence of water.

Timing		**Prep Snapshot**	**21st Century Skills Connection**
Reminder of the Goal	10 min	Prep Time 60 min	• Critical Thinking
Explore Landforms	30 min	As needed, dry sand the day before.	**Science Practices**
Search for Evidence of Water	20 min	Set up Water and Wind Stations.	• Developing & Using Models • Analyzing & Interpreting Data
Reflect	10 min	Print resources.	
Total	**70 min**		

Guiding Question	**Youth Will *Do***	**Youth Will *Know***
Which landforms on Mars hold clues about past water?	• Explore how water and wind create landforms. • Compare landforms on Earth and Mars. • Interpret image data to find safe and scientifically interesting locations.	• NASA is interested in learning whether Mars could have once supported life. • Life on Earth depends on water. • NASA spacecraft take pictures of Mars and send the images back to Earth as data.

Connecting Across Activities

In the Science Context-Setting Activity, youth explored the relationship between scientists and engineers and learned of their task: to choose the best landing site for a Mars rover. In this Activity, youth act as scientists to examine images of landforms on Mars. In Science Activity 2, they will deepen their understanding of landforms by considering topography.

Educator Resources

Access Activity resources using link or QR code.

Activity Resources

QR code leads to resources available for this Activity.

https://planets-stem.org/**betars-activity-s1**/

Family Connection

If time permits, have youth ask the following questions to their Elders, families, or mentors before the Activity:

Q: Why is water important to our family?

Q: Can you tell me a story or a memory about water where we live?

Q: Can you tell me a story or memory about a landform we live near?

Materials and Preparation

Materials

For the whole group

- *Landforms Chart* or displayed document (save for use in Science Activity 4)
- 6 copies of *Landforms Handout*
- *Remote Sensing Definition* from Science Context-Setting Activity
- 2 bags, trash, (clear, if possible)
- 2 baking (cookie) sheets with raised rims
- 2 pieces cardboard wrapped with aluminum foil with small notch cut (alluvial fan barrier)
- 24 cleaning wipes (1 per youth, to clean safety glasses between users)
- 2 cups
- 3 drop cloths, tarps, or large trash bags (if working inside)
- 8 pairs safety glasses
- 2 jugs, bottles, or watering cans, for refilling
- 24 face masks (1 per youth)
- 2 pans or boxes, 9″ × 13″ (approx. 23 cm × 33 cm), such as dish pans, aluminum baking pans, or copy-paper box lids lined with plastic
- 2 cups gravel or pebbles
- 2 – 3 rocks, large, dry
- 7 cups of completely dry sand
- 24 straws (1 per youth)
- water
- 6 page protectors (optional)
- gloves, plastic (optional)

For each group of 4

- 1 copy of *Science Activity 1 Data Packet* (in color and in page protectors, if possible)
- 1 *Landing Site Oval* (on transparency, if possible)
- 1 dry-erase marker, fine point (optional, if using page protectors)
- 1 piece felt or soft paper to erase marker (optional, if using page protectors)
- items marked *1 per youth* in Landforms Stations, above

For each youth

- Science Notebook

Teaching Tip

Quantities listed are for two setups per landform station (8 stations total). Two setups per landform station accommodate 24 youth total (6 groups of 4). For 12 youth (3 groups of 4), use half the materials and create one setup per station.

Activity 1 Materials Preparation (60 min)

1. See *Station Assembly Instructions* on pages 35 – 38 for instructions on using the materials to set up the stations. Ensure all youth can access the stations.

2. Print one *Science Notebook* in color, if possible, for each youth.

3. Print one *Science Activity 1 Data Packet* in color, if possible, for each group of 2 – 4 youth.

4. Print one copy of the *Landforms Handout* in color, if possible, for each group of 2 – 4 youth, in addition to the six copies needed for the stations.

5. Print one copy of *Landing Site Ovals* on transparency or regular paper. Cut along the dotted lines to separate the ovals so there is one oval for each group of 2 – 4 youth. Cut around the oval to make individual ovals.

Teaching Tips

Laminate or place the *Landforms Handouts* in page protectors or large plastic zip-top bags to keep them from getting wet at the Water Station. Laminate or place *Science Activity 1 Data Packets* in plastic page protectors or large plastic zip-top bags so youth can write on them with dry erase markers and they can be reused. You can reuse the *Landforms Handouts* from the stations instead of making new ones for each group.

To reduce mess, work outdoors. Use a hose for the Water Stations and create the dunes for the Wind Stations directly on concrete.

Play sand or aquarium sand work well. If you are only able to find wet sand, be sure to build in time to spread it out and let it dry.

Do one station at a time on different days to reuse the sand, saving the Water Stations for the end to keep the sand dry.

For safety at the Wind Station, have youth wear safety glasses and masks to prevent the sand from blowing into their eyes and noses.

Craters are visible in the images of Mars. If you have time, add a Crater Station by following online directions such as those on the Activity Resources page. Craters are fun and interesting but to model usually are not directly related to finding water on Mars.

Activity Guide

Guiding Question: Which landforms on Mars hold clues about past water?

Post the question somewhere accessible, such as on chart paper or a shared document, so that youth can refer to it throughout the activity.

Reminder of the Goal (10 min)

1. If you sent youth home with the Family Connection questions, ask:

   Q: Did anyone talk with their families about water or landforms? If so, is there anything you would like to share?

   A: Accept all responses. Youth may identify water or landforms related to sacred sites, family memories, or direct experience visiting or living near these places.

2. Remind youth of what they learned in the Science Context-Setting Activity. Ask:

   Q: What do NASA planetary scientists do?

   A: NASA planetary scientists analyze data or information gathered from remote sensing devices to understand things about planets such as how they formed and if they might have once had life.

   Q: As planetary scientists studying Mars, what kinds of things might we want to know about it? What questions do you have about Mars?

   A: Accept all responses. Possible questions include Is there life there? Was there life there? What are the weather and atmosphere like?

   Encourage youth to record some questions on *My Questions about Mars*, page 4 in their Science Notebooks, then have them share out. Let youth know these are all great questions.

3. Remind youth that NASA scientists are working with engineers to search for signs of liquid water in the solar system. Ask:

   Q: What do you already know or what have you learned from your Elders, families, teachers, or mentors about the importance of water?

   A: Answers may be similar or vary by culture; accept all answers as equally valid.

   If it hasn't come up, emphasize that water is needed for life. This connection is the reason that the science question, "Which planets and moons have, or used to have, water?" is the driving force behind some NASA missions.

   Ask:

   Q: How do NASA planetary scientists get the information to answer their questions?

   A: On NASA planetary missions, scientists work with engineers to design instruments to gather information about planets without going there. This is called remote sensing.

   Remind youth of their *Remote Sensing Definition Chart* from the Science Context-Setting Activity.

Note

Earth-like life needs more than just water. The water must have a chemistry that is safe for life, key nutrients, and a safe temperature range. There also can't be too much radiation on the planet's surface where the water is located.

Connecting Across Activities

The Engineering Series, *Worlds Apart: Engineering Remote Sensing Devices,* challenges youth to design many different remote sensing technologies to gather data from a distance.

4. Let youth know that as scientists, their task is to examine data collected by remote sensing technologies that engineers designed. They will use this data to choose the best site to send a rover to look for past water. Then they will compare their choice to NASA's. Ask:

   Q: How can you tell where water once was, after it's gone?

   A: Possible responses include dried mud with cracks, ripples in sand, and dry riverbeds.

   Q: What kinds of Mars data might we want to examine to look for evidence of water?

   A: Responses will vary. Possible responses include images to determine what the surface is like, whether there are mountains, whether there is water, if there is any sign of life, and whether people could live there.

   Remind youth about ***landforms***, shapes on the surface of a planetary body. Make connections to local phenomena with which youth are familiar, such as nearby landforms or sources of water.

5. Share the Guiding Question with youth:

   Q: Which landforms on Mars hold clues about past water?

Explore Landforms (30 min)

1. Tell youth that today, they will think specifically about how landforms might hold evidence of past water. Ask:

   Q: Here on Earth, what are some ways you can tell that water used to be somewhere, even though it is gone now?

   A: Responses will vary. Possible responses include lines, such as on the side of a teacup or bathtub, and patterns, such as the collapse of land at the edge of a riverbed.

2. Explain that they will get to explore Mars data soon, but before scientists study Mars data, they study data on Earth. First, youth will gain some experience deciding if a landform was created by wind or water using models.

3. Invite small groups to come to the two stations you have prepared and use sand, water, and air (wind) to model different landforms. They will rotate through all the stations, spending about 15 minutes at each center. Point out the *Landforms Handout* at each station and encourage youth to try to make the landforms by simulating the natural processes involved (water, wind).

   - At the Wind Station, demonstrate how to have a partner hold the bag open as youth use a straw to blow across the sand to form dunes. Encourage youth to explore placing large rocks as obstacles.

   - At the Water Station, demonstrate how to create a river valley by tilting a container of sand and slowly pouring water into it at the higher end in one location. Encourage youth to explore tilting at different angles and to try to make different landforms. Caution youth to tilt the container gently, so they do not spill the sand. Demonstrate how to pour water slowly in one spot on one side of a barrier and explore what happens to the sand.

Supporting Learner Differences

Consider running this activity as a whole group, guiding youth to create specific landforms or as a demonstration rather than allowing groups to freely explore.

Supporting Youth Thinking

Remind youth that they are creating a model of how landforms naturally develop. So, youth should not sculpt the landforms with their hands. The idea is to allow the "natural" processes (wind, water) to create the landforms. Emphasize safety as you demonstrate.

4. While groups are working, ask:

   Q: Where have you encountered landforms like these before?

   A: Accept all responses.

   Q: What do you notice about the shapes of different landforms when you observe them from above?

   A: Accept all responses. Possible responses include snakes, rope, and fans.

   Q: What are the different ways that land is shaped by water near our community?

   A: Accept all responses. Responses will vary. Possible responses include hills, mesas, mountains, and plateaus; canyons, valleys, and ravines; and lakes, ponds, coastlines, and deltas.

   Youth may name or describe their experiences with specific landmarks.

5. As a group gains experience with each landform, have the youth in that group look at the examples and read the landform's name and description from the *Landforms Handout*.

6. When all groups have finished exploring, gather them and ask:

Q: Which landforms were you able to make? Which were you not able to make? Why?

A: Responses will vary. A possible response is that they were not able to make lava flows because those are not shaped by water, impact, or air.

Q: What similarities or differences did you notice between landforms on Earth and Mars? What do these observations tell you?

A: Responses will vary. A possible response is that landforms are similar on Earth and Mars, suggesting that Mars has things like wind and water on it.

Q: Why might scientists be interested in these landforms?

A: Responses will vary. A possible response is the landforms formed by water on Earth may provide evidence of past water on Mars.

Supporting Youth Thinking

If groups finish early, share definitions and some resources about the following terms. Allow them to explore individually or in small groups.

Orbiter: a spacecraft designed to circle around a planet or moon without landing on it. (Examples include the Viking orbiters, the Mars Reconnaissance Orbiter, the Mars Global Surveyor, and MAVEN.)

Lander: a non-moving spacecraft for exploring a planet or moon. (Examples include the Viking landers, Pathfinder lander, and InSight lander.)

Rover: a vehicle for exploring a planet or moon. (Examples include Sojourner, Spirit and Opportunity, Curiosity, and Perseverance.)

Mars Helicopter: a spacecraft that flies on Mars using spinning rotors. (Ingenuity is the first Mars helicopter.)

Teaching Tip

If time is limited, consider stopping after the *Explore Landforms* section and conducting *Search for Evidence of Water on Mars* another day. You can begin the later session by reviewing the landforms youth created and which ones they want to look for on Mars as evidence of water.

Search for Evidence of Water on Mars (20 min)

1. Let youth know that, now they have some experience with landforms, they are ready to explore real NASA data from Mars to search for landforms that may have been created by water. Remind youth that NASA scientists are interested in evidence of past water because water might have supported life.

   Provide each small group with a *Science Activity 1 Data Packet.* Remind youth that scientists need images to study planets from a distance. Camera technologies designed by engineers provide images. Multiple NASA spacecraft are circling Mars, and they have cameras on them that take pictures of the surface. These pictures are one type of data sent back from the spacecraft that youth can now explore.

2. Explain to youth that as scientists, they will study the data of four potential landing sites (Gale Crater, Iani Chaos, Jezero Crater, and Nili Fossae). Then, they will choose a place on each possible site to land a rover. Point out the map and the explanation of each site on *Map of Mars*, pages 2 – 3 in the *Science Activity 1 Data Packet.* Go through the images. Point out that each site has multiple images. Some of the images are really zoomed out and look a bit fuzzy (Viking images), and others are of the same sites but are more zoomed in and are much clearer (Context Camera (CTX) and High-Resolution Imaging Science Experiment (HiRISE) images). Each set of images provides details about a different property of each site.

Teaching Tip

Although this Activity works best with all four possible landing sites, if the number of sites listed here is too many to manage in one session, consider excluding Nili Fossae, Iani Chaos, or both.

3. Pass out a landing site oval and a dry erase marker, if you are using page protectors, to each small group. Say: Landing on Mars is difficult! Engineers can design a rover to be able to land in an area the size of this oval (10 miles by 5 miles; 16 km by 8 km), but they can't pinpoint the landing location any better than that.

Supporting Youth Thinking

Help youth think about how big the oval is by talking about local landmarks that are 5 miles and 10 miles away. It’s a large area!

4. Remind youth that rovers drive slowly over short distances, so a scientifically interesting landing site should contain evidence of water within the oval or very nearby.

Supporting Learner Differences

If youth need a bonus challenge, they can search for evidence of volcanic activity. Such activity is scientifically interesting because it can tell scientists how old rocks are and how geologically active Mars is.

5. Give groups time to choose and trace landing site ovals within the Gale Crater, Iani Chaos, Jezero Crater, and Nili Context Camera (CTX) images. Tell them not to trace ovals on the High Resolution Imaging Science Experiment (HiRISE) or Viking images because the size of those images isn't the same as the oval size. Ensure they write their group name on this packet, so they get the same packet back to refer to in future sessions.

Teaching Tip

If necessary, suggest roles that group members can fill, such as organizing the data, searching for landforms, and tracing the oval.

6. On *Landforms on Mars*, pages 5 – 9 of their Science Notebook, have youth record the landforms they found at each site and why they think each landform is interesting, including any notes about evidence of water. Then have them rank the sites in terms of how likely each is to have evidence of water. Allow youth to update their landing oval locations if necessary to focus on evidence of water.

Reflect (10 min)

1. Summarize youth's work by discussing the landforms at each site. Record their ideas on the *Landforms Chart* or a shared document that is accessible to the whole group.

2. Revisit the Guiding Question:

   Q: Which landforms on Mars hold clues about past water?

   A: Alluvial fans, deltas, and river valleys all provide evidence of water.

3. Ask:

   Q: How did the landforms on Mars help you to rank some areas as the best landing sites for finding evidence of past water?

   A: Responses will vary. A possible response is that those areas had landforms such as alluvial fans, deltas, and river valleys that provide evidence of water.

Supporting Learner Differences

If needed, allow students to first use their non-English, home language to think about and describe their work before using and applying the vocabulary and definitions from this activity in English.

Note

Use the following key for reference, but do not share it with youth.

- Gale Crater contains a river valley, alluvial fan, layered rocks*, sand dunes, and craters.
- Iani Chaos contains layered rocks*, chaos terrain**, canyons, lava flow, and sand dunes.
- Jezero Crater contains a delta, river valley, lava flow, crater rim, and craters.
- Nili Fossae contains sand dunes, craters, lava flow, and a cliff.

Alluvial fans, deltas, and river valleys are evidence of water.

*Layered rocks are ambiguous. Sometimes they form in water, other times not.

**Chaos terrain itself (best seen in the Viking data) is thought to be water related.

4. Ask:

   Q: What questions do you still have?

   A: Responses will vary. A possible question is what other types of data—besides visual data—are available.

   Tell youth that the visual data that was collected by the cameras that engineers designed is limited and provides only some information. They will need other types of remotely sensed data to choose a landing site—they cannot rely on just one sense.

5. Wrap up for the day by congratulating youth on their excellent scientific work and what they are doing is very similar to the actual landing site selection process used by NASA for past, future, and present missions. Let youth know that next time, they will use a different type of remotely sensed data to learn more about Mars.

After the Activity

1. Plan ahead for Science Activity 2. See Activity 2 Materials Preparation on page 42.

2. Take time to reflect on the following educator prompts:

   Q: How did you get youth engaged in data analysis? How could you use similar strategies during future activities?

   Q: How did you support youth's learning needs in acquiring the vocabulary used in this activity?

Remote Sensing Unit Resources

QR code leads to resources available for this unit.

https://planets-stem.org/**betars-unit-landing-page**/

Science Activity 1

Wind Station Assembly Instructions

Use these materials to set up the Wind Station. Two setups are needed for a group of 24 students. The Materials list at the start of this Activity has additional details about the materials.

Materials for each setup:

• 1 *Landforms Handout*	• ½ cup dry sand	• 4 safety glasses
• 1 page protector	• 1 drop cloth	• 12 cleaning wipes
• 12 straws	• 1 – 2 rocks	• 12 face masks
• 1 cookie sheet	• 1 trash bag	

1. If youth are working inside, lay out the drop cloth underneath the work area to make sand cleanup easier.
2. Place the cookie sheet inside the trash bag.
3. Pour the sand onto the cookie sheet.
4. Fold the bag closed until youth are ready to use it. You can use a rock to hold it closed.
5. Put the *Landforms Handout* in the page protector and place it next to the bag.
6. Place the straws, safety glasses, cleaning wipes, and face masks next to the bag.

1. In the Wind Station setup, the table is covered with plastic to protect against sand. The pan is placed inside a trash bag for protection. Plastic sheet protectors keep the Landforms Handouts from getting sandy.

Science Activity 1

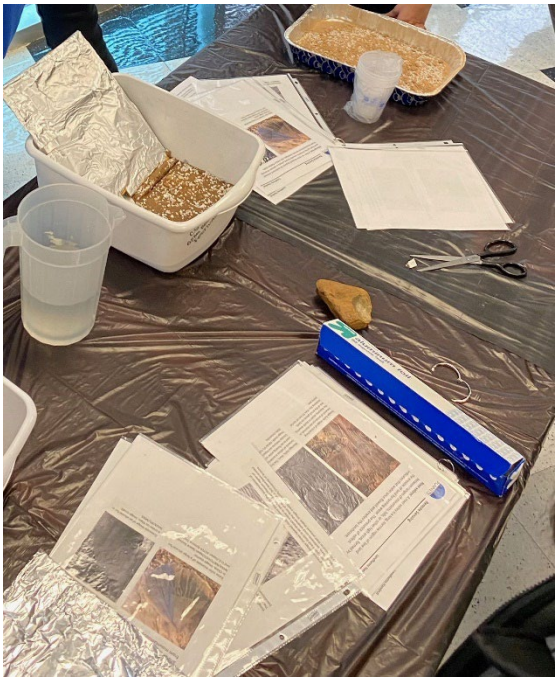
Water Station Assembly Instructions

Use these materials to set up the Water Station. Two setups are needed for a group of 24 students. The Materials list at the start of this Activity has additional details.

Materials for each setup:

- 1 *Landforms Handout*
- 1 page protector
- pan or box
- Mixture of 3 cups dry sand and 1 cup pebbles or gravel
- 1 cup
- 1 drop cloth
- 1 jug
- 1 alluvial fan barrier
- water

1. If youth are working inside, lay out the drop cloth underneath the work area to make water cleanup easier.
2. Place the pan or box on the drop cloth.
3. Fill the pan or box with the sand and pebble mixture.
4. Create the alluvial fan barrier. Cut a piece of cardboard the width of the pan. Cover it in aluminum foil. Add a 1″ notch at the bottom to allow water to stream through the hole.
5. Put the *Landforms Handout* in the page protector and place it next to the pan of sand.
6. Set the cup and alluvial fan barrier next to the pan of sand.
7. Fill the jug with water and place it near the pan of sand.



2. In the Water Station setup, the table is covered with plastic to protect against spills. Two pans hold the gravel and sand mixture; an alluvial fan barrier is placed in one of them. Plastic cups are provided for pouring and a pitcher of water for refilling. Plastic sheet protectors keep the Landforms Handouts from getting wet.

3. A close-up view of the alluvial fan barrier. The one-inch notch allows water to flow through and create a fan-like shape in the sand.