THE FRANKLIN INSTITUTE

Be a **Space Scientist!**

Be a **Planetary Geologist**

Educator Guide

Big Question: How can we learn about landscapes on Mars where future astronauts might go?

GSK Science in the Summer™

In collaboration with GSK

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Be a Space Scientist! Big Ideas

These are the themes you'll find running through all five *Be a Space Scientist!* activities.

- ***Space science is about exploring and traveling outside our planet.*** *Space scientists study questions like:*
  - *What kinds of things are in the universe?*
  - *How can we learn more about them?*
  - *How might people (and other living things) travel or live in space?*
- ***Space is really big! Almost everything in space is too far away and hard to reach for space scientists to visit and study.*** *Instead they:*
  - *Use tools and machines to* ***gather information*** *and send it back to Earth*
  - ***Compare*** *what they see in space to things they know about on Earth*
  - ***Use models*** *to represent things that are too big, too small, or too far away to study directly*

Core Four Strategies

Use the Core Four Strategies as you guide your learners through this activity.

- **Ask questions** to spark curiosity and encourage new ideas
- **Encourage scientific thinking** with chances to observe, make predictions, and test ideas
- **Cultivate rich dialogue** with chances to talk together, share ideas, and use science words
- **Make connections** between learners' experiences, science careers, and this activity

Ask Questions

Encourage Scientific Thinking

Cultivate Rich Dialogue

Make Connections

Be a Planetary Geologist

Big Question: *How can we learn about landscapes on Mars where future astronauts might go?*

MATERIALS:

Per class:

- Planetary geologist career card
- 4 3D-printed landscapes of Mars Tharsis region
- Lab notebooks
- Pencils
- Science skills stickers

Per group of 2–3 learners:

- 1 container of playdough, 4 oz
- 1 large marble

Per group of 2–3 learners continued:

- 1 small marble
- 1 pencil
- 1 straw
- 1 frame
- (Optional) 1 small bin or bucket for all above tools
- 1 photo sheet of Mars Tharsis region
- 1 colored relief map of Mars Tharsis region

Prepare

1. Put the 3D landscapes and the relief maps aside and **keep them out of sight** until Part 3 of the activity, so they don't influence learners' investigations.
2. (Optional) Make tool kits by putting one of each of the materials—playdough, marbles, pencil, straw, and frame—into small bins or buckets.

Engage

1. Introduce the planetary geologist career by showing the group the career card and asking questions to encourage students to think about what a planetary geologist might do:
   - *What do you notice about this picture? What do you think this person is doing?*
   - *Have you heard words like "planetary" or "geologist" before?*
   - *What do you think a planetary geologist might do or study?*
2. Explain that a geologist studies the surface of the Earth: what it's made of (like rocks) and how it changes. A planetary geologist studies OTHER planets—what they're

made of, how they're like or different from Earth, and how they might have changed.

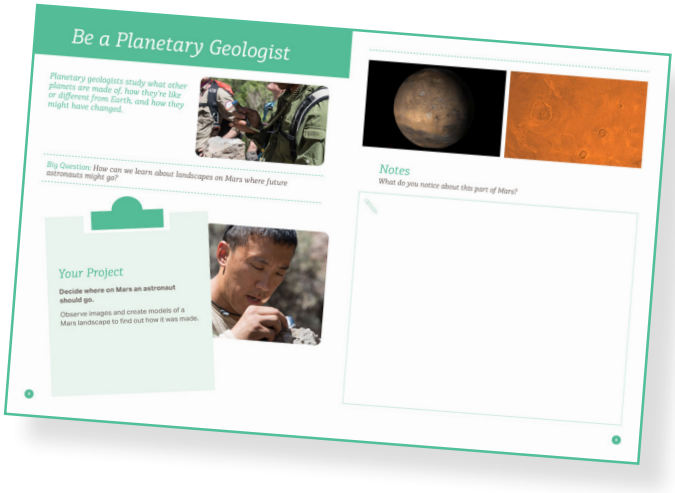
- *Why might we want to know about the surfaces of other planets?*
- *What kinds of things might a planetary geologist want to know about the surface of another planet?*
- *How do you think we can learn about other planets if we haven't been able to get to them?*

3. Introduce the storyline like this:
   - Imagine we are a team of planetary geologists planning to someday send astronauts to Mars.
     - *What do you know about Mars?*
   - We need to decide where on Mars would be the best place for the astronauts to go, and we need to know what kind of landscape they might find there. But we can't go there to check it out first!
     - *How could we know about the surface Mars without going there ourselves?*
   - We have satellites that have sent back some pictures of Mars. **Our job is to use these pictures to see what we can figure out about what the surface of Mars is like.**

Explore

Part 1: Image Observations

1. Ask the group to look at the images of Mars and the Tharsis region on page 9 of their lab notebooks. Explain that the second one is a closer up view of part of the whole-planet image.



For younger groups, you might need a quick review that this is a bird's-eye view, which means looking down on the land from high up.

2. Divide the class into teams of 2–3. Hand out the large photo sheet of Mars Tharsis region. Ask teams to discuss their observations about the Tharsis region. They may want to write or draw them on page 9 of their notebooks:
   - *What shapes or features do you see?*
   - *How big or small do you think they are?*
   - *What do you think they could be? What could have made them?*
   - *If you could stand on Mars and look at them, what do you think you would see?*
3. Lead a brief whole-group discussion about the teams' observations.
4. Explain that your team is especially interested in finding out more about the circles—what they are and what could have made them.

5. Invite the group to look at the images of Earth volcanoes and impact craters on page 10 of their lab notebooks.
   - *How are these landscapes similar or different to each other?*
   - *How are they similar or different to the circles in our Mars image?*
   - *What happens on Earth to form the shapes of volcanoes?*
   - *What happens on Earth to form the shapes of the impact craters?*
   - *How could we figure out if the circles on Mars are from a volcano, a meteorite impact, or something else?*

For younger learners who may not know much about volcanoes and impact craters, be sure to emphasize that volcanoes form from magma/lava pushing UP from underneath the surface, while meteorites push DOWN to create craters as they hit the surface.

Part 2: Modeling

6. Explain that they will use a model—a smaller, simpler version—to get some ideas about how the circles on Mars may have formed. Remind them to consider what they know about landscapes on Earth and how volcanoes and craters form.
7. Demonstrate how to create a flat layer of playdough and lay it over the frame to represent the Mars surface.
8. Give each group a bin/bucket with modeling tools (1 frame, 1 jar of playdough, 1 large marble, 1 small marble, 1 pencil, 1 straw). **Ask them to use the tools to explore different ways to create shapes that look like the ones in the image.** As they explore, circulate and ask questions like:
   - *What different techniques can you try? (harder/softer, pushing, dragging, pencil point vs. eraser)*
   - *What could you do that would model a meteorite hitting the surface?*
   - *What could you do that would model a volcano erupting?*
   - *Can you think of anything else that might make a circle shape in the ground? How could you model that?*

Facilitation tips:

- To model impacts, pushing the tool into the playdough works better than dropping or throwing (for both safety and effect). Point out that a meteorite is moving much faster than a dropped object, so the push represents the extra strength the meteorite would have.
- To model volcanic eruption, push a tool upward from underneath the dough until it breaks through. This represents the magma building up pressure and pushing through the crust.

9. Check in with the whole group about their results:
    - *What did your tests tell you about what made the circles on Mars? What's your best guess: a volcano, or a meteorite impact, or something else? Why?*
    - *If we still aren't sure, or we don't agree on the answer, what could we do to find out?*

Part 3: Incorporating New Data

10. Explain that we have received new information about the Mars landscape that includes height and a 3D-printed landscape! Place your 3D landscapes and colored relief maps at the front of the class and invite a few groups at a time to come up to observe the new information! Ask questions like:
    - *What does this new information tell you?*
    - *Does it change your ideas about what made the circles?*
    - *What else would you like to try now with your playdough model?*
11. After groups have a chance to observe the 3D landscapes and relief maps, give them a chance to return to their playdough models again and try to recreate the features including the height evidence.

Reflect

1. Bring the whole group together to discuss their results:
    - *What techniques did you try in your model and what did they create?*
    - *What did you find out about what those circles on Mars might be? What's your best guess about how they were made?*
    - *What does this tell us about the past of Mars' surface?*
    - *If we were going to send our astronauts to one place on this part of Mars, which would you choose? Why?*
    - *What do you think would be important for our astronauts to know about the landscape in that place? Is there anything they would need to plan for?*
2. Help the group connect their work back to the planetary geologist career. Refer to the career card and the science skills stickers:
    - *How were you like a planetary geologist today?*
    - *What did you do that is like what a planetary geologist does?*
    - *How did we think like scientists today? What science skills did you use?*
3. Allow time for students to draw or write their reflections on page 11 of their lab notebooks. Invite them to choose a science skills sticker that reflects a skill they used and add it to their notebooks.

Background

- Planetary geologists **study the makeup of other planets and celestial bodies.** They use their knowledge of Earth's surface, satellite images, models, measurements taken by telescopes, and evidence from rovers and probes to learn about the landscapes on rocky planets and the material makeup of gaseous planets.
- Planetary geologists know a lot about Mars from NASA's many rovers exploring the planet. **The landscape studied in this activity is called the Tharsis region.** The 3D prints of this region are made from satellite images and measurements taken by rovers.
- The first human mission to Mars is currently planned for the 2030s.

- On Earth, **volcanoes form when magma pushes up from under the crust**, eventually erupting at the surface. This creates tall mountains with craters at the top, much like what we see in the Tharsis region on Mars.
- **We know the Tharsis region on Mars was created by long-dormant volcanoes, which has helped planetary geologists prove that Mars used to be volcanically active, just like Earth!**
- Mars also has many small **craters created when meteorites hit its surface**, much like on the Moon. Earth has also been hit with meteorites in the past, but the craters are harder to find because the wind, air, and rain in Earth's atmosphere wear away the land's surface over time.

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Planetary Geologist Quick Guide

EDUCATORS DO:	EDUCATORS ASK:	LEARNERS DO:
ENGAGE		
Introduce Career • Use career card • Ask discussion question • Explain what planetary geologists do	*What do you notice about this picture?* *Have you heard words like "planetary" or "geologist" before?* *What do you think a planetary geologist might do or study?*	• Make observations about the image • Make connections to their own experience • Share their ideas
Introduce Story • We're planetary geologists sending astronauts to Mars • We need to know about landscapes on Mars	*What do you know about Mars?* *How could we learn about the surface of Mars without going there ourselves?*	• Imagine being planetary geologists • Discuss their ideas about how to study the surface of Mars from afar!
EXPLORE		
Part 1: Image Observations • Hand out images of Mars and Tharsis • Guide whole-class discussion • Invite learners to look at volcano and crater images in notebook	*What shapes or features do you see on Mars?* *What happens on Earth to form the shapes of volcanoes? Impact craters?* *How could we figure out if the circles on Mars are from a volcano, a meteorite impact, or something else?*	• Observe and compare pictures of landscape on Mars and volcanoes/ craters on Earth • Make guesses about what formed the Mars landscape
Part 2: Modeling • Demonstrate how to place playdough on frame • Encourage exploration and model creation	*What different techniques can you try?* *What could you do that would model a meteorite hitting the surface? A volcano erupting?*	• Create a model of the Mars landscape using playdough and tools • Test ways of pushing up and pushing down with tools

***Quick Guide continues on the following page.*

Planetary Geologist Quick Guide

EDUCATORS DO:	EDUCATORS ASK:	LEARNERS DO:
Part 3: Incorporating New Data • Introduce the 3D prints • Invite groups to observe prints • Invite groups to recreate models	*What does this new resource tell you?* *What more would you like to try with your playdough model?*	• Observe 3D prints of Mars landscape • Recreate playdough models with new data from 3D prints
REFLECT		
Share Group Results	*What's your best guess about how the circles on Mars were made?* *What do you think would be important for our astronauts to know about the landscape in that place?*	• Draw conclusions • Make recommendations
Make Career Connections	*How were you like a planetary geologist today?* *How did we think like scientists today? What science skills did you use?*	• Use skill stickers • Draw/write reflections

Notes

Notes