Engineering Activity 4: Hide and Seek: Finding Minerals

Educator Preview

Activity Snapshot

Learners work to distinguish between minerals using sight and/or sound.

Timing | 45 minutes

Get Ready and Team Up	10 min.
Detect Minerals Remotely	25 min.
Reflect	10 min.
Total	**45 min.**

Level Up Activities 5–10 min. each

Prep Snapshot*

Prep Time 35 min.

- Print and cut materials.
- Set up a Materials Table.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Collaboration
- Communication
- Critical Thinking

Habits of Mind

- Innovate processes, methods, and designs.
- Investigate properties and uses of materials.

Guiding Question

How can we learn what the surface of Mars is made of?

Learners Will Do

Use a system of cellophane and mirrors to identify hidden symbols. Use scrapers to identify textures.

Learners Will Know

Engineers can design technologies that enhance human senses.

Connecting Across Activities

Activity 3: Redirecting Light	Activity 4: Finding Minerals	Activity 5: Taking Shape
Last time, learners designed portable light redirection systems. These systems are one technology they can use when designing their complete remote sensing technologies.	**Today,** they explore the use of filters and scrapers to gather more data, specifically about minerals. These tools are a second technology they can use when designing their complete remote sensing technologies.	**Next time,** they will design straw model LiDAR systems to gather data on a new subject: topography. These systems are a third technology they can use when designing their complete remote sensing technologies.

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/aca4805b

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document). See Prep & Setup Guide (PDF) Examples | Templates
- markers
- paper, chart
- 50 sheets of paper

For each group of four

(in the half of the class composing the Sound group)

- Sound Model Directions, pg. 64 and Image of Mars, p. 59
- 4+ Data Collection Grids
- 4 folders, manila
- 1 pair of scissors
- 1 roll of tape, masking
- bag containing the following items:
  - 2 quarter sheet pieces of felt
  - 2 quarter sheet pieces of foam, craft
  - 2 quarter sheet pieces of paper
  - 2 craft sticks
  - 2 large straws
  - 2 small straws

For each group of four

(in the half of the class composing the Light group)

- Light Model Directions, pg. 65 and Image of Mars, p. 59
- 4+ Data Collection Grids
- 4 folders, manila
- 1 pair of scissors
- 1 roll of tape, masking
- 1 portable light redirection system from Engineering Activity 3
- bag containing the following items:
  - 2 quarter-sheets of cellophane, blue
  - 2 quarter-sheets of cellophane, red
  - 4 quarter-sheet test sites, blue, cut from Test Site—Blue
  - 4 quarter-sheet test sites, red, cut from Test Site—Red
  - additional copies of the red and blue test sites for use in recording observations (optional)

For each learner

- Engineering Notebook (PDF)

Activity 4 Materials Preparation (35 min.)

Ahead of Time

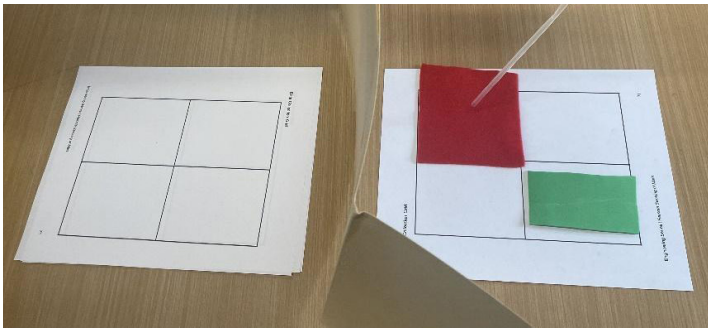
1. Review the "In-Use Example" in the in Prep & Setup Guide - Examples (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this activity.
2. Find a large area in which to teach this activity so that learners are not confused by sounds from each other's groups. Alternatively, plan to allow learners to use devices to record and amplify sounds during the activity.
3. Print out Test Sites, pgs. 60-61, in color. Cut along the lines to provide 4 blue quarter-sheets and 4 red quarter-sheets to each group of four in the half of the class composing the Light group.
4. Print out 4–5 Data Collection Grids, pgs. 62-63, per group.
5. Print out Sound Model Directions, pg. 64, for half the groups and Light Model Directions, pg. 65, for half the groups.
6. Assemble the following materials into bags so that there are enough for half of the learners to have materials for Sound Exploration and half to have the materials for Light Exploration. If you have 24 learners, there should be three bags for Sound Exploration and three bags for Light Exploration.

Sound Exploration Materials

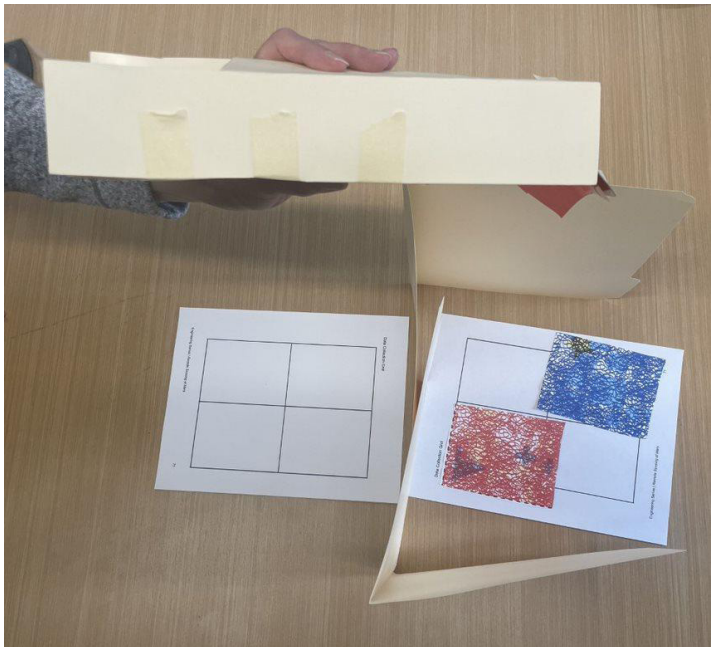
- 2 pieces of felt
- 2 pieces of craft foam
- 2 pieces of paper
- 2 craft sticks
- 2 large straws
- 2 small straws

Light Exploration Materials

- 4 blue test sites
- 4 red test sites
- 2 pieces of red cellophane
- 2 pieces of blue cellophane



Scraper test setup



Light filter test setup

In Your Space

7. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.
8. Prepare a Materials Table with the materials listed above.
9. Cut sheets of felt, paper, and craft foam into four pieces each to provide two quarter-sheets of each material to each group of four in the half of the class composing the Sound group.
10. Cut cellophane into half-sheets to provide two half-sheets to each group of four in the half of the class composing the Light group.

Support Learner Differences

- If it is helpful for learners, you can use full sheets from Test Sites, pgs. 84-85 rather than quarter-sheets. You can also provide each group with additional copies of the quarter-sheets for use in the "Detect Minerals Remotely" section.
- Instead of felt, foam, and paper, you can use other textured materials that are familiar or meaningful to learners. You can also give learners the opportunity to bring in materials to represent minerals. If you use different materials, use those same materials when building the model landscapes for Engineering Activity 6.

Preparation for Engineering Activities 6–9 (60 min.)

The final design challenge for this unit requires the educator to prepare a multi-part model so learners can test their remote sensing devices. Read Activity 6 Materials Preparation on pg. 80 and decide whether to use the Space Screens with learners. **Then consider preparing the following models in parts, or set aside at least an hour to assemble them in one session.**

- Model Landscapes for Site A (2 copies) and Site B (2 copies)
- Optional: Space Screens that prevent learners from looking at the model landscapes on the opposite side and represent the distance between the Earth and other planets

The complete instructions for building Site A and B, pgs. 85-87 and the Space Screens, pg. 88-89 are outlined in this guide, and a video that shows the process of assembly is available. Since remote sensing engineers cannot see the surface of a planet up close, it is important that learners use only the remote sensing devices they create to gather information about each site and that they do not look at the models directly. Keep the model landscapes covered when not in use until groups complete their tests Activity 9.

Activity Guide

Get Ready and Team Up (10 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We designed portable light redirection systems and used them to gather data about objects to answer "How can we use a system to redirect light to gather data from a distance?")* As necessary, draw learners' attention to the *Our Ideas* poster and the term remote sensing.
2. Ask: **What is the problem we are trying to solve?** *(We are trying to figure out how to gather information about Mars from far away.)*
3. Organize learners into groups of four.

Support Learner Differences

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

Level Up!

Show the video Why Do Scientists Need to Measure Infrared Light? (5 min.)

Detect Minerals Remotely (25 min.)

Detecting Minerals Using Light and Sound (10 min.)

4. Distribute one copy of *Image of Mars* to each group. Say: **Cameras on spacecraft have captured images of Mars.** Invite teams to discuss this question and then share out: **What does this image tell us about Mars? What does it not tell us?** *(It tells us the planet is round, some areas on it are darker and some are lighter; it has some channels. It does not tell us what the planet is made of or what shape its surface is.)*
5. Say: **NASA is interested in finding out what planets are made of because this can tell them about a planet's history. The types of rocks and minerals on a planet can reveal whether it once had liquid water on it, which means it could have been habitable.** Point to the *Our Ideas* poster and questions this information will answer, such as "How can we learn where water used to be?"
6. Say: **By studying minerals on Earth, scientists know certain minerals reflect certain colors of visible and invisible light. They use this information to identify unknown minerals on other planets. Scientists need engineers like you to create technologies to distinguish between minerals.** 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 we learn what the surface of Mars is made of?**
7. Say: **In the first investigation, half of you will explore minerals using sound, and the other half will explore minerals using sight.**

8. Hold up the materials for the Sound Model and demonstrate as you say: **In the Sound Model, felt, foam, and paper represent different minerals. If you feel these materials, you will notice they have different textures. Felt represents clay minerals, foam represents volcanic minerals, and paper represents sulfate minerals. You will investigate these materials by scraping them with craft sticks, large straws, and small straws. You will listen to the sounds they make and feel the vibrations to figure out which scrapers are best at identifying each type of mineral by sound and touch only.** Pass around the materials so learners have a chance to feel them.
9. Hold up the materials for the Light Model and demonstrate as you say: **In the Light Model, triangles, circles, and stars printed on *Mineral Test Site paper* will represent different kinds of minerals that might be found on Mars. Triangles represent clay minerals, circles represent volcanic minerals, and stars represent sulfate minerals. You will notice the shapes are difficult to see. You will use a technology called cellophane. You may recognize cellophane from gift baskets and your kitchen, but this kind is sturdier.** Demonstrate the process as you say: **Cellophane blocks some light but lets other light through, just like the light filters used on NASA spacecraft. Cellophane filters allow some colors to be seen more clearly. You will investigate which colors of cellophane filter the light to make the different shapes easier to see.**
10. Assign groups to either the Sound or the Light exploration and review the instructions on *Data Detection Investigation – Sound*, pgs. 8-9, or *Light*, pgs. 10-11, in their *Engineering Notebooks*. Answer any questions they have. Say: **You will share materials among your group but may work independently for this part of the activity. You have 10 minutes. Don't forget to record your observations in your Engineering Notebooks. You will have to share what you learn with the rest of the group.**
11. Invite one person from each group to gather the supplies and begin the investigation.

Teaching Tip

In this activity, half of learners participate in a sound investigation and half participate in a light investigation. Below are the instructions for both investigations. If you have time, switch groups so that everyone explores both sound and light.

Support Learner Differences

- The "Detect Minerals Using Light" portion of this activity is not accessible to all learners. Therefore, the "Detect Minerals Using Sound" portion presents data that are typically presented visually in tactile and auditory forms for learners to perceive with other senses. Make sure that learners don't misunderstand and think that minerals can actually be identified by scraping the surface of the planet!

  Some learners may find the sound of scraping materials irritating. Consider ways to provide choice to learners about the kinds of scrapers they use. If scraping does not work for learners, they may touch the materials directly instead.
- Encourage learners to use their preferred language as they record their observations.
- As needed, provide groups with a tub or other container to hold their materials.

12. As learners work on the Sound Model, circulate among groups and ask one or more of the following questions: **Which scraper materials are easiest to use? Sturdiest? Easiest to handle?** *(Learners may think that some materials are best in one category but not another.)* **Which scraper is best for identifying the differences between felt and paper? Paper and foam? Felt and foam?** *(Accept all responses that learners can support with observations.)*

13. Write "Scraper Investigation" on the *Our Ideas* poster and draw two columns beneath it–one titled "Texture" and the other titled "Scraper Material." Have learners record their findings in this chart.

14. As learners work on the Light Model, circulate among the groups and ask one or more of the following questions: **What changes do you observe when looking at the red test site through the red filter? Why?** *(Blue and green look darker. See Teaching Tip.)* **Do you see a difference if you fold the cellophane in half? In quarters?** *(The effect of the cellophane becomes stronger, making certain colors easier to see.)*

15. Write "Filter Investigation" on the *Our Ideas* poster and draw two columns beneath it–one titled "Color" and the other titled "Filter Material." Have learners record their findings in this chart.

Detecting Hidden Minerals (15 min.)

16. Get learners' attention and invite those who explored sound to find a partner who explored light.

17. Say: **Engineers sometimes combine remote sensing technologies in spacecraft. You will now use what you learned to combine technologies to gather hidden information about minerals by engineering remote sensing devices.** Point to learners' definition of *remote sensing* on the *Our Ideas* poster.

Teaching Tips

- The differences between sounds are slight. Have learners use their devices to record audio from the scrapers so they can play back the sound and increase its volume if necessary.
- A red filter helps blue or green symbols on a red and white background appear more visible by letting only red light through. This makes the red and white parts of the background look the same. Blue and green look dark through a red filter because the blue or green ink on the paper absorbs most of the red light, so very little is reflected.
- Learners can communicate what they find during this activity in multiple ways, such as drawing or placing duplicate materials on the grid or describing what they detect. Prepare additional red and blue test sites and *Data Collection Grids* to provide multiple options.

18. Grab a portable light redirection system from Activity 3, a *Data Collection Grid*, and two manila folders. Demonstrate as you say: **You will play a game that demonstrates how these technologies are used to gather information about minerals remotely. You will work in pairs. One player will be the Hider. The Hider will set up two manila holders to hide a *Data Collection Grid*. They will then put two pieces of felt, foam or paper OR two red or blue *Test Sites* on the grid in secret. The other player will be the Detector. They will use a scraper, a *Light Redirection System,* and cellophane to figure out what minerals are hidden and which boxes–A, B, C, or D–they are in.** As needed, allow learners to feel the demonstration setup.
19. Say: **The Detector will record what they find on their own *Data Collection Grid*. Afterward, they will check if they were correct. Then the players will switch roles and play again.**
20. Distribute two manila folders, a portable light redirection system from Engineering Activity 3, and two *Data Collection Grids* to each group.
21. While learners are working, circulate and ask: **What worked well to identify the hidden surfaces? What was challenging about detecting the sites?** *(Our system reversed the image, so we saw the sections in a different direction, etc.)* **How did you combine the filters with your detection systems so you could use them at the same time?** *(We taped cellophane to the mirrors, etc.)*
22. Have learners keep track of what they learn on *Data Detection Investigation* in their *Engineering Notebooks*.

Teaching Tips

- The manila folders are intended to block the view of the Detector. Allow learners to modify their scrapers and light redirection systems, but challenge them not to modify the manila folder barriers too much.
- If time permits, and learners are ready, allow them to create and test hidden surfaces using both the different materials and the red and blue test sites.

Reflect (10 min.)

23. Have a few volunteers share their experiences using the scrapers and filters with the group. Ask: **Would you be able to use scrapers to transmit sounds from Mars to Earth?** *(No, because you would have to touch the surface, so it's not remote sensing. No, because sound can't travel through space—it can exist only when there is something to vibrate.)*

24. Revisit the Guiding Question on the *Our Ideas* poster. Ask: **How can we learn what the surface of Mars is made of?** (*We can design/combine technologies like filters that use light to identify minerals*.) Remind learners of the term *filter*.

25. Say: **Today we used filters to let some light pass through but keep other light out. Turn and talk to a partner about how you might use filters, which let some things pass through, but keep other things out, in everyday life.** *(Polarized lenses in sunglasses, separating soil from rocks, photography, etc.).* Have learners record their ideas on the *Our Ideas* poster. Consider returning to learners' ideas at the start of the next activity.

26. Point to the *Our Ideas* poster and ask: **What questions do you still/now have?** (*How can we figure out where to land a rover? How can we learn about the physical properties of the surface?*). Record any new ideas.

Level Up!

- Scientists use filters to identify minerals on Mars. Minerals absorb specific colors of visible or invisible light. By using a filter that lets through only that color of light, minerals appear darker in images and can be identified more easily. To help learners better understand the concept of mineral reflection at different wavelengths, you can share images and videos about spectroscopy from the Activity resources page. (5+ min.)
- The Worlds Apart Science Pathway goes into more depth about how scientists use spectroscopy, a remote sensing technology, to identify minerals on other planetary bodies.

It is not possible to scrape the surface of Mars from a distance. However, scraping can be useful up close: for example, Mars rovers can use drills to learn about rock hardness. Check out the one on the Perseverance Mission in the article "Testing Rocks on Earth to Help NASA's Perseverance Work on Mars." (10 min.)

Support Thinking

Have learners consider what sound and light have in common. If necessary, explain that they are both waves. Studying the waves can provide information about where they came from.

27. Say: **Good job working as engineers today! Next time, you will learn about a remote sensing technology that uses lasers to gather information about the shape of the surface of Mars.**

Level Up!

Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the *Engineering Design Process* did you use today?** *(Investigating how filters work; iterating filters to make information easier to collect.)* (5 min.)

After the Activity

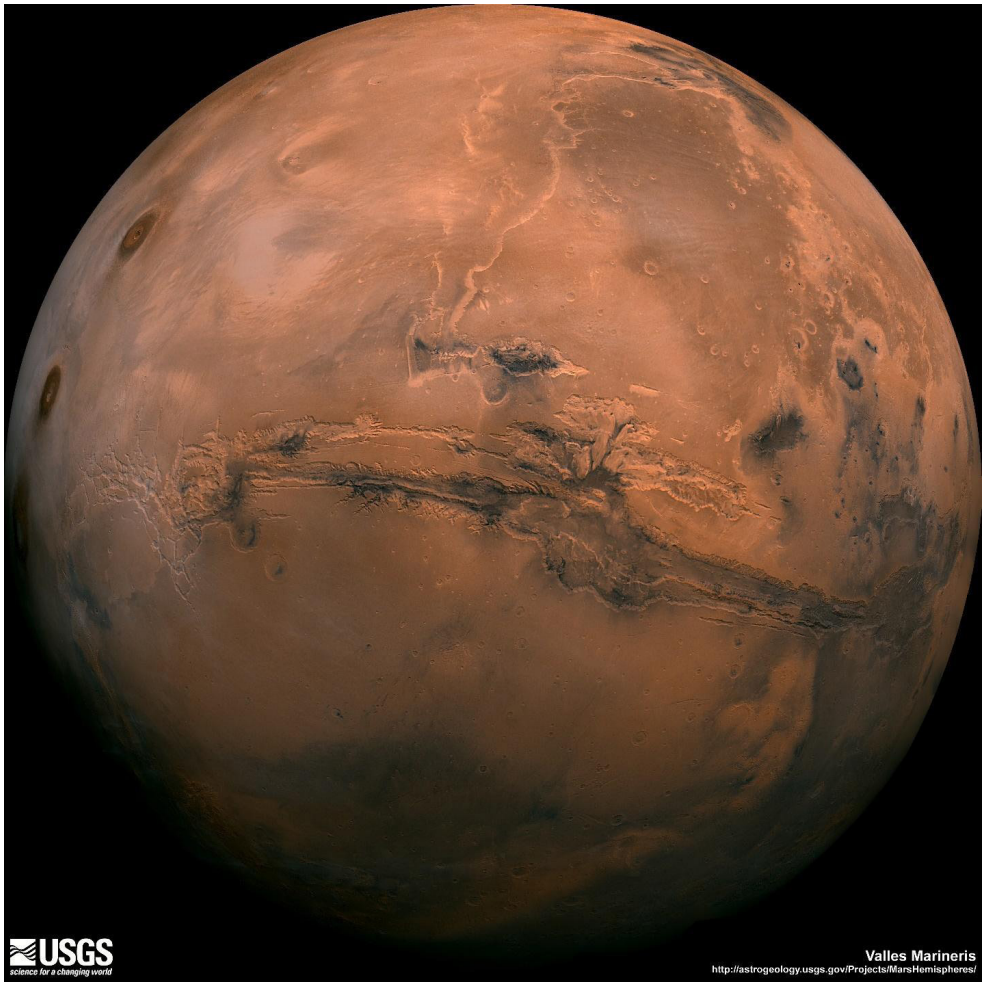
1. Clean up:
   - Keep the *Our Ideas* poster for use in Activity 5.
   - Collect and save the folders and *Data Collection Grids* for use in Activity 5.
   - Save pairs' scrapers and light redirection systems for use in Activity 6.
   - Collect and save the remaining materials for future use.
2. Plan ahead for Engineering Activity 5. See Activity 5 Materials Preparation on pg. 68.
3. Take time to reflect on the following educator prompt: **How did learners interpret the different sensory options (sight and hearing/touch)? What strategies might you use to support multisensory learning in future activities?**

Remote Sensing Additional Resources

QR code leads to resources available for this unit

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

Image of Mars

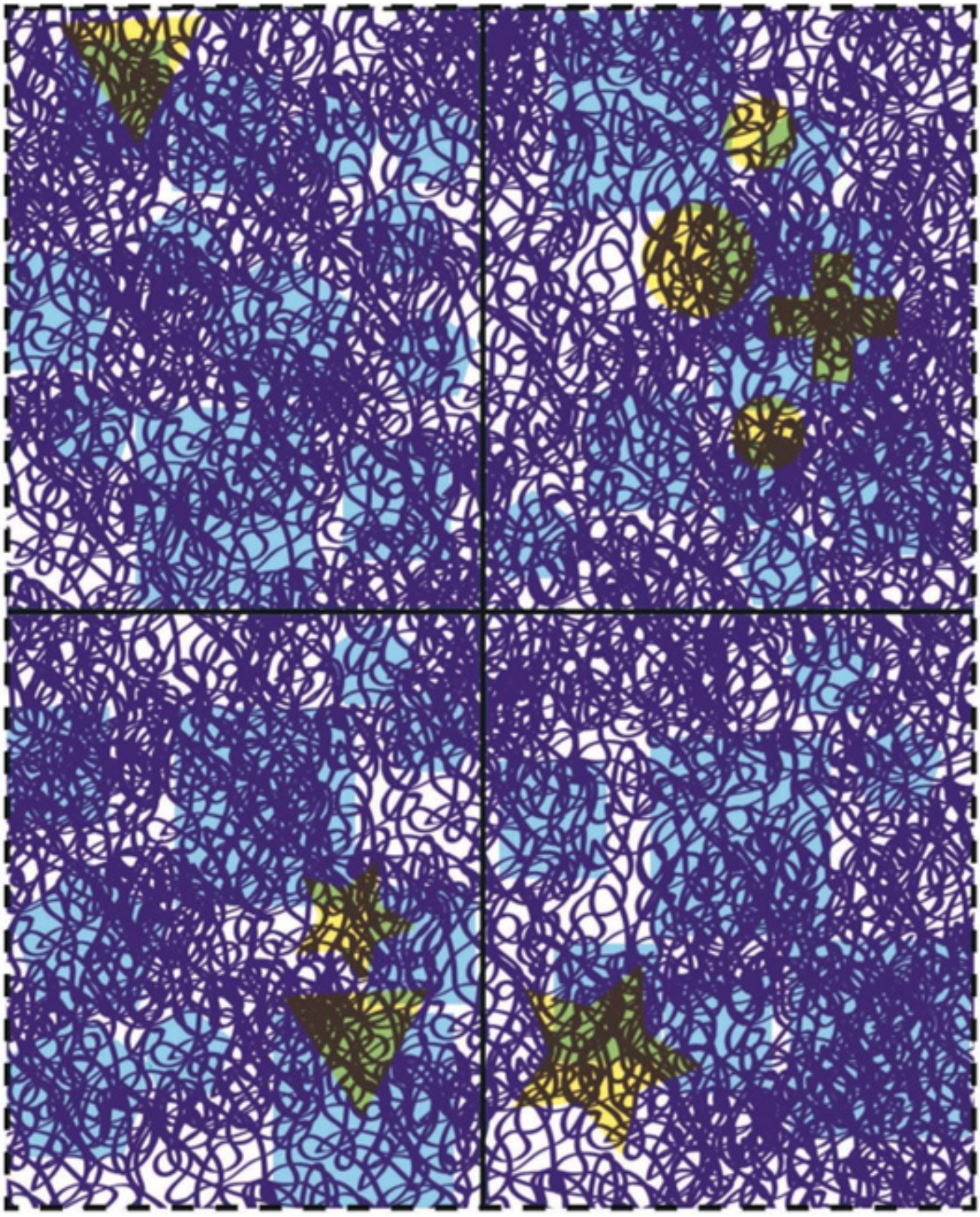


More to Explore

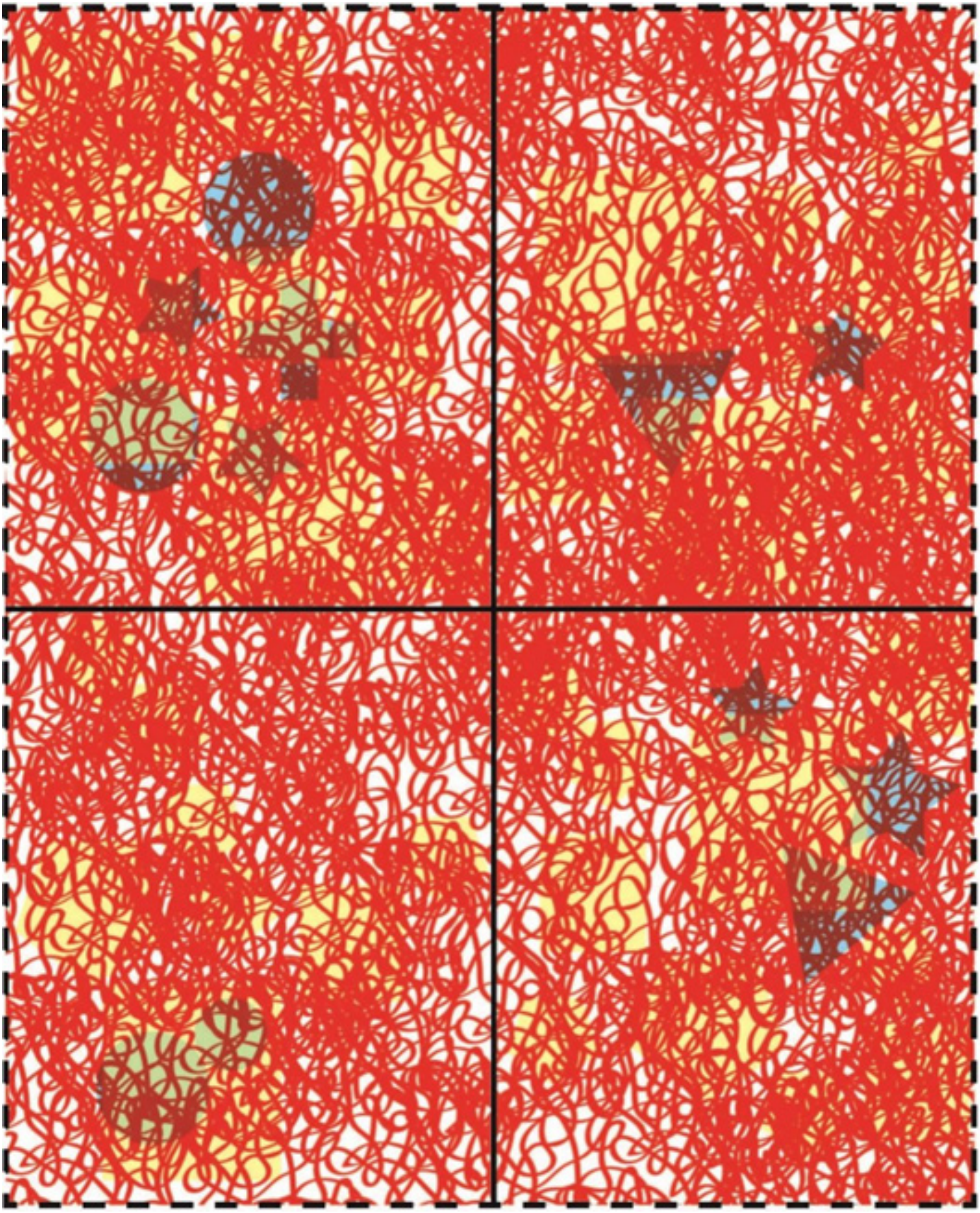
Find out more about NASA on the PLANETS website.

weblink: https://planets-stem.org/remote-sensing/rs-learners/

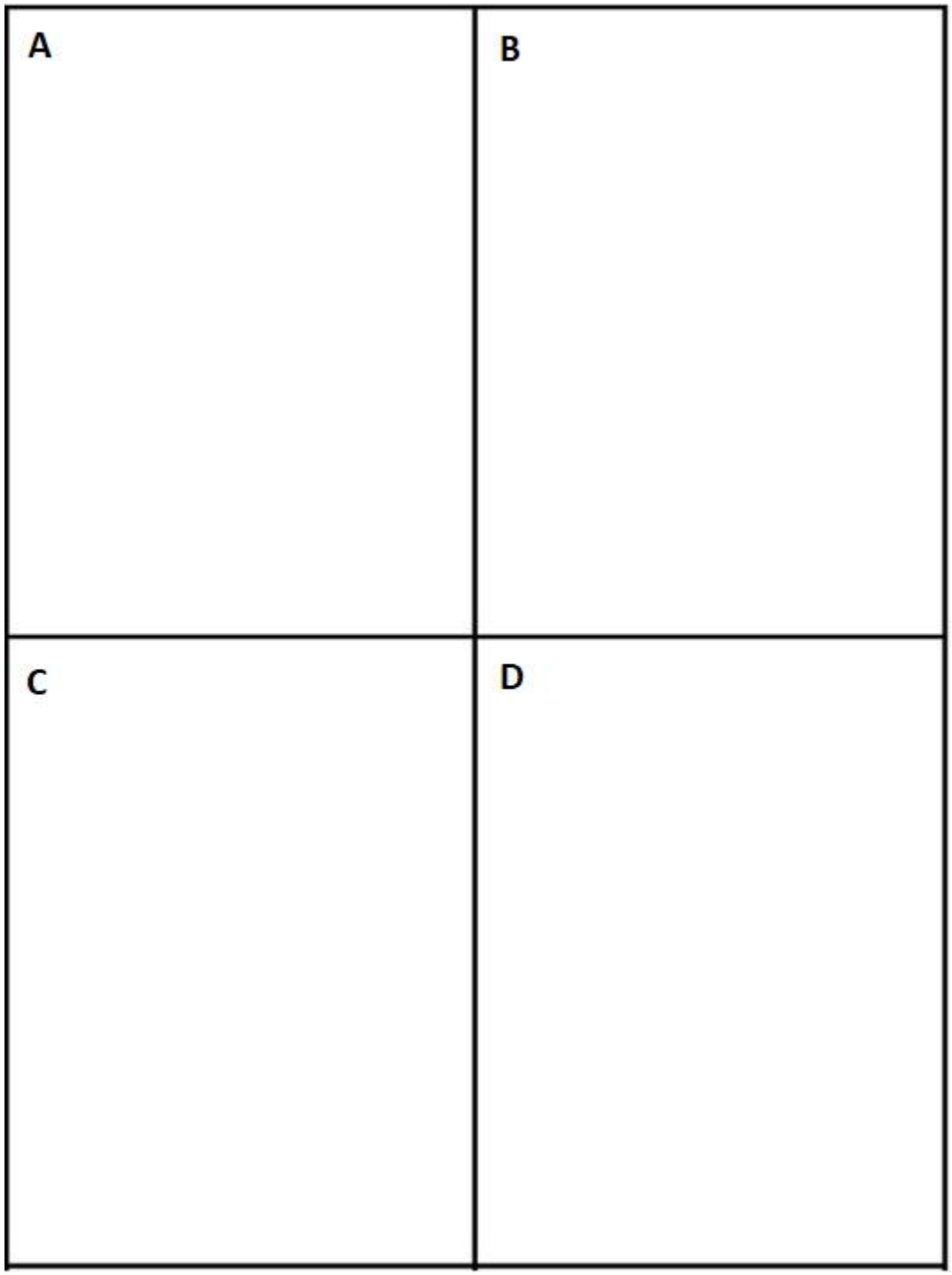
Test Site-Blue



Test Site-Red



Data Collection Grids



Data Collection Grids

A	B
C	D

Sound Model Directions

1. Lay out the materials: felt, paper, and foam.
2. Feel and scrape each material with a craft stick and different-sized straws.
3. Feel and listen to the differences as you scrape.
4. Think about these questions:
   - Which scraper materials are easiest to use?
   - Which scraper materials are sturdiest?
   - Which scraper materials are easiest to handle?
   - Which scraper is best for identifying the differences between felt and paper? Paper and foam? Felt and foam?
5. Record your observations in your Notebook.

Light Model Directions

1. Investigate how the colors on the red and blue test sites look in two ways:
   - with cellophane filters placed over them
   - without cellophane filters placed over them
2. Think about these questions:
   - What changes do you observe when looking at the red test site through the red filter? Why do you think that is?
   - Do you see a difference if you fold the cellophane in half? In quarters?
   - How could a filter help us detect minerals from a distance?
3. Record your observations in your Notebook.