Engineering Activity 2: Hidden Minerals

Educator Preview

Activity Overview

Youth work to distinguish between minerals by processing data presented in different forms.

Timing		**Prep Snapshot**	**21st Century Skills**
Introduction	5 min	Prep Time 10 min	**Connection**
Detect Minerals Using Sound	20 min		• Collaboration
Detect Minerals Using Light	10 min	Print and cut materials and set up Materials Table.	• Communication
Detect Minerals Remotely	20 min		• Critical Thinking
Reflect	5 min		**Habits of Mind**
Total	**60 min**		• Innovate processes, methods, and designs.

Guiding Question	**Youth Will *Do***	**Youth Will *Know***
How can we use remote sensing data to help scientists find out about minerals from a distance?	• Investigate how colored cellophane filters light to distinguish patterns. • Design scraping technologies to distinguish between materials based on their textures. • Develop ideas for combining technologies to collect data from a distance.	• Engineers design technologies that process complex data to make it easier to understand/use for different purposes. • Materials have properties that make them better for some purposes than for others. • Engineers must investigate the properties of materials to inform their design choices. • Technologies can change how data is received and measured.

Connecting Across Activities

In Engineering Activity 1, youth explored the properties of mirrors to design light redirection systems to gather data. In this Activity, they explore the properties of filters and scrapers to gather more data, specifically about minerals. In Engineering Activity 3, they will explore how to use straws to design LiDAR systems to gather data on an additional subject: 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-a2**/

Family Connection

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

Q: Can you tell me a story about a time you removed distractions and noticed something that you missed before?

Materials and Preparation

Materials

For the whole group

- engineering design process depiction created in the Engineering Prep Activity
- *Scraper Investigation* chart or shared document: A chart to record different surface textures and scraping tool materials that work well to distinguish each of those textures.
- *Optical Filter Investigation* chart or shared document: A chart to record different surface colors and optical filter materials that work well to distinguish each of those colors.
- *Remote Sensing Definition* chart paper
- markers
- paper, chart
- 50 sheets of paper, copy

For each group of 4

- 2 quarter-sheets of cellophane, blue
- 2 quarter-sheets of cellophane, red
- 4+ *Data Collection Grids*
- 2 quarter sheet pieces of felt
- 2 quarter sheet pieces of foam, craft
- 4 folders, manila
- 1 light redirection system from Engineering Activity 1
- 2 quarter sheet pieces of paper, construction
- 1 pair of scissors
- 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 the Materials Table (for scrapers and image detection devices)

- mirrors, extra (if available)
- 30 sticks, craft
- 30 straws, regular
- 30 straws, thin
- 1 roll of tape, masking

For each youth

- Engineering Notebook

Activity 2 Materials Preparation (10 min)

1. Post youth's engineering design process depiction and *Remote Sensing Definition* chart.
2. Create the *Filter* and *Scraper* charts described in the Materials and post them somewhere that youth can refer to them during the Activity and Engineering Activity 4.
3. Prepare a Materials Table with the materials listed above.
4. Print out 4 – 5 *Data Collection Grids*, page 67 in this guide, per group.
5. Print out *Test Sites* in color and cut along the lines to provide 4 blue quarter-sheets and 4 red quarter-sheets to each group. (You may also provide each group with additional copies of the quarter-sheets for use in the "Detect Minerals Remotely" section.)
6. Cut sheets of felt, construction paper, and craft foam into four pieces each to provide two quarter-sheets of each material to each group.
7. Cut cellophane into half-sheets to provide two half-sheets to each group.

Teaching Tip

Package all the materials each group needs into one bag per group for easier distribution. See pages 56 and 58 for lists of materials needed for each activity.

Instead of felt, foam, and paper, you can use other textured materials that are familiar or meaningful to youth. You can also give youth 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 4.

Preparation for Engineering Activities 4, 5, and 6 (60 min)

The final design challenge for this unit requires the educator to prepare a multi-part model so youth can test their remote sensing devices. Read Activity 4 Materials Preparation and decide whether to use the Space Screens with youth. **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 youth 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 Sites A and B and the Space Screens are outlined on pages 99 – 105 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 youth use only the remote sensing devices they create to gather information about each site. Keep the model landscapes covered when not in use until groups complete their tests in Activity 5.

Activity Guide

Guiding Question

How can we use remote sensing data to help scientists find out about minerals from a distance?

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

Introduction (5 min)

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

   Q: If anyone talked to their families about removing distractions to notice something new, would you like to share about it?

   A: Accept all responses.

2. Have youth think back to the previous activities. Ask:

   Q: What problem are we trying to solve? What have we done so far to solve it?

   A: NASA wants to send a rover to Mars to see if life once existed there. As engineers, we need to design remote sensing technologies to gather information that will help scientists choose the best location to send a rover. We have designed light redirection systems to get images.

3. Remind youth that cameras placed on spacecraft have captured images of other planets, like the images of Mars shown in the video. Have them turn to *Image of Mars*, page 19 in their Engineering Notebooks, to observe the image. Ask:

   Q: What does this image tell us about Mars? What does it not tell us?

   A: Accept all answers. Possible responses include that it tells us the planet is round like a ball and that some areas on it are darker and some are lighter. It does not tell us what the planet is made of or what shape its surface is.

4. Remind youth that, from the video, they learned NASA is interested in finding out what planets are made of. Ask:

   Q: Why might it be useful to know what Mars is made of?

   A: Accept all answers. Possible responses include to learn about its history, whether it has water, the minerals it has, and whether it could support life.

5. Let youth know it is possible to learn what other planets are made of from a distance because the minerals on other planets are the same as the minerals on Earth. Scientists use their understanding of minerals on Earth to understand the minerals on other planets. They know that certain minerals reflect certain colors of light, and they can use this information to identify them. Unfortunately, the light reflected from specific minerals is hard to pick out from all the other light reflected from the surface. It's like trying to hear one voice in a crowded room. So, they need engineers like you to create technologies to process light data, so it is easier to make sense of and understand. Share the Guiding Question with youth:

   Q: How can we use remote sensing data to help scientists find out about minerals from a distance?

Note

Studying the colors of light reflected off a planet can tell scientists a lot about the minerals on the planet, which in turn can provide clues about its history. One way to make sense of the light is to use an optical filter to control what colors of light a remote sensing device can collect. In the "Detect Minerals Using Light" section of this Activity, youth determine the most effective way to combine filters with mirrors to interpret data. Another way to present the data is in tactile and audible form. In the "Detect Minerals Using Sound" section of this Activity, youth explore and choose materials that help them distinguish between minerals using data in these forms as well.

Supporting Youth Thinking

To help youth better understand the concept of mineral reflection at different wavelengths, you can share images and videos about spectroscopy from the Activity resources page.

Connecting Across Activities

PLANETS *Remote Sensing: Science Series* goes into more depth about how scientists use spectroscopy, a remote sensing technology, to identify minerals on other planetary bodies.

Detect Minerals Using Sound (20 min)

Teaching Tip

If you are short on time, you can run "Detect Minerals Using Sound" and "Detect Minerals Using Light" concurrently. However, it can be difficult to hear the scraping sounds in a noisy room. You might also want to make sure some youth from each group are teamed up for the final engineering challenge.

1. Explain that youth will use models to represent complex data that is collected from a distance. The data must be processed so humans can use it—for example, by hearing or seeing the data. Data about the minerals on a planet is usually collected by recording the light reflected from that planet. Humans can make sense of that data using their eyes, but it is also possible to interpret it with other senses such as hearing and touch. Let youth know they will first explore data that can be felt and heard, then they will explore the same data as light that can be seen.

   Let youth know that in the sound model, felt, foam, and construction paper will represent the different kinds of minerals that might be present on a planet. Youth will need to engineer scraping devices that enable them to distinguish between the minerals without looking. Allow youth to examine the materials they will investigate by scraping them and listening (and feeling), and the materials they have available to design a scraping device to produce the sounds and vibrations (craft sticks, large straws, and small straws).

Supporting Learner Differences

The "Detect Minerals Using Light" portion of this activity will not be accessible to all learners. The scrapers and different-textured materials are a way to convert visual data so it can be perceived with other senses. Scrapers are analogous to different light filters, and the textured materials are analogous to the image data. This exercise is not meant to suggest that scraping the actual surface of a planet is the main way that scientists distinguish minerals.

Some youth may find the sound of scraping materials irritating. Consider ways to provide choice to youth about the kinds of scrapers they use.

2. Show youth the felt, foam, and construction paper, which represent different kinds of minerals that might be found on Mars (felt represents clay minerals, foam represents volcanic minerals, and construction paper represents sulfate minerals). Let youth know they will investigate these materials by scraping them with craft sticks, large straws, and small straws. They will listen to the sounds they make and feel the vibrations.

3. Explain that youth will share materials among their group but may work independently for this part of the activity.

Supporting Learner Differences
Depending on the level of detail appropriate for your students, you can decide whether to name the mineral categories for youth in this Activity or wait until Activity 4 to do so.

4. Split youth into groups of four and assign one person from each group to gather the following supplies from the Materials Table:
    - 2 pieces of felt
    - 2 pieces of craft foam
    - 2 pieces of construction paper
    - 2 craft sticks
    - 2 large straws
    - 2 small straws

5. Have youth compare the felt, paper, and foam by feeling each with their fingers. Ask:

    Q: How would you describe each material?
    A: Possible responses include that felt is soft, foam is spongy, and paper is rough.

6. Then, encourage youth to scrape each surface with a craft stick and with different-sized straws and to feel and listen to the differences as they scrape. Have youth record their observations on *Data Detection Investigation—Sound*, page 20 in their Engineering Notebooks.

Teaching Tip
Have youth use their devices to record audio from the scrapers so they can play back the sound and increase its volume if necessary.

7. As youth work, circulate among groups and ask one or more of the following questions:

   Q: Which scraper materials are easiest to use, sturdiest, and easiest to handle?

   A: Accept all responses. Youth may think that some materials are best in one category but not another.

   Q: Which scrapers are best at revealing data through sound?

   A: Accept all responses that youth can support with observations.

   Q: Which scraper is best for identifying differences between felt, paper, and foam?

   A: Accept all responses that youth can support with observations.

Detect Minerals Using Light (10 min)

1. Let youth know they are ready to investigate ways to process data using light. Remind youth that scientists use reflected light to identify minerals from a distance, but the scientists need engineers like them to create technologies to process the data that comes back as light, so it is easier to make sense of and understand. Explain that youth will now investigate a technology that blocks some light but lets other light through.

   Hold up a piece of cellophane and ask:

   Q: What do you know about this technology?

   A: Accept all responses. Possible responses include that some cellophane is used to cover things and for gift wrapping. This kind is stiffer, and it can be used to see only one color if you look through it. Youth may share different names for it.

   Explain that the technology is called *cellophane*.

2. Have one person from each group gather the following supplies from the Materials Table. Allow youth to investigate the materials.

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

3. Explain that youth will share materials among their group but may work independently for this part of the activity.

4. Have youth 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

    Have youth record their observations on *Data Detection Investigation—Light*, page 21 in their Engineering Notebooks.

Supporting Learner Differences
To support emerging multilingual youth, encourage them to use their primary language alongside English as they record their observations in their Engineering Notebooks.

5. As youth are working, circulate among the groups and ask one or more of the following questions:

    Q: What changes do you observe when looking at the red test site through the red filter? Why do you think that is?
    A: Accept all responses with justification. Possible responses are blue and green look darker. Responses about why will vary.

    Q: Do you see a difference if you fold the cellophane in half? In quarters?
    A: Accept all responses with justification. A possible response is that the effect of the cellophane becomes stronger, making certain colors easier to see.

    Q: Which pieces of cellophane allow you to see the shapes that stand for minerals on each test site? Why?
    A: Accept all responses with justification. A possible response is that the red cellophane makes it easier to see the shapes on the red test sites, and the blue cellophane makes it easier to see the shapes on the blue test sites.

    Q: How could a filter help us detect minerals from a distance?
    A: Responses will vary. A possible response is by blocking out all kinds of light except the ones from the minerals we are interested in, so it is easy to determine if those minerals are present.

Detecting Minerals Remotely (20 min)

Supporting Learner Differences

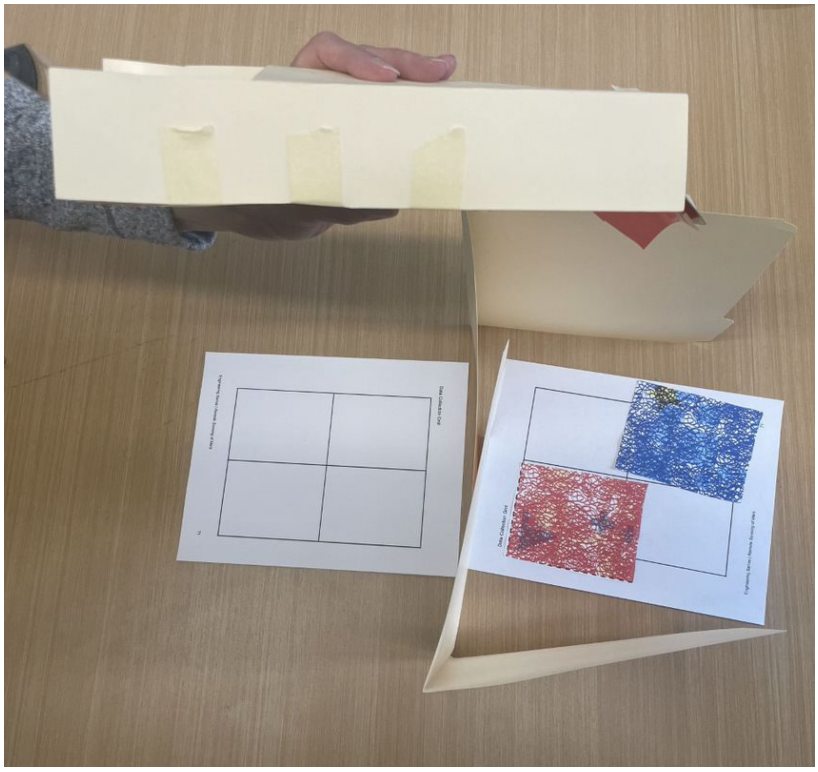
Youth can communicate what they find during this activity in multiple ways, such as drawing or placing duplicate materials on the grid or describing what they detect. Prepare additional red and blue test sites and *Data Collection Grids* to provide multiple options.

4. Explain that engineers sometimes combine remote sensing technologies in spacecraft, like the Mars Reconnaissance Orbiter discussed in the video. They will now use what they learned to combine technologies to gather hidden information about minerals.

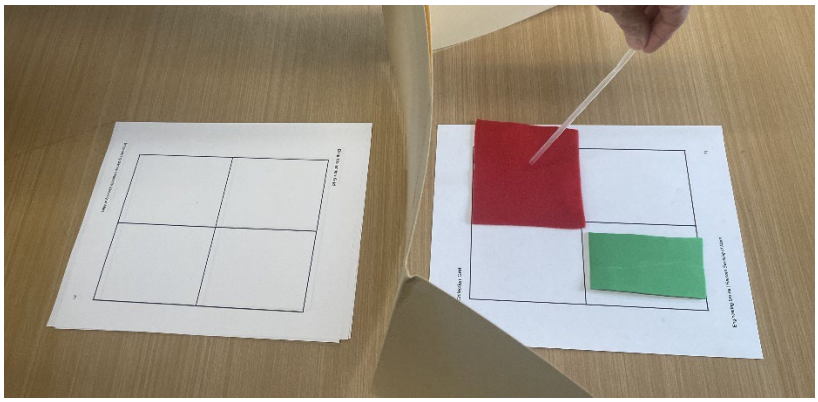
5. Demonstrate how youth will take turns working in pairs within their groups, with one youth using manila folders as a barrier to hide the test surface while the other detects visual and textural information on the hidden surface:

    - Set up the hidden test area using the manila folders as a barrier with a *Data Collection Grid* on each side. Have youth label the quadrants on each grid so they know which they are exploring. One youth places a red or blue test site on each section of the grid, hidden from the other youth, who will test.
    - The youth who cannot directly see the grid uses the light redirection system combined with the optical filters to find shapes on the test sites and documents them on their grid.
    - Let youth know they can use tools such as tape and scissors and materials from the Materials Table to modify their light redirection systems to get information around and over the barriers, but they cannot modify the barriers themselves.
    - Youth change roles and rearrange the test sites so that each youth gains experience detecting the hidden shapes on the blue and red test sites behind the barrier using the light redirection system.
    - Repeat the process using felt, craft foam, and construction paper pieces on the grid, detecting information from the surface using scrapers, and rotating roles. Again, they can modify their scrapers to get around and over the barriers, but they cannot modify the barriers themselves.
    - Have youth document what they detect on the *Data Collection Grid*.

6. Distribute two manila folders, a light redirection system from Engineering Activity 1, and two *Data Collection Grids* to each group. If time permits, allow youth to create and test hidden surfaces using both the different materials and the red and blue test sites.



1. Optical filter test setup



2. Scraper test setup

7. While youth are working, circulate and ask:

   Q: What worked well to identify the hidden surfaces?

   A: Accept all responses.

   Q: What was challenging about detecting the sites?

   A: Accept all responses. A possible response is that our light redirection system reversed the image, so we saw the sections in a different direction.

   Q: How did you combine the filters with your detection systems so you could use them at the same time?

   A: Accept all responses.

8. Have youth keep track of what they learn on *Data Detection Investigation*, page 22 in their Engineering Notebooks.

Reflect (5 min)

1. Have youth reflect on the Guiding Question:

   Q: How can we gather remote sensing data to help scientists find out about minerals from a distance?

   A: Accept all responses. A possible response is that remote sensing technologies can use filters and scrapers to let through only certain kinds of light and sound. This filtering helps humans identify certain kinds of information more easily.

2. Remind youth they were gathering information from a distance. Ask the following questions:

   Q: What kind of data were you gathering when you were investigating filters? What was receiving the data?

   A: Accept all answers with justification. A possible response is that we were gathering light using eyes.

   Q: What kind of data were you gathering when you were using scrapers? What was receiving the data?

   A: Accept all answers with justification. A possible response is that we were gathering sound and vibrations using ears and skin.

3. Have a few volunteers share their experiences using the scrapers and optical filters with the rest of the group. Record what worked well on the *Filter and Scraper Investigations* charts. Ask one or more of the following questions:

   Q: Which filters allowed you to detect the minerals on each test site?
   A: Accept all responses.

   Q: Which scrapers allowed you to detect the differences between different minerals?
   A: Accept all responses.

   Q: Would you be able to use scrapers to transmit sounds from Mars to Earth?
   A: Possible responses include no, because you would have to touch the surface, so it's not really remote sensing, and no, because sound cannot travel through empty space—it can only exist when there is something to vibrate.

   Possible responses may also include fun imaginings of how you might scrape the surface of Mars, but youth should recognize that this would not produce useful data from a distance. However, scraping can be useful up close: for example, Mars rovers can use drills to learn about rock hardness. Remind youth that the scrapers were just a way to turn the light data into data that could be perceived by other senses.

4. Gather youth together in front of their engineering design process depiction and the Investigations charts. Ask:

   Q: Which steps of our engineering design process did we use today?
   A: Accept all responses. Possible responses include asking, investigating, questioning, and exploring how filters work. Youth may also describe how they improved the filters to make information easier to collect.

5. Save the *Investigations* charts for use in later activities.

6. Congratulate youth on their hard work and thorough investigations. Let youth know that next time, they will explore a remote sensing technology that uses lasers to gather information about the shape of the surface of Mars.

After the Activity

1. Plan ahead for Engineering Activity 3. See Activity 3 Materials Preparation on page 72.

2. Take time to reflect on the following educator prompt.

   Q: How did youth interpret the different sensory options (sight and hearing/touch)? What strategies might you use to support multisensory learning in future activities?

Remote Sensing Unit Resources

QR code leads to resources available for this unit.

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

Data Collection Grid