NAVIGATING® NUCLEAR
Energizing Our World

Project Starter

Destination Deep Space

GRADE RANGE

Elementary, primarily grades 3–5

DURATION

Two 50–60-minute class sessions

Overview

After observing a mock-up of a proposed Martian outpost, students will brainstorm what humans would need in order to survive in a colony that exists in the distant regions of outer space—otherwise known as deep space. They will explore the importance of electricity in space as they consider everything for which. space colonists would need energy. Student teams will ultimately be challenged to provide a recommendation on the type of power that future Martian colonies should use. They will research conditions on Mars and read about various power options to select, justify, and present a power source that they believe would work best in deep space.

Essential Question

Why is energy needed in space colonies? How could we power a Martian colony?

Instructional Note

Students will benefit most from this Project Starter if they have already completed **Activity 1: Amazing Atoms** and **Activity 2: Energy Decisions**.

Instructional Delivery Method

This project starter is presented as an in-classroom experience, but it can also be easily completed at home. Feel free to make modifications based on your teaching environment. For example:

- The Think-Pair-Share may be completed as a written reflection.
- All partner activities may be completed independently.
- Small groups can prepare for their presentations using a collaborative document.
- Presentations can be held virtually as a full class and in breakout rooms if your virtual platform allows.

NGSS Standards

Next Generation Science Standards

Engineering Design:

- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Energy:

- 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

Space Systems: Stars and the Solar System

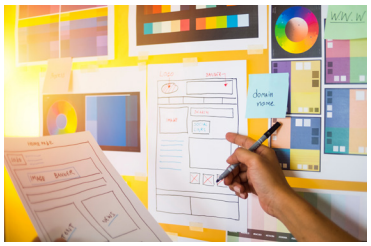
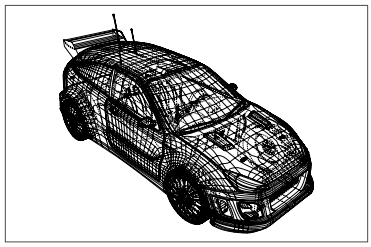
- 5-ESS1-1: Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from the Earth

Materials

- Device with Internet access and projection capabilities, one for the teacher
- Devices with Internet access, at least enough for half the class
- **Martian Outpost Mockup Images** One, Two, and Three, to project or share
- **Electricity on Mars Handout**, enough for half the class
- **Step 1: Mars Quick Facts Research Organizer**, enough for one-third of the class
- **Step 2: Power Source Overview Handout**, enough for one-third of the class
- **Step 3: Powering Mars Rubric**, enough for one-third of the class
- Highlighters, colored pencils, or markers, two colors per student

Procedure

1. Begin class by projecting the **Martian Outpost Mockup Images**. Toggle back and forth between the designs. Explain that these are different mockups of a base on Mars where humans could live.
2. Before discussing the image's content, explain: A mockup is a representation, or an image, of a design. It usually includes as much detail as possible.
    - To help students understand how broadly mock-ups are used, you may display and share these sample mock-ups of interior home design, websites, and/or cars.

    - Then ask: Why may mockups be important to create before a design is actually built? Be sure students understand the mockups give people (designers, scientists, engineers, etc.) a chance to review and evaluate the design before time, money, and effort is put into building it!
3. Explain that they are about to brainstorm what humans may need to live on Mars. But before they do, it will be helpful to brainstorm what we need to live in our own community! Encourage students to brainstorm what they need to survive in their community on Earth. Keep a list on the board as students share.
4. Then bring students' attention back to Martian Outpost Mockup Image 1 and ask them to observe it quietly. After a moment has passed, ask students to think-pair-share*: If this mockup was actually built on Mars, what may humans need in order to live there? Remind the class that Mars is very far from Earth—it takes about seven months to travel there!
    - In a think-pair-share, students think about the question independently, discuss their answers with a partner, and then share their thoughts with the larger class.
5. When students have finished brainstorming, add or reiterate that electricity would be needed on Mars in order for humans to live there. If students aren't yet sure *why* electricity would be needed, they are about to investigate it further!

Create

1. Divide students into pairs and distribute one **Electricity on Mars Handout** to each pair. Explain that this handout describes just some of the reasons why electricity would be important to a Mars colony. Review the instructions provided and then allow students about 15 minutes to complete the activity.
2. When students have finished their headlines, encourage partners to share what they developed. As students share, record their ideas on a piece of chart paper or another location where you can access them easily in a proceeding class period.
3. Then ask students to answer with their fingers (1 being unimportant and 10 being very important): If humans were to live on Mars, how important would it be to have electricity? Wrap up by calling on a few students to explain their reasoning.

Connect

1. Once students have determined that electricity would be important on Mars, explain that they will now be challenged to recommend the type of power that future Martian colonies should use.
2. Divide students into groups of three and distribute three handouts to each group: **Step 1: Mars Quick Facts Research Organizer Handout**, **Step 2: Power Source Overview Handout**, and **Step 3: Powering Mars Rubric**. Review each of the handouts and explain that groups must complete the handouts in numerical order, so they can ultimately present the power source that they believe would work best on Mars.
    - Tip: Encourage students to also refer to the headlines they previously created for additional background information about Mars.
3. Once groups are ready, lead the class through their presentations and keep track of the power source that each group recommends. Encourage students to ask each other questions based on their research.
4. At the end of the presentations, review the power source recommendations and declare that it seems like NASA scientists should consider _____ power as they look towards life on Mars!

Extension

Students can try their hand at becoming an agricultural director for a colony on Mars with this interactive game. They will be responsible for feeding the settlement, which is home to research scientists and volunteers from Earth. During the simulation, encourage students to consider: What types of environmental and weather conditions may affect their crops? Would these conditions also affect the colony's power sources?

Name: _____

STUDENT HANDOUT

Electricity on Mars Handout

Directions:

1. Read the paragraphs one at a time.
2. Then create a headline that summarizes each one. Your headline must:
   - Explain why electricity would be needed on Mars.
   - Use 8 words or less! (It does *not* need to be a complete sentence.)

Headline #1: The average temperature on Earth is 57 degrees Fahrenheit. The average temperature on Mars is -81 degrees Fahrenheit. (That's 81 degrees *below* zero!) It can get much colder than this, too. Fires are unable to burn on Mars, so it's not a surprise that electricity is needed. Astronauts need heat to survive!

_____

_____

Headline #2: Humans need oxygen to breathe. There is no oxygen on Mars. The trip to Mars is also very long. It would take a spaceship about seven months to travel from Earth to Mars. It's not possible to carry all of the oxygen that would be needed for this trip *and* for the time on Mars. It would be better to have electricity on Mars, so astronauts can create their own oxygen using technology!

_____

_____

Headline #3: Vehicles on Mars are called rovers. They move across the planet's surface. Some rovers are like cars for astronauts, and they help astronauts get from place to place. Other rovers may move around all by themselves and collect data and other important information. Rovers need power to move, explore, and communicate with Earth.

_____

_____

Name: _____

STUDENT HANDOUT

Electricity on Mars Handout

Headline #4: Anyone living on Mars would also need food and water. Plants can be grown in greenhouses on Mars. Power will be needed to create light and make sure the temperature inside greenhouses is okay. Power will also be used to clean and recycle water so that it can be used again and again. Astronauts would not be able to bring enough food and water, so they must be able to create it.

_____

_____

Headline #5: Can you think of any other reasons why astronauts might want electricity on Mars? Your ideas may be for survival *or* for fun! Explain below and then create your own headline.

_____

_____

_____

_____

_____

_____

Name: _____

STUDENT HANDOUT

Step 1: Mars Quick Facts Research Organizer

Directions:

1. Visit the webpage **What is Mars?** by typing tinyurl.com/z4pe6jy or nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-mars-k4.html into your Internet browser.
2. Read the first paragraph and the **What is Mars Like?** section.
3. Fill in the missing quick facts below.

Mars Quick Facts

Location:

Distance from Mars to the Sun:

_____ miles

Distance from Mars to Earth:

At least **34 million miles**

and 7 months of travel!

Land:

What is the surface of Mars like? Label and draw a picture:

Weather:

Temperature on Mars: _____

What kinds of storms does Mars have?

_____

Who gets more sun: Mars or Earth?

Earth! Earth gets three times more sun than Mars.

Is there wind on Mars? _____

Name: _____

STUDENT HANDOUT

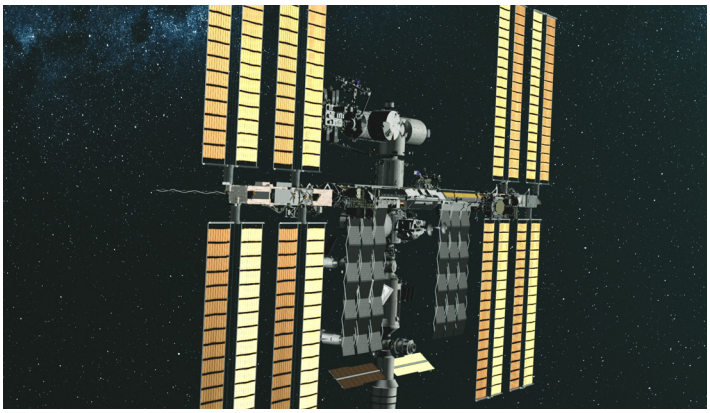
Step 2: Power Source Overview Handout

Directions:

1. Grab two highlighters, markers, or colored pencils.
2. Read the Power Descriptions below and try to think about how each one would do on Mars based on what you have learned.
3. Then read the Power Descriptions a second time. As you read this time:
    - Use one color to underline details that may mean the power source could work well on Mars.
    - Use the second color to underline details that may mean the power source would have trouble on Mars.

Tip: Use your **Mars Quick Facts** to help you!

Solar Power:

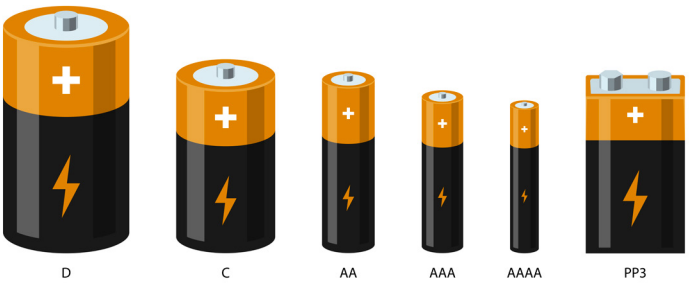


Solar power gets energy for electricity from the sun. To have solar power, you need solar panels like you see in the picture here. Solar panels are made of atoms called silicon. These atoms produce electricity when they are heated by the sun. Solar panels only work when they are in the sun. If it is cloudy, if the sun is not strong, or if the solar panels are covered by another material, they will not create electricity.

Other important facts:

- Solar power is cheap!
- Solar power does not cause pollution.

Battery Power



A battery stores energy that can be used for electricity. Batteries can only store a certain amount of energy. When they run out of energy, they can no longer create electricity. Thankfully, most batteries can be recharged! To be recharged, batteries need help from another source of energy.

Other important facts:

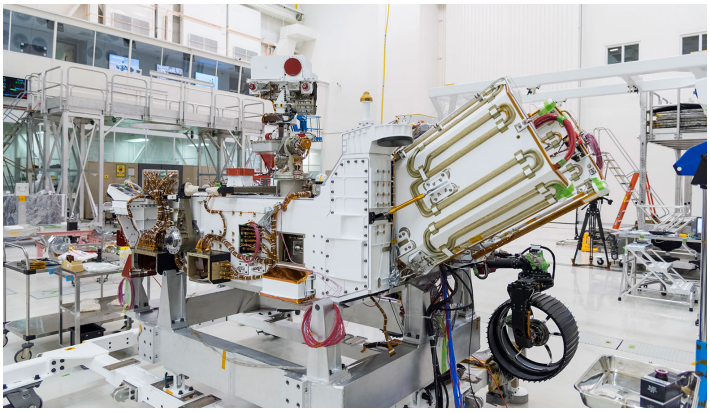
- Space batteries are designed to be tough and survive on other planets.
- New batteries can store more energy in smaller sizes!

Name: _____

STUDENT HANDOUT

Step 2: Power Source Overview Handout

Radioisotope Power

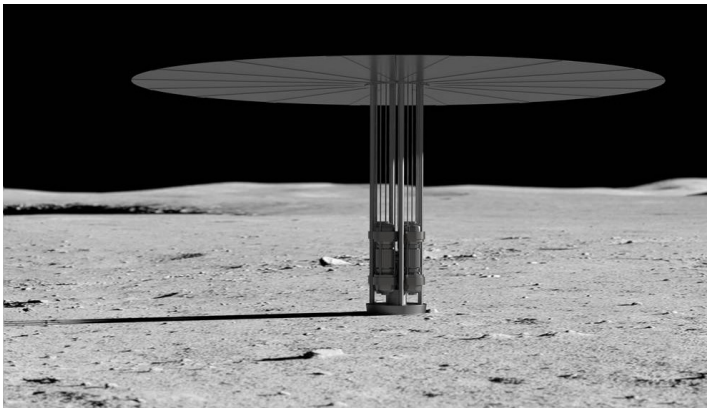


Radioisotope power is one kind of nuclear power. It gets energy for electricity from atoms. Power generators, like the one here, hold special atoms called radioisotopes. These are special atoms because they have trouble staying together. As they fall apart, they let off energy. This energy can be used to create electricity in space!

Other important facts:

- These power generators are small, solid, and strong. They have no moving parts and can survive in harsh environments.
- The power generators can work for years at a time without stopping or needing work.
- Many NASA spacecrafts and missions have used this kind of power in space.
- Each generator creates a small amount of electricity. One generator may create enough power to send radio signals back to Earth or power one camera.

Kilopower



Kilopower is another kind of nuclear power. It gets it energy from uranium atoms. (This is the kind of nuclear power that you have likely already learned about!) When uranium atoms split in half, they cause other uranium atoms to split in half… and this chain reaction creates electricity. This power can be created in a kilowatt reactor, which looks like the picture here.

Other important facts:

- Kilopower is new and has not yet been used in space.
- The reactors are lightweight and strong. They can survive in harsh environments for a long time.
- They can work for years at a time without stopping or needing work.
- Each reactor can create a lot of electricity. As few as four reactors could be needed to power an entire space colony.

Sources:

- https://cen.acs.org/energy/nuclear-power/NASA-thinks-nuclear-reactors-supply/98/i19
- https://www.nasa.gov/directorates/spacetech/kilopower/Kilopower_whats_next
- https://www.nasa.gov/feature/jpl/fueling-of-nasas-mars-2020-rover-power-system-begins

Name: _____

STUDENT HANDOUT

Step 3: Powering Mars Rubric

If NASA were to choose one power source as it begins to plan for a Mars colony, what would you recommend?

Create a presentation that:

- Explains what Mars is like and why power would be needed for a Mars colony.
- Selects one power source that would be best for a Mars colony and gives at least three reasons, backed by facts, that explain why.
- Explains why this power source is better than the other power options.
- Includes at least one visual that supports your answer.

Content Criteria:

	3	2	1
Introduction	Describes the conditions on Mars in detail, and gives at least three reasons why a Martian colony would need power.	Describes the conditions on Mars, and gives two reasons why a Martian colony would need power.	Does not describe the conditions on Mars *or* gives one or no reasons why a Martian colony would need power.
Argument	Describes at least three factual reasons why your power source would be good for a Mars colony.	Describes at least two factual reasons why your power source would be good for a Mars colony.	Describes only one factual reason why your power source would be good for a Mars colony *or* does not give facts to support your reasons.
Comparison	Provides at least one reason, backed by facts, of why this option is better than the other power options.	Provides at least one reason, backed by facts, of why this option is better than some of the other power options.	Explains why your option is better than only one of the other power options *or* does not give facts to support your answer.
Visual	Includes at least one visual and clearly explains how it connects to your answer.	Includes at least one visual in your presentation that connects to your answer.	Includes at least one visual that does not seem to connect to your answer.