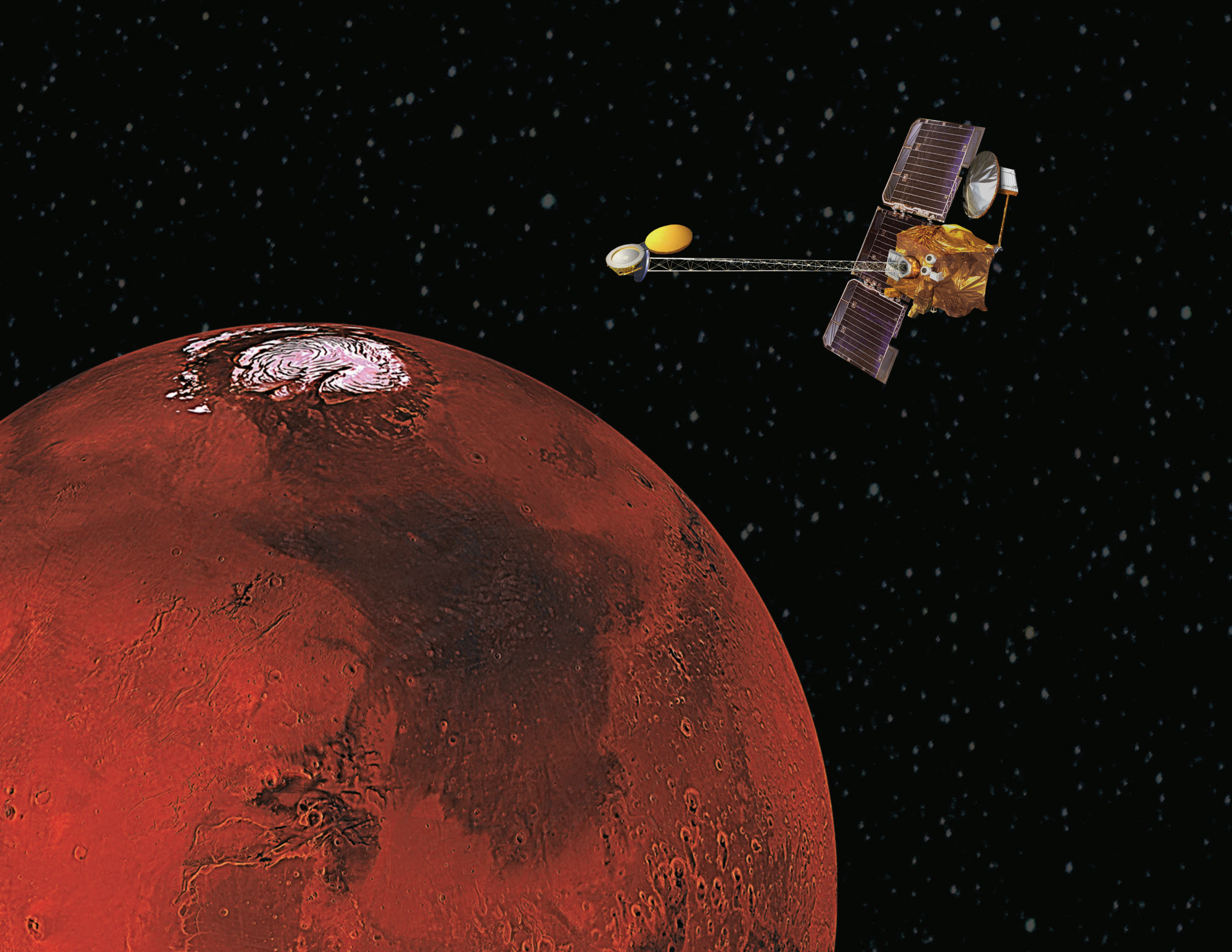
MARS BASE CAMP

4-H STEM CHALLENGE

FACILITATOR GUIDE



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Kit Materials

These materials are included in this kit. If you want to create more, printable materials are also available on the included USB drive or online at **4-H.org/STEMChallenge**.

EDUCATOR KIT INCLUDES:

- Facilitator Guide (1)
- Youth Guides (12)
- Parachute Toys (4)
- Landing Mat (1)
- Landing Site Cards (16)
- Dice (1)
- Rover Kit (3)
- Crop *Curiosity* Playing Cards (3)
- 20 Marker Chips (3)
- Crop *Curiosity* Module Cards (6)
- Scratch Cards (9)
- USB Drive (1)
    - Offline versions of Scratch Desktop (for Mac OS X & Windows)
    - Printable Facilitator Guide
    - Printable Scratch Cards
    - Printable Youth Guide
    - Printable Landing Site Cards
    - Rover sprite image files
    - Mars background image file

FAMILY KIT INCLUDES:

- Facilitator Guide (1)
- Youth Guides (2)
- Parachute Toys (1)
- Landing Mat (1)
- Landing Site Cards (16)
- Dice (1)
- Rover Kit (1)
- Crop Curiosity Playing Cards (1)
- 20 Marker Chips
- Crop Curiosity Module Cards (2)
- Scratch Cards (9)

Introduction

Welcome to Mars Base Camp, the 2020 4-H STEM Challenge!

If you're new to 4-H, we're the largest youth development organization in the United States, serving more than six million youth each year. Our philosophy is to engage youth in hands-on learning that gives them a chance to make mistakes, learn from each other, and develop important life skills like problem solving, patience and teamwork. 4-H takes place in classrooms, clubs, after-school programs and camps across the country. It covers almost any topic you can think of, from computer science to music, animal husbandry, robotics, food security and much more. Youth can decide to pursue the topics that interest them the most. In general, 4-H projects can be grouped into four main categories or pillar areas: STEM (science, technology, engineering and math), civic engagement, healthy living and agriculture. The 4-H STEM Challenge is our signature annual initiative in STEM, and is designed to help make STEM fun and accessible to young people everywhere.

This year, we've partnered with Virginia Cooperative Extension (Virginia Tech and Virginia State University), Google, Bayer, Toyota, the United States Air Force, the Carnegie Institute for Science, NASA, including the NASA Astrobiology Institute ENIGMA Project and the Mars Science Laboratory mission, and Virginia Episcopal School to create activities that explore the topic of a mission to Mars. The challenge activities allow youth to develop quantitative, observational and critical thinking skills while they have fun making discoveries and designing solutions that are out of this world! Mars Base Camp consists of four activities, each of which make connections to at least one of the 4-H pillars — agriculture, STEM, healthy living or civic engagement — to help participants develop a STEM identity.

In this guide, you'll learn everything you need to know to facilitate the four activities: Landing Zone *Surveyor*, Red Planet *Odyssey*, Crop *Curiosity*, and *Insight* from Mars. The title of each activity is a play on words using names from a NASA Mars mission — see if youth recognize them! You don't need prior experience with STEM to bring Mars Base Camp to your youth. All the activities have been designed to make it easy for everyone, including teen teachers, to facilitate. Each activity includes background and preparation details for the facilitator, activity details, opening questions and reflection questions. Mars Base Camp is perfect for youth ages 8 to 14 to enjoy, from those inexperienced in STEM to the budding scientist.

As you use this guide, take note of the icons. Each icon indicates the type of information appearing in a given section. For example, **Tips for Engagement** and **Important Vocabulary** are for your reference as a facilitator, but do not need to be read aloud to the group. Sections like **Suggested Script** and **Pillar Tie-In** would be great to read to the entire group.

ICON KEY

As you use this guide, take note of the icons. Each icon indicates the type of information that appears in a given section, including instructions you can read aloud like a script, helpful facilitator tips, tie-ins to 4-H pillar areas and important vocabulary words.

SUGGESTED SCRIPT

FACILITATOR TIPS

IMPORTANT VOCABULARY

PILLAR TIE-IN

Take on the 4-H STEM Challenge

October is officially 4-H STEM Month, and we estimate that hundreds of thousands of youth will take part in the 4-H STEM Challenge at events in households across the country. Help us exceed our goal by joining the STEM Challenge movement — together we can make hands-on STEM accessible to all!

- **Prep:** Get ready to facilitate Mars Base Camp by reading through this guide. Focus on the Facilitator Preparation section for a concise overview of how to prepare. For families wanting to engage with the activities right away, use the Youth Guide as a Quick Start guide to the challenge.
- **Plan:** October is 4-H STEM Month and we encourage educators to plan their 4-H STEM Challenge celebrations during this month. An event can be as simple as taking over a class lesson or teaching a few youth at home, or as big as planning a virtual community event. Beyond October, re-use or purchase more kits anytime to bring STEM to more youth!
- **Check in:** Visit **4-H.org/STEMChallenge** for the latest updates. As October gets closer, we'll add details and resources to help you make the most of the 4-H STEM Challenge, including promotional materials, printable resources and webinars for adults and teens to better facilitate your event.
- **Share:** Tell your friends and colleagues about the 4-H STEM Challenge, and don't forget to share on social media using **#4HSTEM**.

Your feedback helps us improve the 4-H STEM Challenge each year! Once you've completed the Mars Base Camp Challenge, please take a few moments to fill out this survey about your experience: **4-H.org/STEMChallengeSurvey**.

Facilitator Preparation

This section provides the background needed to comfortably teach the STEM topics covered in this year's 4-H STEM Challenge. Read through this section first to determine which activities you'd like to use, and brush up on STEM concepts that will help make facilitating a breeze. Let's get started!

Facilitator Checklist

- ❑ Visit **4-H.org/STEMChallenge** for information, webinars and training videos for this year's challenge.
- ❑ Review the basics of the engineering design process on page 20.
- ❑ Select the activities that best fit your group and available time, space and tech.
- ❑ Review the vocabulary, materials and full instructions of the activities you choose.
- ❑ Print additional Youth Guides from the website or the included USB (optional).
- ❑ Source any additional materials needed for the activities, including pens and pencils.

Why are STEM learning skills important?

STEM learning skills are the skills needed to do science, math and engineering, and those needed to use technology effectively to help youth be successful in school and careers. These important skills can be linked closely to the life skills that are taught within 4-H. These STEM skills are:

- **Problem Solving:** Thinking quickly and effectively to solve a problem. This requires youth to use the information they have to create appropriate solutions.
- **Creativity:** Looking at and proposing solutions to a problem through multiple approaches, including ones that are "outside the box." In STEM, mistakes and failed attempts are positive experiences, offering opportunities for deeper learning.
- **Inquiry Skills:** Solving problems by asking questions, proposing ideas and testing solutions, thereby putting youth in the driver's seat.
- **Real-World Application:** Taking the skills youth learned in school and applying them to real-world STEM problems. This helps them to connect geometry, data, observation and other math and science skills to real life scenarios, careers and workplace applications.
- **The Engineering Design Process:** Using a cycle of developing, testing and refining design ideas to solve a problem. Through each step, youth get closer to finding a functional solution to the problem, while using other STEM skills in the process.
- **Critical Thinking:** Analyzing, evaluating, reflecting, synthesizing and proposing solutions using critical thinking. This process helps youth develop into independent, critical thinkers.
- **Collaboration:** Teamwork and working in groups. This is critical for all youth to learn and is an important STEM workforce element. Collaboration teaches youth how to identify strengths of team members and how to work together to efficiently complete a task.

Career Connections

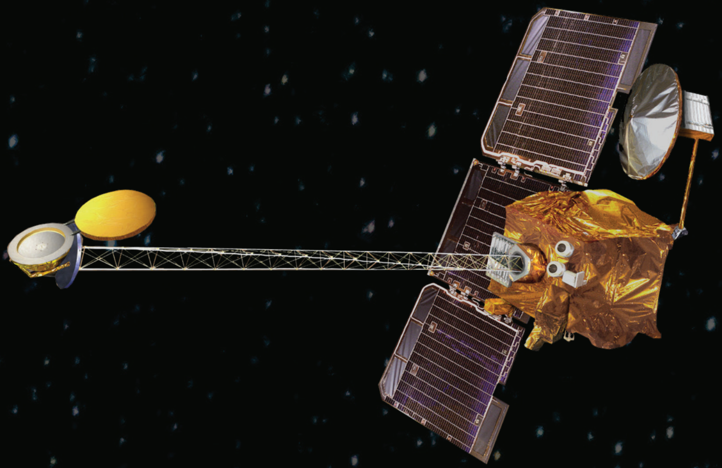
The 4-H STEM Challenge gives educators the opportunity to link careers to the activities that the youth are doing. STEM careers are all around us, and in the 4-H STEM Challenge we will be highlighting a few. One way to enhance learning for youth is to be intentional about how we link careers. Here are a few examples, but other examples appear in the Youth Guide.

Career Examples

Health: Nutritionists at NASA monitor an astronaut's health and food intake before, during and after a mission to make sure they receive the right combination of nutrients to maintain their health and safety during long-term spaceflight.

Agriculture: Chemists experiment with fertilizer formulas in order to add the right amount of nutrients to plants — without any mixing or measuring — to make it easier for astronauts to grow vegetables on the International Space Station.

Civic Engagement: Data Scientists use satellite data from NASA to develop a system to monitor global deforestation in real-time in order to advocate for conservation.



Planning your Mars Base Camp Event

Mars Base Camp is adaptable to a wide range of space, time and technology constraints. Most of the activities are unplugged and do not need tech equipment. The computer-based *Insight* from Mars activity includes instructions and resources that allow it to be completed with or without internet access.

The four activities in Mars Base Camp can be enjoyed individually or together in any order or combination, making it a perfect fit for classrooms or outside school learning. Activities can also be completed from start to finish in one sitting or spread out over several hours. We've provided examples of how you might structure your 4-H STEM Challenge, but please feel free to experiment and find a format that works for you.

	Landing Zone *Surveyor*	Red Planet *Odyssey*	Crop *Curiosity*	*Insight* from Mars
The Full Challenge	90 Minutes	45 Minutes	60 Minutes	75 Minutes
Short & Sweet	35 Minutes	45 Minutes		
Low-Tech	35 Minutes (90 with add-on)		60 Minutes	
Computer Science Fun				60-75 Minutes

Facilitating the Activities

Facilitating STEM activities gives us an opportunity to use a guiding approach to facilitation. This means that rather than telling the youth what to do, we give them direction and let them develop their inquiry skills to find solutions to the problem.

Each activity is written in an experiential learning style: Do, Reflect, Apply. The idea with experiential learning is that first youth do the activity, then they talk about their experience, and lastly they apply the experience to real-world problems and ideas.

Some activities will need to be modified based on your group size and location. When planning your activity, make sure to think about your audience, space needed for activities location as you pick the right activity for your group.

Facilitating reflection and application questions can look different for each group. We have listed several options:

- **Paired Response:** Have each pair discuss each question. You can also ask pairs to report back if you want to have a larger discussion.
- **Team Answers:** Keep teams together and have them discuss the questions as a group before sharing their summary.
- **Graffiti Think Tank:** Use a large sheet of poster paper and markers and, in teams, youth can write down the first word/words that come to their minds when considering the prompt. This is a way to give all youth a chance to answer, especially those who struggle with public speaking.
- **Group Answer:** This is most commonly used, where questions are answered by the entire group by raising hands or shouting out responses.

The suggestions above encourage total participation, but know that Group Answer sometimes engages only those who are already confident or knowledgeable.

Activity Overviews

This section introduces the four activities that make up the Mars Base Camp Challenge. It gives a brief overview of each, lists the STEM concepts covered, and describes each activity's tech requirements.

Landing Zone *Surveyor*

In this activity, participants model the general process of Mars exploration through the stages of launching from Earth, attempting to land on the surface of Mars, and discovering the surface features of Mars based on where they land. Using real images and data generated by NASA missions, youth are introduced to some of the key characteristics of the Martian surface, as well as how we have discovered these features through decades of scientific exploration.

STEM Skills & Pillar Tie-In

STEM Skills:
Inquiry Skills
Collaboration

4-H Pillar Alignment:
STEM

Total Time Required: 35 min
Optional add on activity:
60-75 min

Additional Materials:
Pencils and Post-it Notes, coins, or similar to mark landing spots

Red Planet *Odyssey*

This activity introduces the engineering design process through building and driving a rover. In this activity, youth will:

1. learn how to navigate by writing directions;
2. build a rover.
3. navigate the red planet by moving their rover from the landing site to another site on the planet.

STEM Skills & Pillar Tie-In

STEM Skills:
Engineering Design Process
Problem Solving
Real-World Application

4-H Pillar Alignment:
STEM

Total Time Required: 45 min

Additional Materials:
Pencils and tape (masking prefered)
Obstacle course items, like:
boxes, cardstock,
books, craft sticks

Crop *Curiosity*

In this activity, youth will encounter concepts like natural resources, environmental science, biology and agriculture in the context of Mars exploration. Humans can't grow food directly in the Martian landscape as we do in farm fields or orchards on Earth because of how different Mars's environment is to ours. Youth will play a card game to learn about the items needed to grow food plants on Mars in an artificial growing environment. As they play the card game, they will race to earn all of the parts they need to make a complete agriculture module and be the first to grow food plants on Mars.

STEM Skills & Pillar Tie-In

STEM Skills:
Creativity
Critical Thinking Skills
Problem Solving (Strategy)

4-H Pillar Alignment:
Agriculture, STEM

Total Time Required: 30-60 min

Additional Materials:
Optional: name cards/tents and pencil for scorekeeping

Insight from Mars

In this activity, youth will use code to present an interesting thing they have discovered about Mars. By animating interactions between characters, changing the environment and adding sounds, movement and more, their stories will present Mars from their perspective and encourage interaction from the audience. This activity introduces youth to computer science using an activity from CS First, Google's free computer science curriculum, and Scratch, a block-based coding language developed by MIT.
Visit **4-H.org/InsightfromMars** to explore the *Insight* from Mars activity.

STEM Skills & Pillar Tie-In

STEM Skills:
Creativity
Inquiry Skills

4-H Pillar Alignment:
STEM

Total Time Required: 60-75 min

Additional Materials:
None

Landing Zone *Surveyor*

In this activity, you'll guide youth on a mission to learn about Mars's features that were discovered through previous NASA exploration. Working as a team, the group will attempt to complete their mission by safely reaching Mars before time runs out. In the Launch, Cruise and Approach Phase, youth will toss a parachute toy onto the map of Mars and figure out if they went into orbit, had a safe landing, or need to try again. Next, they will move on to the Discovery Phase, sharing information about their orbiter or landing site with the group. Finally, in the Reflection Phase, the group will consider which of their landing sites would be good places to potentially send a rover and/or people to.

Fun Fact

This activity's title is a tribute to the Mars Global Surveyor, NASA's mission to study the entire Martian surface, atmosphere and interior: mars.nasa.gov/mars-exploration/missions/mars-global-surveyor/

Goals, Objectives and Outcomes

By the end of the lesson, youth will:

Discover features of the surface of Mars that are important for:

- a safe landing;
- traveling around the landscape
- setting up a base camp.

Full Activity Time: 35 minutes

- Intro and opening questions: 5 minutes
- Activity: 20 minutes
- Reflection: 10 minutes

Materials

- 4 landing devices (parachute toy)
- Target Mars map with grid
- Landing site cards (16 total)
- 1 die
- 1 Youth Guide per youth

Not included in kit:

- Landing site marker (Post-It Notes, coins, or similar)

Important Vocabulary

Channel: A feature of the landscape formed by flowing liquid, such as water or lava.

Dune: A mound of sand formed by the wind, usually along the beach or in a desert, that grows as sand accumulates.

Fault: A fracture in a planet's crust that appears when large blocks of rock slowly move past each other. Earthquakes can occur when the movement is faster.

Ice cap: A glacier — a thick layer of ice and snow — that covers a large area and is typically found at the poles of a planet.

Impact crater: A large depression or hole in the ground that is formed when impactors such as meteorites smash into a moon or planet's surface.

Lander: A spacecraft that is designed to land on a celestial body (such as the moon or a planet) and stay in one place. Landers collect various scientific data through several instruments such as seismometers, temperature and pressure sensors, and cameras.

Lava flow: A stream of molten rock that pours or oozes.

Orbiter: A spacecraft designed to revolve around a celestial body and collect data using remote sensing without landing on its surface.

Remote sensing: Gathering information about an object or celestial body without making physical contact with it by using electromagnetic radiation.

Rover: A vehicle for exploring the surface of a planet or moon that typically collects information about the planet/moon's soil, rocks and any surface liquid.

Volcano: Openings in a planet's surface that release ash, gas and hot liquid rock (lava) in sometimes violent eruptions.

Steps

1. Designate a launch site (spot for youth to stand) and set up the Mars map 3-5 feet away. Younger children (age 8-10) will likely need it closer than older ones (11+).
2. Split youth into groups or pairs (depending on numbers). Kit materials are provided for four groups.
3. Read the Suggested Script section out loud to the group.
4. Engage the group by asking the Opening Questions.
5. Pass out one Landing Device to each group or pair.
6. Facilitate the Experience.
7. Facilitate the Reflection section at the end of the activity.

Tips for Engagement

Youth should feel a sense of ownership for the sites where they land. If they are not comfortable reading out loud, the facilitator can help them, but should hand the card over to the youth so that they can see and describe the pictures there.

Suggested Script

Have you ever seen a picture of Mars? Have you ever wondered how we got these pictures? NASA scientists have been exploring the surface of Mars since the Mariner 4 spacecraft captured the first close-up images in 1965. These images, taken by cameras on the spacecraft as it flew past the planet, revealed that Mars has craters that are similar to what we find on the Moon. Imagine how exciting it was for scientists to see those first pictures!

Since Mariner 4, many more missions have deepened our understanding of the rocks, weather and surface features on Mars. In fact, this activity is named for the Mars Global Surveyor, which launched in 1996. In addition to spacecraft that take pictures from the sky, NASA has also landed probes that sit on the surface of Mars and rovers that can move around.

Now is your chance to explore features of the red planet. In this activity you will try to get into orbit or land on the surface of Mars, find out if you had a safe landing, and learn something new about Mars and tell others. Let's see what we discover!

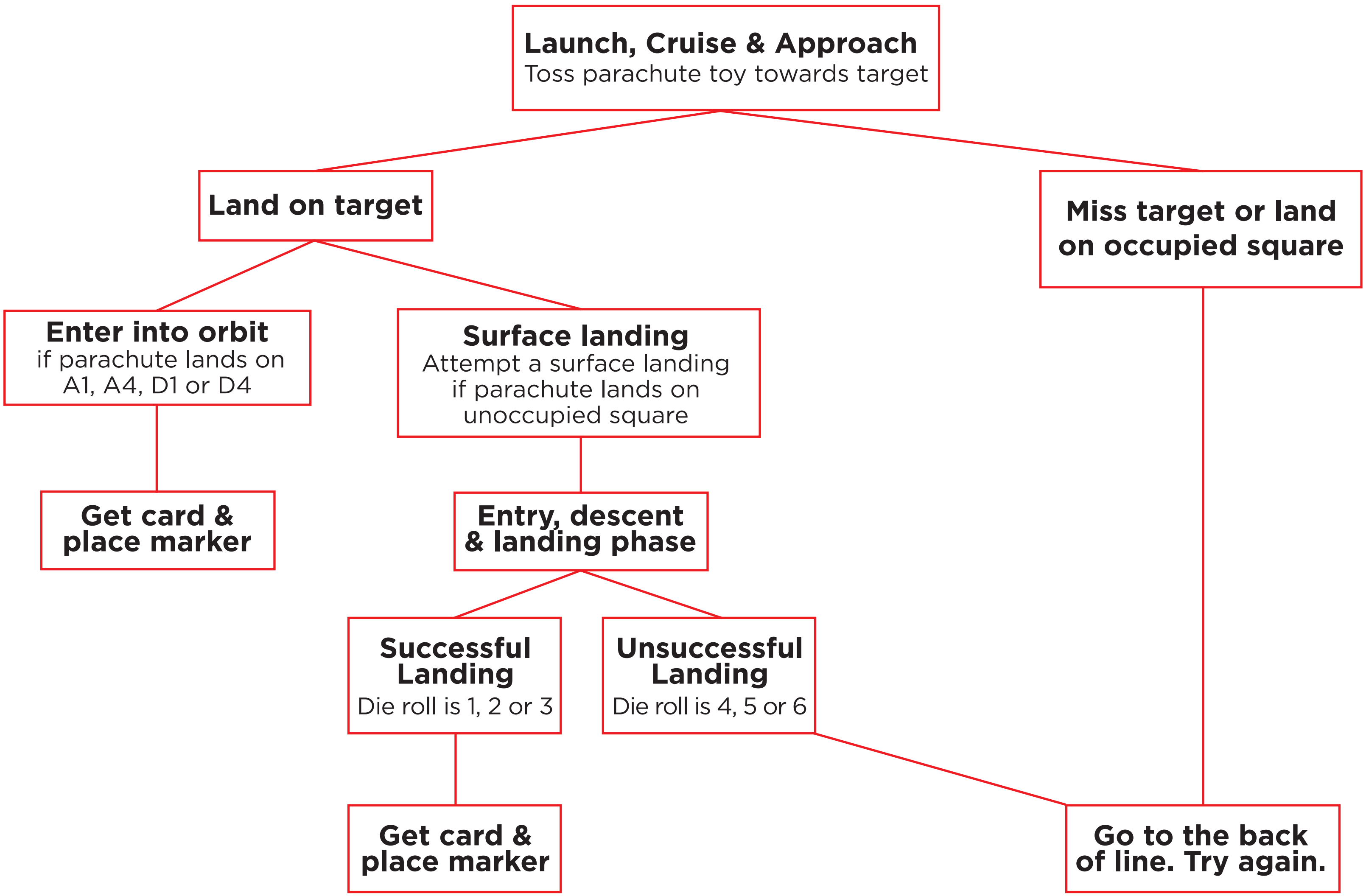
Opening Questions

Ask the group (take any answers):

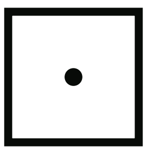
1. What are some things you have already learned about Mars?
2. What do you think the surface of Mars is like?
3. What are some things you wonder about the surface of Mars?

Experience: Explore Mars

Overview of Activity Sequence

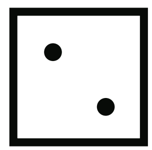


1. **Launch, Cruise and Approach Phase:** Each team/individual, in turn, will do the following:
   A. Launch landing device from launchpad towards Mars. Group will count down for them from T minus 3, 2, 1 - LAUNCH!
   B. If they miss the target (land off the map) or land where some-one has already landed they will go to the back of the line to try again. If they land on an empty site on the target, they will move to the next phase.
2. **Orbit or Entry, Descent and Landing Phase:** Each team that lands on the target will:
   A. determine if they went into orbit (A1, A4, D1 or D4) or are in the Surface Landing Zone (all other squares).
      i: Orbiter Sites: Get their card and place marker in orbit.
      ii: Surface Landing Zone Sites: Move on to step B.
   B. Roll the die.
   C. Keep going until all of the landing sites have been hit or time runs out (10 minutes)
   D. if some teams don't land on the target, point out that NASA missions are not always successful, but they can learn from their mistakes and use information from other missions to help them plan for next time. Teams that do not have a card can then look at the map and choose a site that is not taken. Give them the corresponding card and have them place the marker. All of the cards (16 total) should be distributed by the end of this phase. Smaller groups or younger youth who need more help reading may use fewer sites.
3. **Discovery Phase:**
   Each team shares information about their site from their cards:
   A. Everyone should be able to see the Mars map for this discussion.
   B. Have each youth (or group) read their card on their own (or with help from a facilitator or peer) to become familiar with their site. They can record information about their site in the Mars Scientist's Notebook in the Youth Guide.



WHAT HAPPENED?
Congratulations, you successfully launched and landed!

WHAT TO DO NEXT?
Get card and place marker on map.



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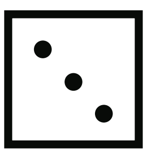
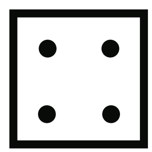


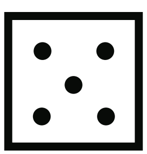
WHAT HAPPENED?
Congratulations, you successfully launched and landed!

WHAT TO DO NEXT?
Get card and place marker on map.



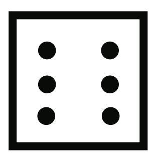
WHAT HAPPENED?
Sorry, you were hit by space debris and you crashed!

WHAT TO DO NEXT?
Go to the back of the line to try again.



WHAT HAPPENED?
Sorry, you landed upside down due to Martian winds and your rover is stuck!

WHAT TO DO NEXT?
Go to the back of the line to try again.



WHAT HAPPENED?
Sorry, your parachute did not deploy and you crashed!

WHAT TO DO NEXT?
Go to the back of the line to try again.

C. Ask the group to share information about their locations through the following series of questions. Encourage them to point out features on the Mars map and show the group the images on their card.

   i. Who went into orbit (four sites)? For each one, ask:
      1. What is the name of your orbiter?
      2. When did it go into orbit around Mars?
      3. Is it still there?

   ii. Who has a landing site with ice?
   What can you tell us about it? A3

   iii. Who has a landing site with a volcano?
   What can you tell us about it? C1

   iv. Who has a landing site with a channel?
   What can you tell us about it? B1, B2, C3

   v. Who has a landing site with a canyon?
   What can you tell us about it? D2

   vi. Who has a landing site with a crater?
   What can you tell us about it? B4, D3

   vii. Who has a landing site that might have a fault?
   What can you tell us about it? C2

   viii. Who has a landing site with dunes?
   What can you tell us about it? A2

   ix. Who has a landing site that is flat?
   What can you tell us about it? B3, C4

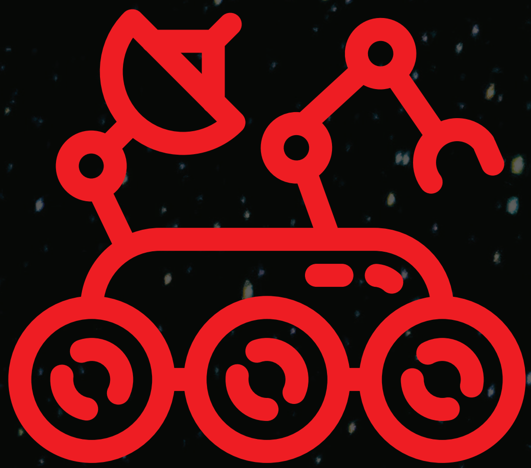
Reflection

Giving everyone a chance to reflect on what they have learned is an important part of the experiential learning process. For this activity, try a paired response technique. Have each pair discuss each question. You can also ask pairs to report back if you want to have a larger discussion.

1. **Share:** What are some things you noticed or learned about Mars through our activity?
2. **Share:** Were all of the landing sites the same? How were they similar or different? (Just like Earth, the planet Mars has different regions.)
3. **Reflect:** Why do you think some places are different? (Weather patterns make different features [old channels, dunes, ice caps]. In different places, tectonic forces have shaped the surface of Mars in different ways [lava flows, volcanoes, faults, visible craters].)
4. **Reflect:** Do we know the same amount of information about each of the landing sites? (No, we have more information if we have landed and collected different types of data.)
5. **Apply:** If you were planning the next mission to Mars, where do you think would be a good place to try to land a rover? Why did you choose that place? (Accept different reasons, such as, "It is interesting, I would want to learn more" and "It is flat, so a rover could easily drive over the terrain.")
6. **Apply:** Did you discover any places on Mars where you think it would be good for people to try to land? Why do you think that would be a good spot? (Similar to #5, accept different reasons. Guide them to think about what we would need to consider for people [ability to grow food, find shelter, etc.] that might be different from landing a rover.)

Add-Ons

1. Engineering Design: Groups can design and build their own launchers and landing devices from simple materials such as clothespins, popsicle sticks, foam board, rubber bands, etc.
   A. Instructions for building launchers can be found on the USB
   B. NASA JPL Make an Astronaut Lander project
   jpl.nasa.gov/edu/learn/project/make-an-astronaut-lander/
2. Mars Virtual Reality: Individuals or groups with access to technology can explore the surface of Mars using virtual reality interfaces.
   A. Access Mars: A WebVR Experiment (accessmars.withgoogle.com) allows users to explore the surface of Mars as captured by NASA's Curiosity Rover.
   B. Google Expeditions: Explore the surface of Mars through the eyes of the Mars Exploration Rover, Spirit, using Google Cardboard or Expedition goggles.
      i. Instructions on how to Find and Download Expeditions:
      support.google.com/edu/expeditions/answer/7271183?hl=en#
      ii. Expedition Title: Spirit: The Life of a Robot.



Red Planet *Odyssey*

In this activity, you'll introduce youth to the concepts of the engineering design process through building a rover and going on an exploratory mission on Mars. The activity focuses on using the engineering design process for both building and exploring!

Fun Fact

This activity's title pays tribute to the Odyssey Orbiter, NASA's longest-lasting spacecraft orbiting around Mars, which launched in 2001 and is still orbiting today: mars.nasa.gov/odyssey. Even though the activity is named after Odyssey, you will notice references to other relevant missions throughout the activity!

Goals, Objectives and Outcomes

By the end of the lesson, youth will be able to:

- Use the steps of the engineering design process to solve a problem.

Full Activity Time: 45 minutes

- Intro and opening questions: 5 minutes
- Activity: 30 minutes
- Reflection: 10 minutes

Materials

- 3 rover kits (4 wheels, 2 axles, 1 battery pack, 1 motor, 2 gears, 4 screws, 1 plastic baseboard per kit)
- 1 Youth Guide per youth
- 1 Mars map

Not included in the kit:

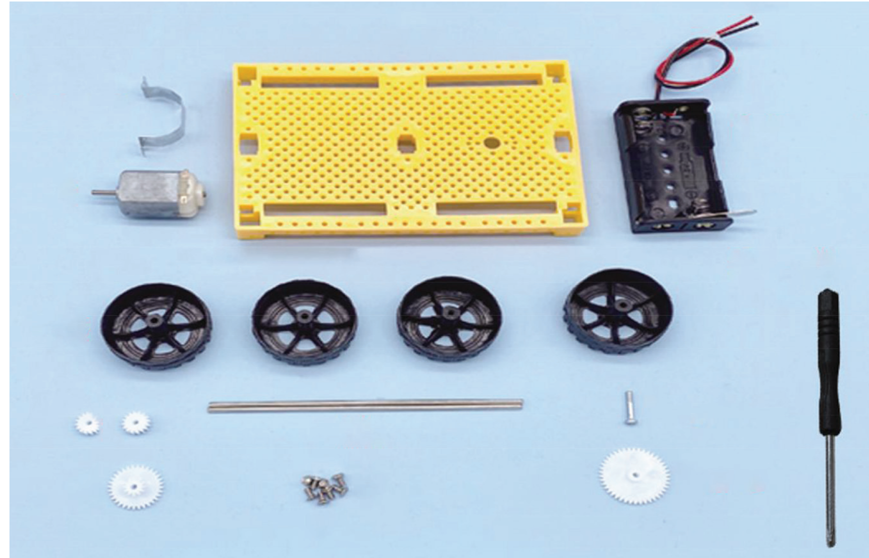
- 1 pencil per group
- Items to build an obstacle course (cones, books, boxes, paper, cardstock, etc.)
- 6 AA batteries
- Tape (masking preferred)

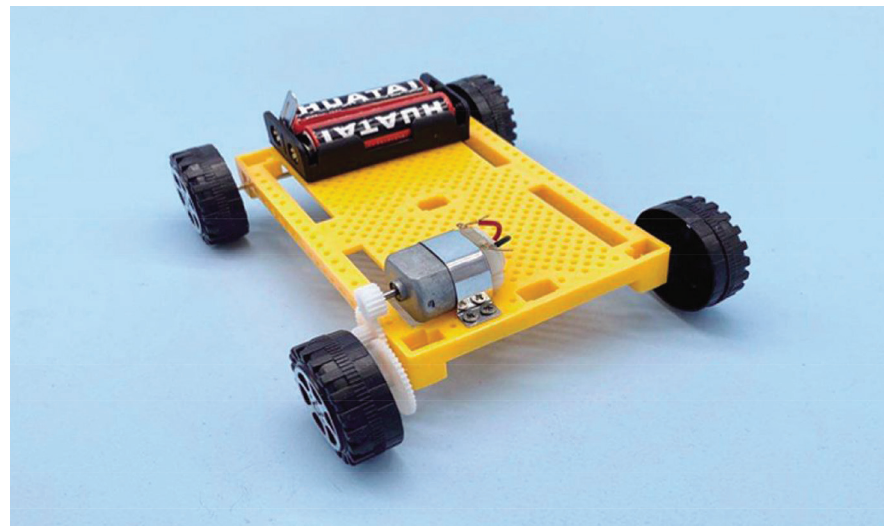
Important Vocabulary

Design: To create a solution to a problem.

Navigation: The process of accurately determining one's position, planning a route, and following that route.

Pathway: A guide that can be followed to get from one point to the next.





Steps

1. Collect items to use for the obstacle course.
2. Break the group into teams of 3-4.
3. Read the Suggested Script section out loud to the group.
4. Engage the group by asking the Opening Questions.
5. Facilitate the Experience.
6. Facilitate the Reflection section at the end of the activity.

Tips for Engagement

1. Even though the rover comes as a complete kit, let youth think about how they can make changes or design theirs differently. Older youth can also brainstorm other supplies they might want to use for their rover (rubber bands, tape, straws, craft sticks, etc.).
2. When preparing to explore the red planet, use the map included in the kit to create a Mars surface for your teams. Designate a place to start (example A1) and where to end (example D4). The easiest way to do this is by using tape labeled with "start" and "finish" at each area.
3. Set out an obstacle course that the rover can go through. This can be simple at first and you can add more items or obstacles as you continue. You can include just two or three items in the grid squares to make the obstacle course initially.
4. Use items in the room to create these obstacles. These could be clothespins, the kit box, a book, binder clips, etc.
5. If you use the planetary scale map, it is important to emphasize that the scale is way off. Driving this rover across the whole planet would be like having a rover the size of the United States driving over the Earth!

Suggested Script

NASA has been exploring Mars since 1964 through missions that fly past the planet, orbit it, land on it, or explore the surface with a rover. This activity is named for the Odyssey mission, an orbiter that has been taking measurements of Mars for 18 years. Part of NASA's Mars Science Laboratory mission is Curiosity, a rover mission after which another Mars Base Camp activity is named. Curiosity is the largest and most capable rover ever sent to Mars. It launched on November 26, 2011 and landed on Mars 254 days later. Curiosity set out to answer this question: Did Mars ever have the right environmental conditions to support small lifeforms called microbes? Early in its mission, Curiosity's scientific tools found chemical and mineral evidence of past habitable environments on Mars. It continues to explore the rock record from a time when Mars could have been home to microbial life (**mars.nasa.gov/msl/home**).

Why the Engineering Design Process?

The Engineering Design Process doesn't just teach youth how to assemble a rover or explain what it takes to grow food on Mars, it teaches them how to solve problems. NASA engineers ask questions; imagine solutions; design, create and test models; and then make improvements.

The Engineering Design Process is a cycle — the steps can be done multiple times as engineers improve solutions and get closer to their goal. Not every step needs to be completed each time. These steps all contribute to mission success:

Ask: Identify the problem, the requirements that must be met and the constraints that must be considered.

Imagine: Brainstorm solutions and research ideas, including identifying what others have done.

Plan: Choose two to three of the best ideas from the brainstormed list and sketch possible designs, ultimately choosing a single design to prototype.

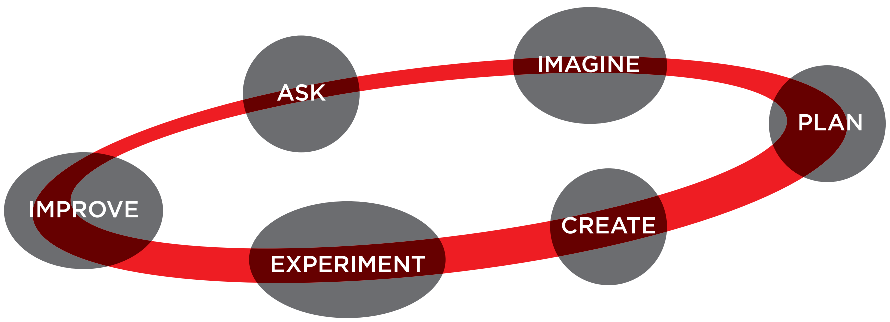
Create: Build a working model, or prototype, that aligns with the design requirements and lies within the design constraints.

Test: Evaluate the solution through testing, collecting and analyzing data, and summarizing the strengths and weaknesses of the design that were revealed during testing.

Improve: Based on the results of the tests, make improvements on the design, identify changes to make, and justify the revisions.

Engineering Design Process

https://www.nasa.gov/audience/foreducators/best/edp.html



Mission Brief

As a team, you need to build a rover that will navigate the surface of Mars. The surface can be uneven and you may encounter obstacles like hills or craters. Look through the Landing Zone *Surveyor* cards to familiarize yourself with some of the terrain that you might see. You will need to design a rover that can withstand some bumps and jarring. Once your rover is built, you will create a physical pathway that will be your "guide path" for the rover to get from start to finish on Mars!

Opening Questions

1. What is the purpose of a rover?
2. Why would we want to explore Mars?
3. What different issues might we have when exploring Mars with a rover?

Experience: Build and Explore

Build

1. Distribute the rover kits to the group.
2. The teams will be using the engineering design process that is available in the Youth Guide and here for your reference. Have youth follow the assembly instructions included with the rover kit to complete their rovers.

Explore

Ask your teams to take a moment to look at the course. They should then discuss within their groups the best way to get their rovers from start to finish while avoiding any unsafe areas on the Martian surface. Use the information below to help them complete this process:

1. As a group, observe the Martian terrain that you will need to navigate. Work together to make notes of areas that you will need to consider for your rover.
2. Talk amongst the group to create a plan for how your rover will get from the starting point to the final destination that you marked on the map.
3. Use materials available to you to create a path for your rover to direct it from Start to Finish. These rovers do not have sensors, so in order to guide them you will need to use objects. Once you put your rover down, you will not be able to touch it. You will use items like cups and straws to guide the rover. Think of these like a fence or a guard rail that directs the rover around the obstacles and to its final destination.
4. Once your path is set, you can put the rover into place.
5. If the rover doesn't work the first time, take it out, redesign your path and try again.

Reflection

Giving everyone a chance to reflect on what they have learned is an important part of the experiential learning process. For this activity, try a team answer approach. Keep teams together and have them discuss the questions as a group before sharing their summary with the entire group.

1. **Share:** Does your rover look like the sketch that you drew? What changes did you make, if any?
2. **Share:** How did your rover navigate Mars? Did you have to change your path? If so, how?
3. **Reflect:** How did your team use the engineering design process in both building the rover and exploring Mars?
4. **Reflect:** What do those controlling the rover need to consider about the Mars surface to be successful?
5. **Apply:** What different careers do you think are important when we think of space exploration on the Martian surface?
6. **Apply:** What skills do you think are important when NASA is planning a rover mission to Mars?

Going Further Activity

Focusing on Computational Thinking while Discovering Mars.

Computational Thinking (CT) is a problem-solving process that includes a number of characteristics and dispositions, and is the process that most computer scientists use to develop programs and systems. The dispositions are listed below:

- Confidence in dealing with complexity.
- Persistence in working with difficult problems.
- The ability to handle ambiguity.
- The ability to deal with open-ended problems.
- Setting aside differences to work with others to achieve a common goal or solution.
- Knowing one's strength and weaknesses when working with others.

The basic skills of computer scientists and the way they think are computational thinking, however, any subject area or topic can utilize CT. CT is essential to the development of computer applications, but it can also be used to support problem solving across all disciplines, including the humanities, math and science.

CONCEPTS	APPROACHES
Logic: predicting & analyzing	**Tinkering:** experimenting & playing
Algorithms: making steps & rules	**Creating:** designing & making
Decomposition: breaking down into parts	**Debugging:** finding & fixing errors
Patterns: spotting & using similarities	**Preserving:** keeping going
Abstraction: removing unnecessary details	**Collaborating:** working together
Evaluation: making judgment	

Computational Practices

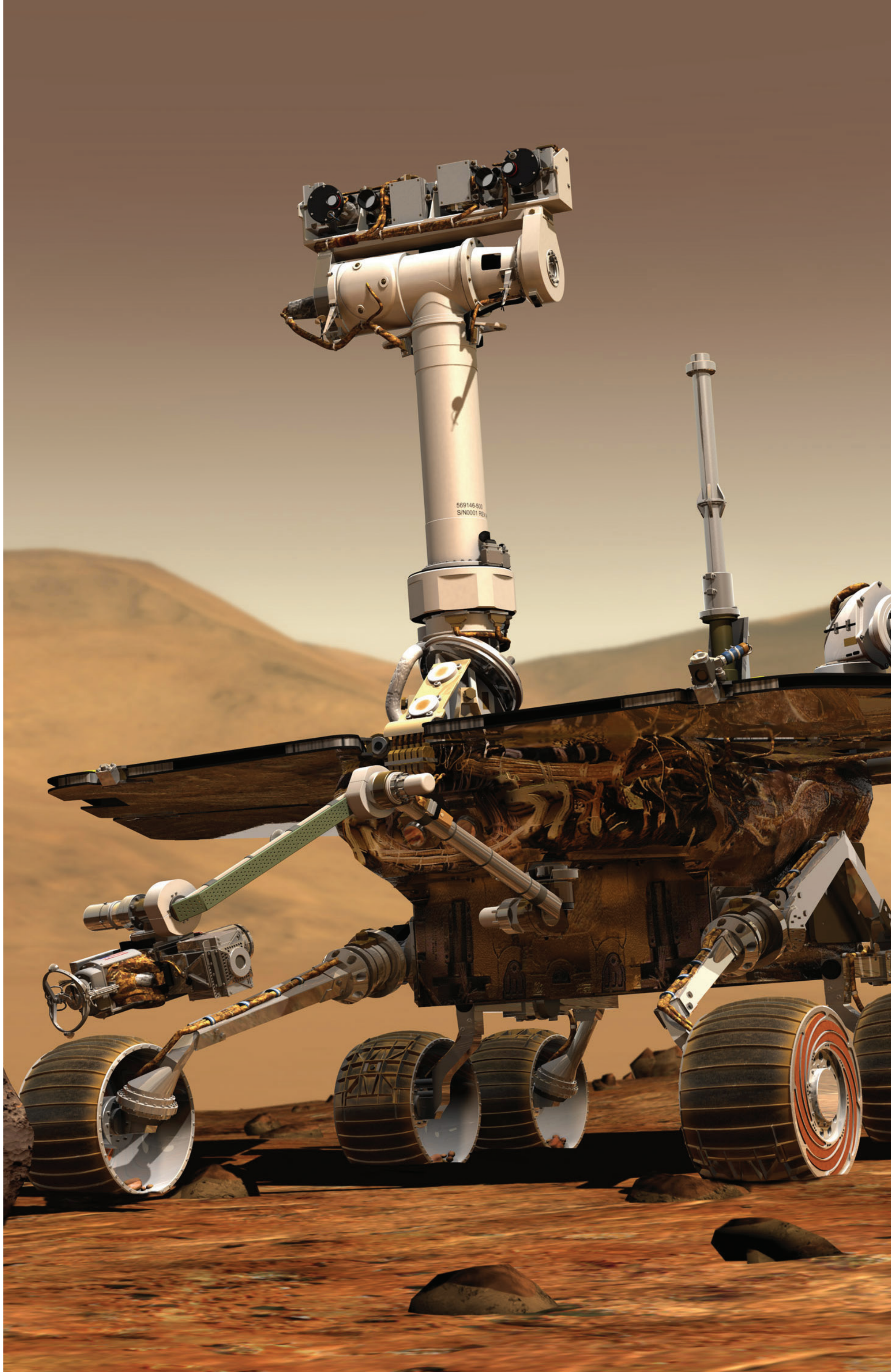
- Experimenting and Iterating - Developing a little bit, then trying it out, then developing more.
- Testing and Debugging - Making sure things work and finding and solving problems when they arise.
- Reusing and Remixing - Making something by building on existing projects or ideas.
- Abstracting and Modularizing - Exploring connections between the whole and the parts.

Using Computational Practices for this activity:

There are many different ways you could do computational thinking practices through this activity, but here are few add-on suggestions that you can use to talk about computational thinking and computer science.

Experimenting and Iterating: Have youth build one section of the path for the rover. Let them try it out and note what worked and what did not work. Have them use that information to continue to build the path section by section, trying out each section and the whole course (so far) as they go.

1. **Testing and Debugging:** Have youth test their rover build. Does it do everything it is supposed to do? (Travel in a straight line, respond correctly when encountering obstacles, etc.) If it doesn't, what is the cause of the problem? Debug your design and build to find the issue. This is similar to debugging a computer program. We need to find the specific component that is not working (it could be one component of your rover or one line of code in a program).
2. **Reusing and Remixing:** Have groups each design a small part of the obstacle course separately, and then combine them into one course. Have them discuss how the parts can fit together.
3. **Abstracting and Modularizing:** Much like LEGO™ bricks fit together with any other brick, how can they build their course pieces from part 3 so they can fit with pieces designed by other groups? (They could make each piece a single "obstacle," and together they combine to be an obstacle "course.")



Crop Curiosity!

In this activity, youth will encounter concepts in environmental science, biology and agriculture in the context of Mars exploration. The current environment of Mars is more similar to Earth than other planets in our solar system, but it is not similar enough to meet the survival requirements for humans, plants or animals from Earth without life support systems. For this reason, humans cannot grow food such as fruits and vegetables directly in the Martian landscape as we do with farm fields or orchards on Earth. Youth will play a card game to learn about the items needed to grow food plants on Mars in an artificial "agriculture module" environment. As they play the card game, they will race to earn all of the parts they need to make a complete agriculture module to be the first to grow food plants in space.

Fun Fact

This activity's title pays tribute to the Mars Curiosity Rover, the largest and most capable rover ever sent to Mars: mars.nasa.gov/msl/

Goals, Objectives and Outcomes

By the end of the lesson, youth will be able to:

- compare and contrast the environmental differences between Earth and Mars;
- understand the conditions required for plant growth or agriculture on Mars;
- describe some natural disasters or things that could potentially go wrong during a mission to Mars;
- find the best strategy to win the game (if playing the strategy game version); and
- understand human nutritional requirements and how plants capable of growing on Mars may sustain human life.

Full Activity Time: 30-60 Minutes

Intro and opening questions: 5 minutes
Activity: 15-45 minutes (rules can be modified to shorten/lengthen game)
Reflection: 10 minutes

Materials

For team gameplay (each set of four players) OR one-on-one gameplay (each set of two players):

- 1 Crop *Curiosity* playing card set (108 cards)
- 2 Module Cards
- 20 Marker Chips
- 1 Youth Guide per youth
- Score sheet (in Youth Guide) if playing for points or playing the strategy game using points and module card completion (optional)

Not included in the kit:

- Name cards/tents with a team name on each (to allow youth to pick a team name and keep track of who is on each team when playing in groups of four) (optional).
- Pencil for scorekeeping (optional).

Important Vocabulary

Agriculture: The science, art or practice of cultivating soil, producing crops and raising livestock.

Amino acid: The chief components of proteins, which can be created by living cells or obtained as essential components of the diet.

Anchorage: Something that provides a secure hold, like a trellis or container.

Atmosphere: The whole mass of air surrounding the Earth or other planets.

Biomass: Living matter or plant materials/animal waste, used especially as a source of fuel.

Component: A part of a whole, an ingredient or a piece of something else.

Disaster: A sudden event bringing great damage, loss or destruction.

Fertilizer: A substance (such as manure or a chemical mixture) used to make soil more rich with nutrients that help plants grow.

Growth medium: Surrounding substance necessary to help plants grow (generally soil, may also be nutrient-enriched water in hydroponic systems).

Module: An independent part of the total structure of a space vehicle or space station.

Moisture: Liquid diffused or condensed in relatively small quantities (such as water droplets).

pH: A measure of acidity and alkalinity of a solution — a value of 7 is neutral, 0 is very acidic and 14 is very alkaline.

Protein: Long chains of amino acids that are essential to all living organisms, especially as building blocks of things like body tissue (for example muscles or hair), enzymes (like those that help us digest food) or antibodies (which help us fight disease).

Radiation: Energy transmitted in the form of waves or particles.

Sabotage: An act or process tending to hamper or hurt progress.

Temperature: Degree of hotness or coldness measured on a definite scale.

Thermostat: An automatic device for regulating temperature.

Trellis: A frame used as a screen or as a support for climbing plants.

Steps

- Read the Suggested Script section out loud to the group.
- Engage the group by asking the Opening Questions and allow time for youth to explore the Mars vs. Earth fact sheets.
- Review the game instructions and rules as a group.
- Play the game!
- Facilitate the Reflection section when teams have finished playing or if time runs out

Tips for Engagement

- Card games are often best taught by learning from others instead of referring to written instructions. Facilitators should review photos and videos of example gameplay and set-up at **4-H.org/STEMChallenge**.
- If there is an odd number of youth, one can be designated as the rule enforcer/scorekeeper instead of actively playing the game. This role can be swapped among youth during multiple games.
- Shorter/simplified gameplay:
  - Set a time limit and direct youth to collect as much of the agriculture module as possible before time runs out. If teams have an equal number of components on the module card, decide the winner by high card draw using the card point values.
  - If playing with only two players for module card completion only (no points), the game can be sped up by removing two of the sabotage cards.
  - The limit on the number of wild cards used at a time may be omitted to speed up the game, if necessary. Some wild cards may also be removed to slow down game play, if desired.
- See the Quick Start Guide in the Youth Guide for a shorter reference regarding gameplay/rules.

Suggested Script

It appears that the Martian environment used to be much more like Earth than it is now. Plants on Earth have adapted to survive within a range of temperature, pH, moisture, light and atmospheric conditions. The Earth's ozone layer serves as an important barrier to protect plants from the sun's radiation. Plant growth is also influenced by Earth's gravitational pull, which is different than on Mars. Mars might have been capable of supporting life at one time, but the environment has changed dramatically over the millenia, and we have not been able to find evidence of current life forms. Mars rover missions continue to search for evidence of past or present microbial life.

Humans need specific environmental conditions and resources to survive as well. If you look at the Mars vs. Earth fact sheet in your Youth Guides, you will notice that several of the environmental conditions on Mars will not support plant or human life. By providing artificial life support systems on Mars, conditions can be controlled to sustain plants that could then serve as important food, oxygen and energy (biomass) sources for human survival. In a way, greenhouses and hydroponic systems (plants grown in water/media instead of soil) found on Earth are forms of artificial life support systems. Greenhouses control temperature, moisture and air movement, as well as protect plants from pests, while hydroponic systems eliminate the need for soil while controlling for moisture, anchorage and nutrition. Let's explore what environmental conditions you would need to change on Mars to be able to grow plants.

Opening Questions

Humans live on Earth and depend on its resources for survival.

1. What are some of the things humans need to survive? Think about what you use or do every day.
2. Like humans, plants also depend on certain resources for survival. Can you think of some items plants need to live and grow? Or, if you have grown plants in the past, what did you do?
3. There are some important differences between the environment and resources of Mars compared to Earth. Do you know what some of the differences are? (After youth attempt to answer this, review the Mars vs. Earth fact sheet in the Youth Guide with them.)
4. Think about where your fruits and vegetables come from on Earth. Do you think you could grow plants for food on Mars like we do on Earth? Why or why not? Which of them would you try to grow on Mars first and why?
5. If your mission is to grow food for yourself on Mars, what items would you pack on your spacecraft to help you complete your mission?

Experience: Learn by Playing

This activity includes a modified version of the playing card game Canasta, (a Rummy-type game). The object of the game is to collect the components necessary to build an agriculture module capable of sustaining plant life and producing food plants for a space station on Mars. There are 10 components of the module to earn. You earn them by collecting three of each type of component card. At the end of the game, the team with the most points or module components will have successfully arrived on Mars, completed their mission to construct an agriculture module, and won the race to be the first to grow food on Mars!

Gameplay Rules and Instructions

The agriculture module card/marker chip pieces:

- Grow lights
- Growth medium
- Containers
- Soil test kit
- Thermostat
- Atmosphere generator
- Water
- Fertilizer
- Trellis
- Plant seeds

The playing card deck consists of:

- 20 wild cards: Can be used with any other component cards in a meld (three-of-a-kind). Cannot be used as disaster or sabotage cards. (20 points)
- 4 disaster cards: The next player cannot pick up the discard pile when this card is placed on top, or this may be played for points. (5 points)
- 4 sabotage cards: Opposing team's/player's module is disrupted and they lose a module component when this card is placed on the discard pile, or this may be played for points. (100 points)
- 8 grow lights cards: For plants to grow and make food for themselves. (5 points)
- 8 growth medium cards: For plants to grow in (soil, or water in hydroponics). (5 points)
- 8 container cards: To hold plants. (5 points)
- 8 soil test kit cards: To check the nutritional status of soil or growth medium. (5 points)
- 8 thermostat cards: For temperature control. (10 points)
- 8 atmosphere generator cards: For carbon dioxide and oxygen so plants can breathe and grow. (10 points)
- 8 water cards: For plant hydration, growth and the ability to make food through photosynthesis. (10 points)

- 8 fertilizer cards: Plant nutrients to supplement soil/growth medium. (10 points)
- 8 trellis cards: For plant support/anchorage. (10 points)
- 8 plant seeds cards: To grow different types of food plants/vegetables. (10 points)

Starting the game

1. Choose a scorekeeper (if applicable) and a dealer before the first hand begins.
2. Teammates should sit across from each other if playing in teams, or opponents should sit across from each other if playing one-on-one. If playing in teams, one player on each team should keep track of the cards played on the table, and the other will keep track of the module card.
3. Choose your preferred style of play before the game starts:
   - A. Module completion: Win by collecting all ten components on the module card.
   - B. Points: The winner reaches 2,000 points first (players still collect module card components, but the first to 2,000 points earns all the remaining components needed).
   - C. Strategy: The winner is either the first to collect all of the module card components or reach 2,000 points (therefore earning all remaining module card components).
4. Dealers rotate in a clockwise fashion. Deal everyone 11 cards facedown. No one should see the cards in another player's hand. Place the rest of the cards facedown in the middle of the table to form the "stockpile." The top card in the stockpile is placed face up next to the stockpile to start the "discard" pile.

Gameplay

1. The object of the game is to make "melds" of at least three of the same card (three-of-a-kind). Players place melds on the table during their turn and collect the corresponding module component by placing a marker chip on their scorecard in that space. For example, to get the plant seeds module component, a player must place a group of three plant seed cards on the table. Points are also accumulated by obtaining melds (exceptions for disaster/sabotage cards, see page 29).
2. During a turn, players must do three things:
   - A. Draw a card from the stockpile or pick up the entire discard pile if at least one card in their hand matches the card on top.
   - B. Lay down melds of three or more cards (which can include up to two wild cards). Players can play as many melds as they have, or wait until later turns to play them. Players can also lay down disaster/sabotage cards for points (see below).
   - C. Discard one card. If a disaster or sabotage card is placed on the discard pile, there are associated consequences for the opposing team (see disaster/sabotage).
3. Teammates may add to melds already placed on the table to accumulate points (by adding a card of the same type or a wild card). If a meld accumulates seven cards, the player/team has a "Canasta" (see Canasta).
4. Players will attempt to "go out" by playing and/or discarding all of their cards. If any player goes out, write down the total score of the cards on the table for each player/team, minus the cards still in their hand. A new hand/deal will begin. If the stockpile runs out before any player goes out, the hand ends, scores are tallied, and a new hand begins by shuffling and dealing. Player/team keep their module components between hands.
5. The game ends when a player/team completes the module or earns 2,000 points, as decided at the beginning of the game.

Wild cards: May be used with any module component card. However, only two wild cards may be used in a single meld. Cannot be used as a disaster or sabotage card.

Canasta: A player has a "Canasta" when they accumulate seven of the same card (including wild cards). A player or team with a Canasta chooses one of the following immediately:

1. Steal a module component from the opposing team. The stolen marker must be placed on the same type of module component, then shuffle all seven Canasta cards back into the stockpile.

You will not receive the points from the cards.

2. Collect a module component chip to be used on any needed component.

3. Pick up the discard pile.

4. Receive a 500 point bonus.

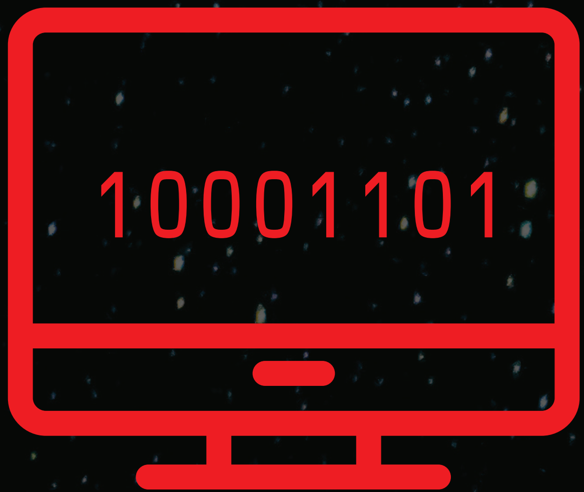
If a player chooses options two, three or four, they must stack their seven Canasta cards to indicate that it has already been used.

Disaster/sabotage cards: When a disaster card is placed on the discard pile, the next player cannot pick up the discard pile (they must draw from the stockpile). If a sabotage card is used on the discard pile, the team playing the sabotage card can pick which part of the module the opposing team will lose, but they will not be able to keep it (the chip is removed from the module card and not claimed by either team). The sabotaged team keeps the points associated with the piece lost (if playing for points). Players can instead use their disaster or sabotage cards for points by laying them down on the table (melds of three are not required).

Reflection

Giving everyone a chance to reflect on what they have learned is an important part of the experiential learning process. For this activity, try a paired response technique. Have each pair discuss each question. You can also ask pairs to report back if you want to have a larger discussion.

- **Share:** What did you need to build an agriculture module and grow plants on Mars? Why?
- **Share:** How did you feel when the other team "stole" the components of your agriculture module, or if they used disaster/sabotage cards? How did the other team feel? (Empathy/concern for others.)
- **Reflect:** Instead of "stealing" the needed parts from the other team or sabotaging, what is a different strategy to build the module quickly so everyone could benefit from it? (Emphasize teamwork and cooperation with others.)
- **Reflect:** What are some of the natural disasters that can occur on Mars (what did you see on the disaster cards)? What are some of the plants you saw on the plant seed cards? If that was all you could eat, how would you feel about it? Would that have enough nutrition?
- **Apply:** What are some of the things you need to grow food on Mars if you wanted to have your favorite foods? This can include animals or plants.
- **Apply:** How can we (and more importantly NASA) use what we know about agriculture on Earth to explore agriculture on Mars?



Insight from Mars

Insight from Mars is an introductory coding activity that teaches youth how to use code as they present an interesting thing they have discovered on Mars. The activities in Mars Base Camp help youth imagine that they are the first human explorers on the red planet. In *Insight* to Mars they will think about allof the interesting things they might see and learn on the surface of Mars, before coding an imaginative story using Scratch, a block-based coding language developed by MIT. This story will teach their friends and family back on Earth about their discovery. This activity can be completed online or offline, but both options require access to a computer.

Fun Fact

This activity's title pays tribute to Mars InSight, the first ever mission dedicated to studying Mars's deep interior: mars.nasa.gov/insight/

Goals, Objectives and Outcomes

Insight from Mars will help youth get comfortable with coding. Scratch is an introductory coding language designed to get youth creating, having fun and feeling confident about their coding skills quickly. With just a few blocks and clicks, they can make a "sprite" (character) dance, talk or come to life in endless ways. Additionally, the computer science concepts used in Scratch can be applied to other advanced programming languages, like Python or Java.

By the end of this activity, youth will:

- be familiar with the Scratch block-based programming language;
- have learned important computer science concepts, like events, sequencing, conditionals and loops; and
- have created an animation project in Scratch.

Full Activity Time: 60-75 minutes

Opening questions: 5 minutes
Activity: 45-60 minutes
Reflection: 10 minutes

Materials

Headphones (recommended but not required)

Online Version Materials

- Computer with internet access (recommend 1 per student or group of 2-3)
- Facilitator Guide
- Activity page: **4-H.org/InsightfromMars**

Offline Version Materials

- Offline version of Scratch (located on USB drive)
- Computer(s) with Scratch desktop installed, 1 per student or group of 2-3
- Scratch Coding Cards

Important Vocabulary

Code: A sequence of instructions computer scientists use to tell a computer what to do.

Conditional: A type of statement that tells you what to do based on the answer to a question, usually shown in programming languages with words like "if," "then" and "else." For example, conditionals could be used to specify different actions within a game: If tagged, then you are "it."

Event: Something that causes an action. For example, doing something when a key is pressed or when a message is sent from one part of a computer to another. Youth could change the color of a sprite or the size of a letter by using an event to initiate the action.

Sequencing: Putting instructions in an order that accomplishes a goal. When writing code, it's important to carefully decide the order in which the instructions will run. For example, youth may create a conversation between two sprites by specifying which sprite speaks first and when the other responds.

Loops: A way to repeat one or more instructions. For example, youth may change how long an object moves around the screen or bounces up and down by specifying how many times to loop.

Steps

Follow the setup instructions to get your devices ready to go. Once you and your youth are ready, read the Suggested Script aloud and present an example project **4-H.org/InsightfromMars**.

- Engage the group by asking the Opening Questions.
- Facilitate the Experience section using Scratch.
- Facilitate the Reflection section.
- Have youth share their projects with a neighbor or do a gallery walk.

Set Up Instructions

1. Decide if you will be using the online or offline version for this activity. We recommend using the online version unless bandwidth or internet access are issues for you.

   If you're using the online version, go to point 3

2. If you're using the offline version, download the Scratch offline editor from **scratch.mit.edu/download** (or your USB drive).

3. Visit **4-H.org/InsightfromMars** to familiarize yourself with the project.

4. Review the Tips for Engagement section, then follow the Suggested Script.

Tips for Engagement

Before the activity

- Don't have a computer or headphones for each student? Here are some ways you can still use Scratch:
  - Pair or group youth: Assign one student as the "driver" who controls the computer and one as the "instructor" who describes what to do. Switch roles every five minutes.
  - Whole class: Project the activity and videos on a screen where all youth can see. After watching the Introduction video, have the class suggest how you might build the project in Scratch.
  - Station rotation: If you have a computer station in your classroom or club space, allow youth to rotate to the computers to complete the activity. For the rest of the youth, consider using the un-plugged activities in this guide.

- Internet connectivity issues? If you experience issues with connectivity (either unexpected or regularly), use the offline version of the activity. You can also consider downloading the Scratch Offline Editor **(scratch.mit.edu/download)** on each computer.

During the activity

- Leverage the expertise of your students. Instead of answering student questions directly, open it up to the class to see if others have suggestions, solutions or a workaround.
- Pass out Scratch cards to help youth who get stuck.

Guiding questions during the activity

- Can you show me what you've created so far?
- What blocks are you using?
- What did you learn from the coding challenge?
- How would you explain the code in your project to a younger student or sibling?

Prompts to encourage sharing and troubleshooting

- What's something else that you could potentially do to this sprite or object?
- If I changed [choose a value or block] to [choose another value or block], what do you think would happen? Let's test that hypothesis. What happened?

Suggested Script

In this activity, you will use code to create an animated story about something exciting you have discovered on the surface of Mars. When astronauts travel to space, they communicate every day with mission control at NASA. They report everything from what they eat to things they are monitoring on their space shuttle and in space. NASA has conducted several missions to Mars using orbiters that take measurements as they fly by the planet, landers that survey and carry instruments to the surface, and rovers that explore areas beyond. Every mission transmits information back to scientists on Earth so that we can learn more about Mars, but no human has yet traveled to the red planet.

This is your opportunity to imagine that you are the first human explorers on Mars. As you prepare to animate your story, think about the kinds of objects, landscapes or features you might discover on Mars. Imagine what questions your friends and family on Earth would ask you about your discovery. To build your story you will use an activity created in CS First called *Insight from Mars*, and you will use the programming language, Scratch, to animate your story. When you program, or code, you provide instructions for the computer to follow. Many programmers write code in text, meaning that they type it out on the keyboard. With the Scratch language, you code using blocks that snap together like puzzle pieces.

Opening Questions

- Who are some of the people astronauts in space communicate with on a regular basis? (Other scientists, friends and family.)
- What types of things do you think astronauts share about their missions in space? (Scientific measurements, what they ate, what they saw/experienced.)
- Why is it important to communicate back to Earth when we are in outer space?

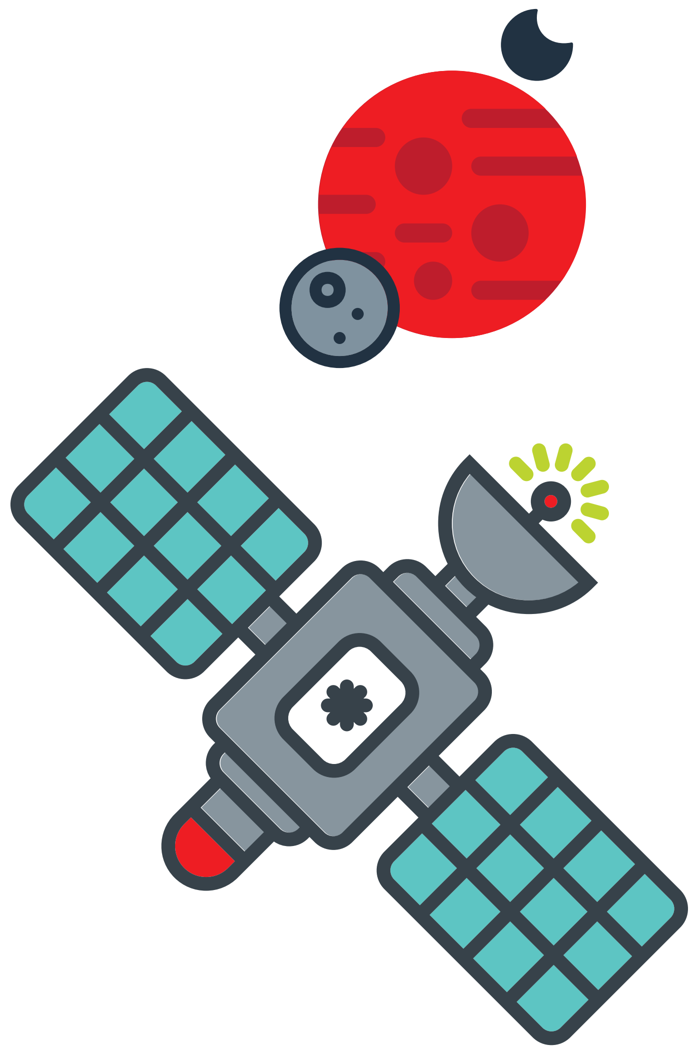
Experience: Let's code!

1. Go to **4-H.org/InsightfromMars** to access the activity.
2. Project the introduction video or have students watch it.
3. At the conclusion of the introduction video, youth should open the Scratch starter project in a new tab to begin their stories.
4. Use the Scratch cards for help with the coding challenges.

Reflection

Giving everyone a chance to reflect on what they have learned is an important part of the experiential learning process. For this activity, try a Graffiti Think Tank. You can use a large sheet of poster paper and markers, and, in teams, youth can write down the first word/words that come to their mind when considering the prompt. This is a way to give all youth a chance to answer, especially those who struggle with public speaking.

1. **Share:** What was your unusual discovery on Mars?
2. **Share:** If you had more time, what would you add to your project? How would you do it?
3. **Reflect:** What did you learn about coding?
4. **Reflect:** What was the most challenging part of this activity?
5. **Apply:** What are some ways that we can communicate over a distance? Why is this important?
6. **Apply:** What are some other ways we can use computer science and computational thinking to "tell a story"?



Educational Standards

Educational Standards:

Next Generation Science Standards (NGSS) Science and Engineering Practices

Using mathematics and computational thinking:

- **Elementary 3-5:** Organize simple data sets to reveal patterns that suggest relationships.
- **Middle School 6-8:** Create algorithms (a series of ordered steps) to solve a problem.

Engineering Design:

- **Elementary 3-5:** Define a simple design problem reflecting a need or want that includes specified criteria for success, as well as constraints on materials, time or cost.
- **Elementary 3-5:** 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.
- **Elementary 3-5:** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- **Middle School 6-8:** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- **Middle School 6-8:** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- **Middle School 6-8:** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each, which can be combined into a new solution to better meet the criteria for success.
- **Middle School 6-8:** Develop a model to generate data for iterative testing and modification of a proposed object, tool or process, such that an optimal design can be achieved.

CSTA Computer Science Standards:

- **1B-AP-09 3-5:** Create programs that use variables to store and modify data.
- **1B-AP-10 3-5:** Create programs that include sequences, events, loops and conditionals.
- **1B-AP-11 3-5:** Decompose (break down) problems into smaller, manage-able subproblems to facilitate the program development process.
- **1B-AP-12 3-5:** Modify, remix or incorporate portions of an existing program into one's own work to develop something new or add more advanced features.
- **2-AP-12 6-8:** Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.
- **2-AP-17 6-8:** Systematically test and refine programs using a range of test cases.

NGSS Earth and Space Science:

- **MS-ESS3-1:** Humans depend on Earth's land, ocean, atmosphere and biosphere for many different resources. Minerals, fresh water and bio-sphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

- **MS-ESS2-6:** Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.

NGSS Life Science:

- **MS-LS1-5:** Genetic factors as well as local conditions affect the growth of the adult plant.
- **MS-LS1-6:** Energy in chemical processes and everyday life. The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen.
- **MS-LS1-7:** Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.
- **MS-LS1-6:** Organization for matter and energy flow in organisms. Plants, algae (including phytoplankton) and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.
- **MS-LS2-1:** Interdependent relationships in ecosystems. Organisms, including populations of organisms, are dependent on their environmental interactions, both with other living things and with nonliving factors. In any ecosystem, organisms and populations with similar requirements for food, water, oxygen or other resources may compete with each other for limited resources, a lack of access to which consequently constrains their growth and reproduction. Growth of organisms and population increases are therefore limited by access to resources.
- **MS-LS2-3:** Cycles of matter and energy transfer in ecosystems. Food webs are models that demonstrate how matter and energy is transferred between producers, consumers and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.
- **MS-LS2-5:** Influence of science, engineering and technology on society and the natural world. The uses of technologies and any limitations on their use are driven by individual or societal needs, desires and values; by the findings of scientific research; and by differences in such factors as climate, natural resources and economic conditions. Thus technology use varies from region to region and over time.
- **MS-LS4-6:** Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.
- **5-LS1-1:** Plants acquire their material for growth chiefly from air and water.
- **HS-LS1-5:** Organization for matter and energy flow in organisms. The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
- **HS-LS1-6:** The sugar molecules formed contain carbon, hydrogen and oxygen. Their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used, for example, to form new cells.

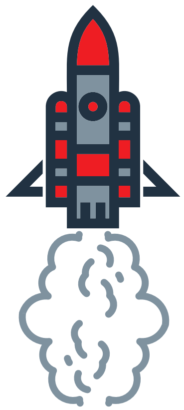
Connecting to Mars after the 4-H STEM Challenge

Interested in more great STEM activities? There are a lot of excellent resources out there. Here are some that we recommend:

- **Adventures in Aerospace** is a 4-H curriculum that can be purchased through Shop4h.org that connects youth to aerospace through project based, hands-on work!
- **NASA STEM Engagement** is a resource developed by NASA to share education and STEM resources for youth. This resource has activities for youth and adults on teaching and engaging in STEM through space exploration (**nasa.gov/stem**).
- **NASA STEAM Innovation Lab** is a part of the NASA Space Science Education Consortium (NSSEC) , a group that links exciting science and missions directly to the American public and partners with programs within NASA and beyond. (steaminnovationlab.org)
- **Evolution of Nanomachines in Geospheres and Microbial Ancestors, or ENIGMA**, is a NASA project, that seeks to make the connections between biology, engineering and geology in the hopes of finding more habitable planets and even new lifeforms. Additional activities are available to introduce young STEM learners to ENIGMA science at **4hset.rutgers.edu/online-learning/.**
- **CS First** (g.co/csfirst) offers an introductory, video-based computer science curriculum that teaches students foundational skills using Scratch. Try another hour-long activity, like "Create your own Google logo," or even a full theme, like Storytelling!
- **Scratch** (**scratch.mit.edu**) is the world's largest and friendliest creative coding community for youth. Encourage youth to create new projects and explore, and you can explore their Scratch Educator community for teaching resources.
- **Mission to Mars** is a new Virginia 4-H curriculum that includes ways to explore Mars, science and STEM through hands-on learning.

Don't forget to share photos from your 4-H STEM Challenge experience to social media using #4HSTEM

Your feedback helps us improve the 4-H STEM Challenge each year!
Please take a few minutes to fill out this survey about your experience: **4-h.org/STEMChallengeSurvey.**



Mars Base Camp Authors

Dr. Erika Bonnett - Virginia Tech
Dr. Chantel Wilson - Virginia State University
Dr. Hannah H. Scherer - Virginia Tech
Ms. Robbie Morrison - Virginia Cooperative Extension
Dr. Shaunna Morrison - Carnegie Institute for Science
Ms. Caitlin Unterman - Virginia Episcopal School

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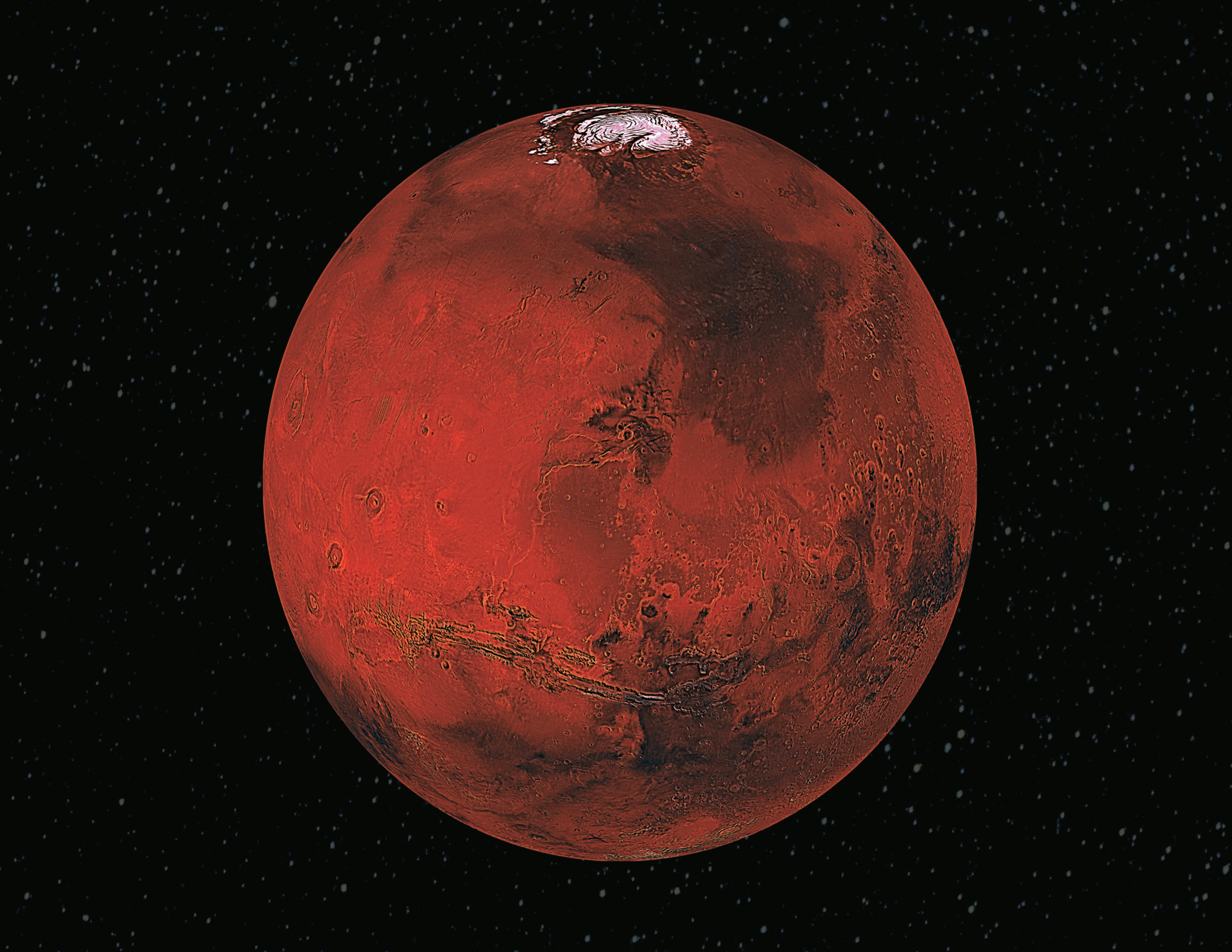
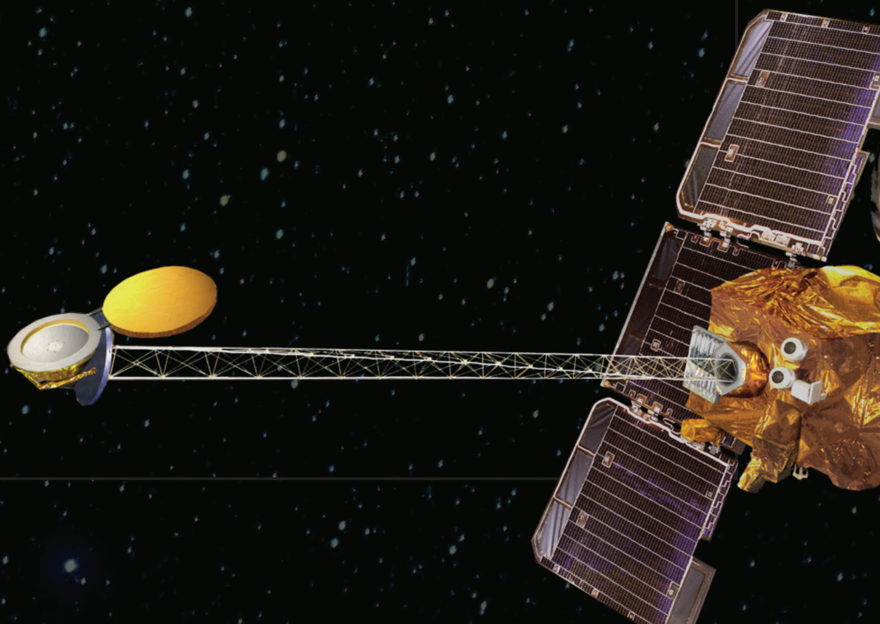
Passaic County 4-H Science Pathways



GOOD LUCK ON YOUR MISSION!



4-H STEM Challenge

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In 4-H, we believe in the power of young people. We see that every child has valuable strengths and real influence to improve the world around us. We are America's largest youth development organization—empowering nearly six million young people across the U.S. with the skills to lead for a lifetime.

Learn more online at: **4-H.org/STEMChallenge**