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:

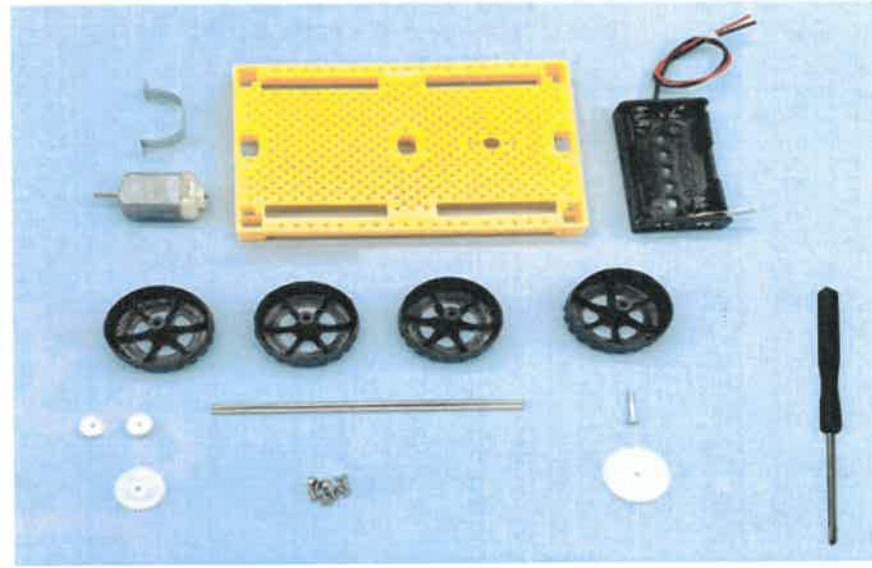
- 1 pencil per group
- Items to build an obstacle course (cones, books, boxes, paper, cardstock, etc.)
- 6 AA batteries
- Tape (masking preferred)

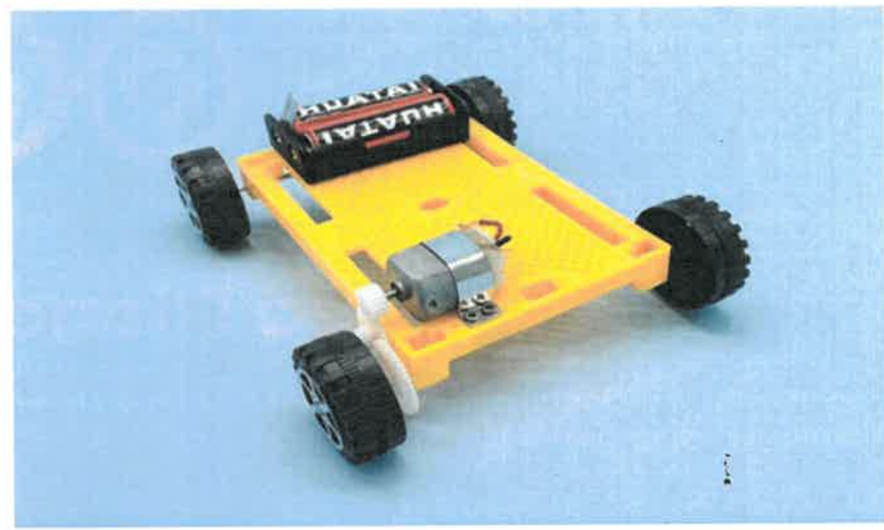
Important Vocabulary

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.

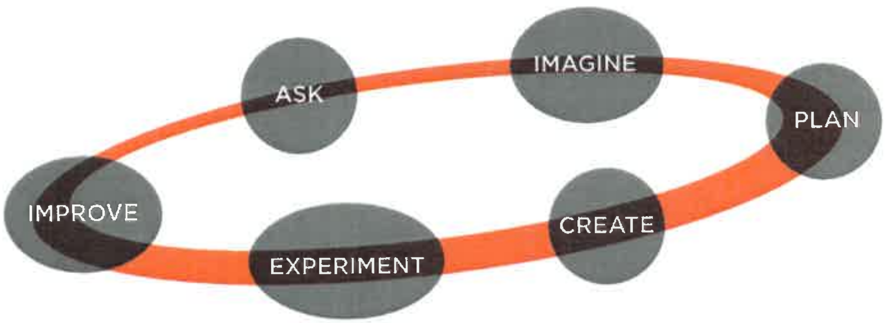
Create: Build a working model, or prototype, that aligns with the design requirements and lies within the design constraints.

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.")