MARS LANDER CHALLENGE

CHABOT SPACE & SCIENCE CENTER

HOW IT WORKS

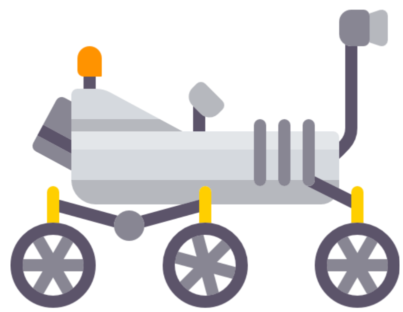
Watch the video included in your virtual package to learn about Mars and the Rovers that have explored there. The video is 32 minutes long without pause, and should take 60 to 90 minutes to complete when incorporating pauses for discussion and the activity. You may complete it all in one session, or split it up into multiple days according to the timecodes listed below.

Sample the video ahead of time to get familiar with the flow and decide how your students will engage with the workshop. Reference this guide and the instructions on the design challenge written below as needed.

Discussion questions, additional resources, and related activities to extend the learning are listed on page 5 and 6.

VIDEO TIME CODES

0:00 – 4:55 - Introduction to Mars
4:56 – 17:38 - Mars Rovers overview
17:39 – 23:21 - Build (first half)
23:22 – 28:24 - Build (second half)
28:25 – 31:50 - Discussion and wrap up



In this activity, learners will design, construct, and test multiple solutions for a Mars Lander. They will attempt to meet the criteria for a successful landing and discuss the strengths and weaknesses of their Lander using critical thinking, evaluation, and design skills.

PRE-WORKSHOP PREP

1. Determine how you are going to watch and discuss your virtual workshop video.
    a. There are moments designed for pause and discussion. It will be up to you to determine how your class will engage during those moments.
2. Share the materials list with your students and discuss any substitutions or accommodations that may need to be considered.
3. Mention to your students that they will need to determine a "drop zone" at home to test their landers.
    a. The zone can be indoors, outdoors, from ground level, or from an elevated height.
    b. They may want to use a towel to cover the drop zone area in case it spills or gets messy.
    c. Adult help during the "drop" is encouraged, if it is available.

OVERVIEW

- **Video length:** 32 minutes
- **Workshop duration** (video, discussion, and activity): 60-90 minutes
- **Grade range:** K – 8th
- **Skills:** Asking questions, Constructing explanations, Obtaining, evaluating, and communicating information
- **Concepts:** Cause and effect, Structure and function

SUGGESTED MATERIALS*

- A fragile object to represent the Mars Rover: water balloon, egg, etc.
- Scissors
- Hole puncher
- Newspaper
- String
- Strawberry baskets, small containers, or cups
- Tape
- Bubble wrap
- Coffee filters
- Rubber bands
- Towel or tarp

*SUBSTITUTIONS

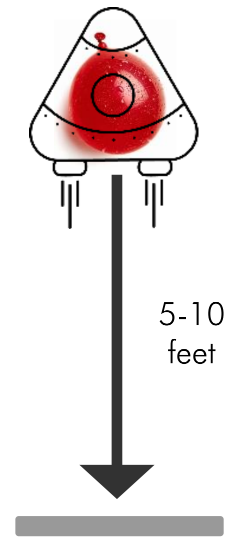
Substitute any of the materials listed above as needed per student and/or household.

Encourage students to get creative, think critically, and use what's available to them in new and exciting ways!

ACTIVITY INTRODUCTION

Congratulate the group! They have all been promoted to "NASA" engineers, and you have a challenge for them.

1. Explain the challenge:
    a. They will build a device, called a Lander, that can protect their "Rover" from being destroyed in a tall drop.
        i. In order to survive, the Rover cannot pop, crack, or break.
    b. The "Rover" will be a water balloon, egg, or fragile object of choice.
    c. They will have 10 minutes to design and build their Lander.
    d. They can use any of the materials they have available at home.
        i. OPTIONAL: build in a budgeting component to incorporate some math and problem solving skills.
    e. When the time is up, they will be dropping their Landers in their drop zone to determine if they can survive the impact of a landing on Mars.
2. Confirm that the group understands the goal of the challenge and take any questions.



BUILD (10 MINUTES)

1. Begin a 10-minute timer. Use more or less time as needed.
2. If it is available to you, check in with your students during the build. Ask how it is going and provide facilitation or feedback using questions such as:

> What do you have in mind for your design? How did you come up with it?
> What are you doing to protect your Rover? What might you need to protect it from?
> What is challenging you during this build? How can you overcome that?

TEST (5-10 MINUTES)

1. When the timer goes off, gather your group's attention and determine the order in which you will be testing.
2. Drop the Landers, one student at a time.
    a. Determine whether each Rover survived or not.
    b. They should NOT take their design apart after the drop. There will be an opportunity for them to improve and add onto their design later.
3. Discuss the results and all of their designs using questions such as:

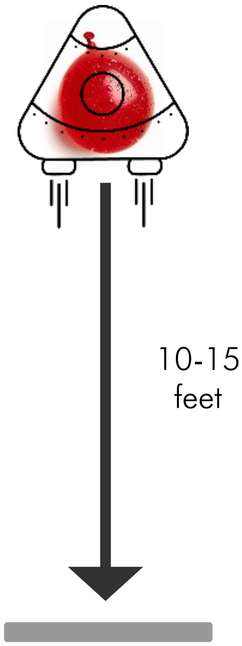
> What worked? What didn't work?
> What could be improved? What would they do differently if they could do it again?
> Are there any materials they wish they had? Are there any materials from home they could use differently to fill that need?
> What challenges did they come across during this? How did they overcome them?
> How might a NASA engineer face a similar challenge or obstacle in their work?

4. Failure is an important part of the engineering process. Redesigning and retesting a design is one of the only ways to improve it.

PHASE TWO INTRODUCTION

They now have an opportunity to re-design and re-test their Landers for improvement!

1. Explain the second part of the challenge:
    a. They will improve their Landers to survive in a second drop! If possible, they will drop it from a higher height than before.
    b. They will have 10 minutes to re-design and improve their Landers.
    c. They can use any of the same materials as before.
        i. If you incorporated a budget into the first round, increase the amount to adjust for the higher drop.
        ii. If their Lander did not survive the first round, they will begin again with a new "Rover" to protect.
    d. When the time is up, they will be dropping their Landers from their drop zone to determine if they can survive the impact of a landing on Mars.
2. Confirm that the group understands the goal of the challenge and take any questions.



SECOND BUILD (10 MINUTES)

1. Begin a 10-minute timer. Give more or less time as needed.
2. If it is available to you, check in with your students during the build. Ask how it is going and provide facilitation or feedback using questions such as:

> What are you doing differently this time around to improve your Lander?
> Did you get any design inspiration from your classmates' Landers? How did seeing other Landers help you think more critically about your own?
> What are you doing to protect your Rover from the increased drop height?

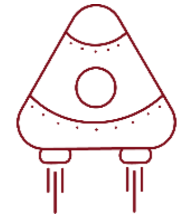
SECOND TEST (5-10 MINUTES)

1. When the timer goes off, gather their attention and drop the Landers again, like before.
2. Discuss the results and compare how it went to the first round:

> Which improvements worked? Which didn't work? What would they do differently If they could do another round of testing?
> How did they feel in the second round compared to the first?
> Are there other materials they wish they had?
> How did results compare between the tests? Did more or less survive? Why do you think that is?
> What were the biggest challenges of this activity and were you able to overcome them?

3. This activity reflects the importance of the engineering process: defining a problem, designing a solution, optimizing the design solution, and repeating it all over again. Engineers must go through this process multiple times and test for multiple challenge before they can be confident that their design will survive all of the possible challenges that space has to offer. And failure is almost always part of the process!

STANDARDS, CONCEPTS, AND PRACTICES (NGSS)



NEXT GENERATION SCIENCE STANDARDS (NGSS)

Completing these activities and experiments will satisfy the following NGSS standards:

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes the specified criteria for success and constraints on materials, time, or cost.
- 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.
- 3-5-ETS1-3. 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.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optima design can be achieved.

NGSS: CROSS CUTTING CONCEPTS

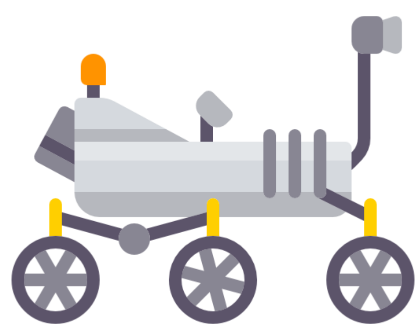
Completing these experiments and activities will help children understand the following about cross cutting concepts:

- **Cause and Effect:** cause and effect relationships are routinely identified and used to explain change and that events have causes that generate observable patterns.
- **Structure and Function:** the shape of designed objects are related to their function within a system.

NGSS: PRACTICES FOR K-12 CLASSROOMS

Throughout these activities, learners of all ages will practice skills such as:

- Asking questions and defining problems
- Developing and using models
- Constructing explanations and designing solutions
- Obtaining, evaluating, and communicating information



DISCUSSION QUESTIONS

Use the discussion questions listed below to guide conversation with your students before, during, and after completing the Mars Lander Challenge workshop. Some of these questions are asked throughout the video as well. Discuss them as a group, in a breakout room, or assign them as a journal prompt or writing exercise.

PRE-WORKSHOP

What do you know about Mars?

What do you think of when you think of Mars?

How do you think scientists discover more information about other planets?

If you could invent something to send to another planet, what would it be?

Would you want to visit Mars?

MID-WORKSHOP

What else do you want to learn about Mars?

Which Rover did you find the most interesting and why?

What did you learn about Entry Descent Landing (EDL) in the NASA video?

What do you think is the most important element to safely landing a Rover on Mars?

What did you learn about yourself during the design challenge?

POST-WORKSHOP

Do you think it is important to send Rovers to Mars? Why or why not?

Do you think it will be possible for humans to live on Mars someday? Why or why not?

Why is it important to learn about other planets besides Earth?

Do you consider yourself an engineer? Why or why not?

What skills or strengths do you think are important for an engineer to have?

ADDITIONAL RESOURCES

FROM CHABOT

Check out Chabot's What Makes a Rover? activity from the Learning Launchpad. This two-part lesson encourages students to independently research the complex structures and functions of a Rover's design. Then build one of their own from household materials.

Rockets are a necessary technology for sending Rovers from Earth to Mars. Learn more about rocket aerodynamics and build your own with Chabot's Aerospace Engineering activity from the Learning Launchpad.

FROM NASA

Discover more Mars facts with NASA's Solar System Exploration. For a more kid-friendly version, visit NASA's Space Place, which features an interactive game where students can control a Rover of their own to maneuver around Mars.

Explore more about NASA's Mars Exploration Program on their website. Stay up to date on the latest missions, technology, and research being done to advance human exploration of the Red Planet.

Re-watch NASA's video, "Seven Minutes of Terror" from the Jet Propulsion Laboratory and find other great videos about the Mars Exploration Program in their video library.

EXTENSION ACTIVITIES

KEEP IT GOING

Add more rounds onto this design challenge. Increase the stakes each time by dropping it higher, using less materials, or using different materials each round. What other ways can you increase the challenge?

THINK DIFFERENT

Encourage your students to think differently about this challenge. If they do **not** have a water balloon or egg to protect during the activity, how else can they determine whether a landing is successful or not? Come up with your own measurement of success and practice designing your own challenge. Some ideas are listed below:

- Time the speed of each drop. Try to create Landers that go slower (or faster) between rounds.
- Drop the Lander onto a delicate surface, such as a paper towel suspended like a bridge, measuring whether *it* gets destroyed during impact, rather than the Lander and its Rover.
- Find an object that is sensitive to movement, like a light up bouncy ball, and use it as the Rover. Try to avoid setting off the sensors during landing to show that it is safely protected inside.

WRITE A STORY

Once your Landers and their Rovers have successfully landed on Mars, write a short story about what happens next from the point of view of the Rover. What would your Rover feel, think, or see as it lands on the Red Planet? What does your Rover find as it begins its exploration? What obstacles does your Rover encounter, and how does it overcome them?