Mars Lander Challenge

CHABOT SPACE & SCIENCE CENTER

HOW IT WORKS

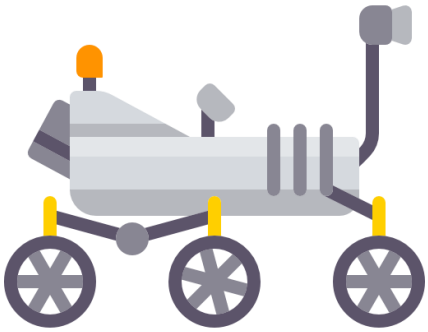
Watch the video included in your virtual package to learn about Mars and the Rovers that have explored there. The video is 32 minutes long without pause, and should take 60 to 90 minutes to complete including pauses for discussion and activity. You may complete it all in one session, or split it up into 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 6 and 7.

VIDEO TIME CODES

0:00 – 4:55 - Introduction to Mars
4:56 – 17:38 - Mars Rovers overview
17:39– 23:21 - Build (First half)
23:33 – 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.

WORKSHOP SET UP

1. Determine how many team stations you will need.
2. Set up stations for each team with the materials listed (right).
3. Set up the store with the materials listed (right).
    a. NOTE: It will get busy to run the store. Set up a line system ahead of time to direct students to wait in.
    b. Substitute any of the materials with other items as needed.
4. **If you choose to forgo the store…** supply each team with a pre-selected set of materials instead.
5. Determine your drop zones.
    a. You will need two drop zones: a small one for the first build, and a larger one for the second build.
    b. Don't be afraid to go big on the second drop! A roof, a balcony, or a really tall ledge can all work great

OVERVIEW

- **Video length:** 32 minutes
- **Workshop duration (video, breaks for discussion, and activity):** 60-90 minutes
- **Grade range:** K – 8th
- **Skills:** Problem solving, Critical thinking, Communication, Collaboration, Risk taking
- **Concepts:** Cause and effect, structure and function

MATERIALS

FOR EACH TEAM

- A fragile object to represent the Mars Rover: water balloon, egg, etc.
- 30 tokens: popsicle sticks, pieces of paper, coins, beads, etc.
- Scissors
- Hole puncher
- Pricing sheet (optional)

FOR THE STORE

- Newspaper
- String cut into 2 to 3-foot-long pieces
- Strawberry baskets, small containers, or cups
- Tape cut into 2 to 3-foot-long pieces
- Bubble wrap cut into squares
- Large coffee filters
- Rubber bands

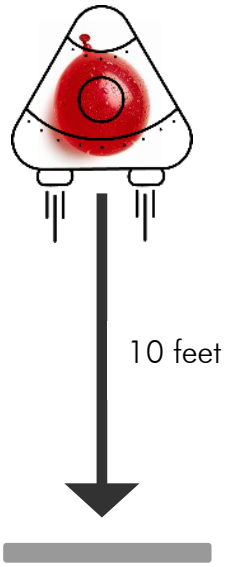
OTHER

- Towel or tarp
- Bucket or target to represent Mars

INTRODUCTION

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

1. Explain the challenge:
    a. Their team must build a device, called a Lander, that protects their "Rover" from being destroyed in a 10-foot drop.
        i. In order to survive, the Rover cannot pop, crack, or break.
    b. The "Rover" will be a water balloon, egg, or other fragile object.
    c. They will be working in teams of 4 (or less).
    d. They will have 10 minutes to design and build their Lander.
    e. Each team will have a budget of 20 tokens to spend on materials to build their Lander.
        i. They can purchase materials from the "store".
        ii. Each item costs a specific number of tokens, based on its value. See chart on page 4 for suggestions.
    f. When the time is up, you will be dropping their Landers from your first drop zone (~10 feet high) 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. Assign them into teams and send them to their stations to begin.
2. Open the "store" and start a 10-minute timer.
    a. Staff that are not running the store should walk around and check in with groups. Ask how their build is going and provide facilitation or feedback as needed. See guide on right.
3. Before time is up, set up the drop zone.
    a. If indoors; place a towel or tarp down to reduce spills
    b. Place a bucket/target on the ground to represent "Mars".

FACILITATION QUESTIONS

What do you have in mind for your design?
How did you come up with it?
What factors do you need to protect your Rover from?
How are you going to protect yours?
What is challenging for you?
How can you overcome them?

TEST (5-10 MINUTES)

1. When the timer goes off, have the teams gather at the drop zone.
2. Drop the Landers, one team at a time.
    a. Determine whether each Rover survived or not, then hand it back to the team.
    b. They should NOT take their design apart. There will be an opportunity for them to improve and add onto their design later, BUT it's a surprise.
3. Discuss the results.
    a. Ask them to think about all of the designs they tested.
    b. What worked? What didn't work? What could be improved? What would they do differently?
4. Tell them that that failure is an important part of the engineering process (Define a problem > Design a solution > Optimize the design > Repeat). Redesigning and retesting a design is one of the only ways to improve it. Which is why there is a second part to this challenge!!

SECOND 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. Their team can now try to improve their Lander to survive in a 15-foot drop! The second drop is taller and higher than the first!
    b. They will be working in the same teams.
    c. They will have 10 minutes to re-design and improve their Landers.
    d. Each team will receive 10 additional tokens to spend on building materials for their Lander.
        i. If a group's design was destroyed and the materials cannot be reused; that team will start again. They will return everything to a staff member.
        ii. In return, they will receive a new Rover and 30 tokens (20 to make up for the lost lander, and the 10 additional for this round).
        iii. The store will operate the same as the first round.
    e. When the time is up, you will be dropping their Landers from your second drop zone (~15 or more feet high) 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)

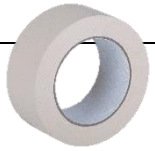
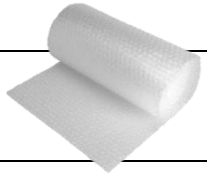
1. Give each team 10 new tokens and send them to their stations to begin.
2. Open the "store" and start a 10-minute timer.
    a. Staff that are not running the store should walk around and check in with groups about the improvements and changes being made.
3. Before time is up, set up the second drop zone like before.

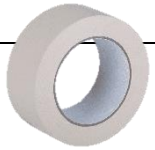
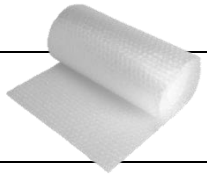
FACILITATION QUESTIONS

What are you doing differently this time to improve your design?
Did you find inspiration in your classmate's designs?
How did seeing other Landers help you think more critically about your own?
What are you doing to protect your Lander from the increased drop height?

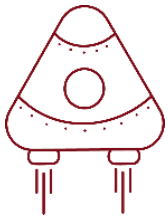
SECOND TEST (5-10 MINUTES)

1. When the timer goes off, have the teams gather at the second drop zone to drop the Landers.
2. Discuss the results and compare them to the first round
    a. How many of them did or did not survive? Which improvements did or didn't work?
    b. What would they do differently If they could do another round? What other materials do they wish they had to work with?
    c. What were the challenges you faced during this activity? How did you overcome them? How might an engineer face similar challenges in their work?
3. This activity reflects the importance of the engineering process. 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!

MATERIAL	PRICE
NEWSPAPER 	5 TOKENS
STRING 	1 TOKEN
BASKETS 	5 TOKENS
TAPE 	5 TOKENS
BUBBLE WRAP 	10 TOKENS
COFFEE FILTERS 	6 TOKENS
RUBBER BANDS 	1 TOKEN

MATERIAL	PRECIO
PERIÓDICO 	5 MONEDA
CUERDA 	1 MONEDA
CESTA 	5 MONEDA
CINTA ADHESIVA 	5 MONEDA
PLÀSTICO DE BURBUJAS 	10 MONEDA
FILTRO DE CAFÉ 	6 MONEDA
BANDA ELÀSTICA 	1 MONEDA

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

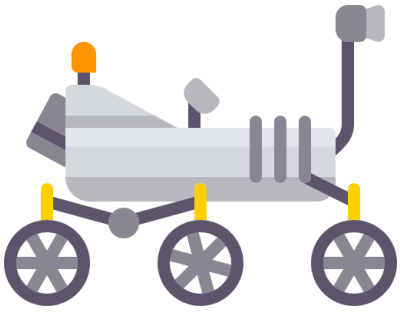
Completing these experiments and activities will help children understand the following about cross cutting concepts:

- **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.

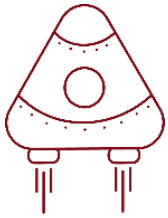
NGSS: PRACTICES FOR K-12 CLASSROOMS

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. Some of these questions are asked throughout the video as well. Discuss them together as a group, 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.
- Land the Rover 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 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?