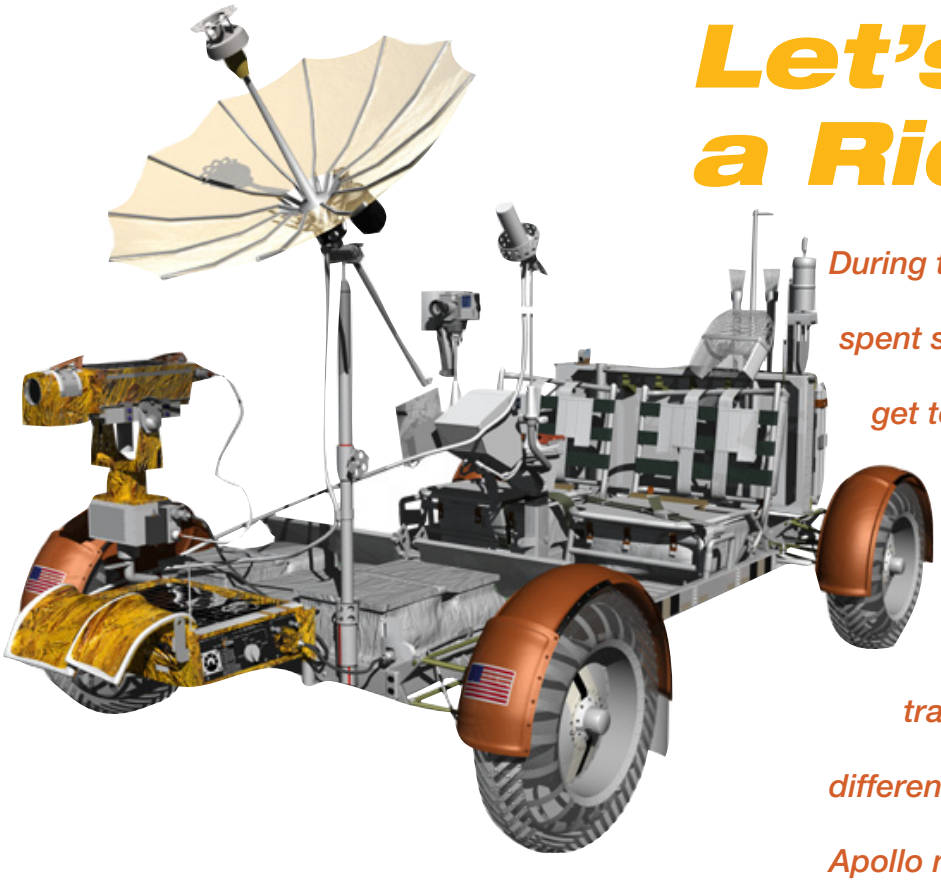
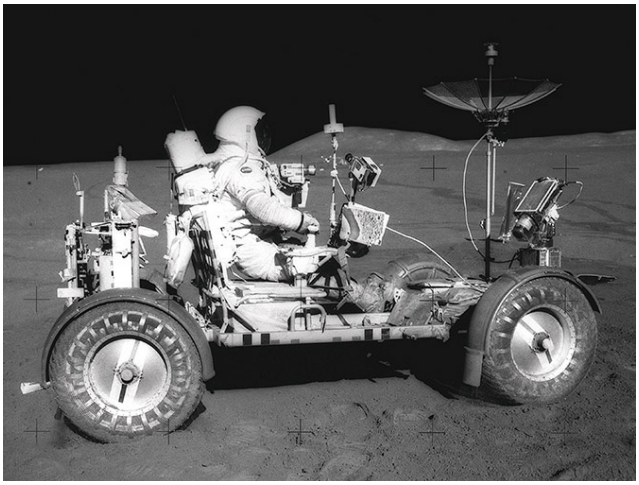


# Let's Go for a Ride!

*During the first set of activities, you have spent some time thinking about how to get to the Moon. Now you need to think about landing on the Moon, and how to deliver cargo to the Moon. Astronauts will need a mode of transportation in order to investigate different areas of the Moon. During the Apollo missions, astronauts drove a Lunar Buggy several kilometers away from their spacecraft. Today you get to be the engineers designing a new Lunar Buggy that can perform functions the Apollo Lunar Buggy could not. Your challenge is to build a model of a Lunar Buggy that astronauts will eventually use to carry astronauts and cargo on the Moon.*

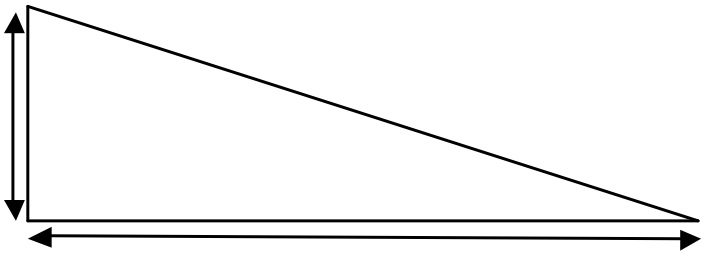


# THE CHALLENGE:

## *Each team must design and build a Lunar Buggy with the following constraints:*

1. ***The Lunar Buggy must carry one plastic egg snugly. The egg may not be taped or glued into place. (The egg represents the cargo hold.)***
2. ***The Lunar Buggy must be able to roll with the cargo hold carrying 10 pennies (or washers).***

3. ***The Lunar Buggy must have room for two "astronauts". You may use plastic people provided to you or make your own. Your astronauts may not be taped or glued into place.***
4. ***The Lunar Buggy must roll on its own down a ramp with a rise-over-run of 1-over-3 for a distance of approximately 100 cm in a straight line beyond the end of the ramp.***
5. ***The Lunar Buggy must be able to hold cargo and astronauts in place and intact as the Buggy rolls down the ramp.***




## DESIGN challenge

*To design and build a model of a Lunar Buggy that will carry equipment and astronauts on the surface of the Moon as well as determine the best slope of ramp for the rover to travel the farthest distance.*

Design a Lunar Buggy
**Student page**

lunarbuggy

# ASK IMAGINE &PLAN

**What questions do you have about today's challenge?**

**What parts do you need in order to make your buggy roll?**

**What will hold the egg in place?**

**What will hold the astronauts in place?**

**What is the height of the ramp (rise) and the horizontal distance (run) for this Challenge?**

| | |
|---|---|
| Rise | cm |
| Run | cm |

**Draw your Lunar Buggy and provide a close-up view of your wheel and axle design. Make sure to label all the parts of your design.**

*Buggy design:*

*Wheel and axle design:*

Approved by: _____

## DESIGN challenge

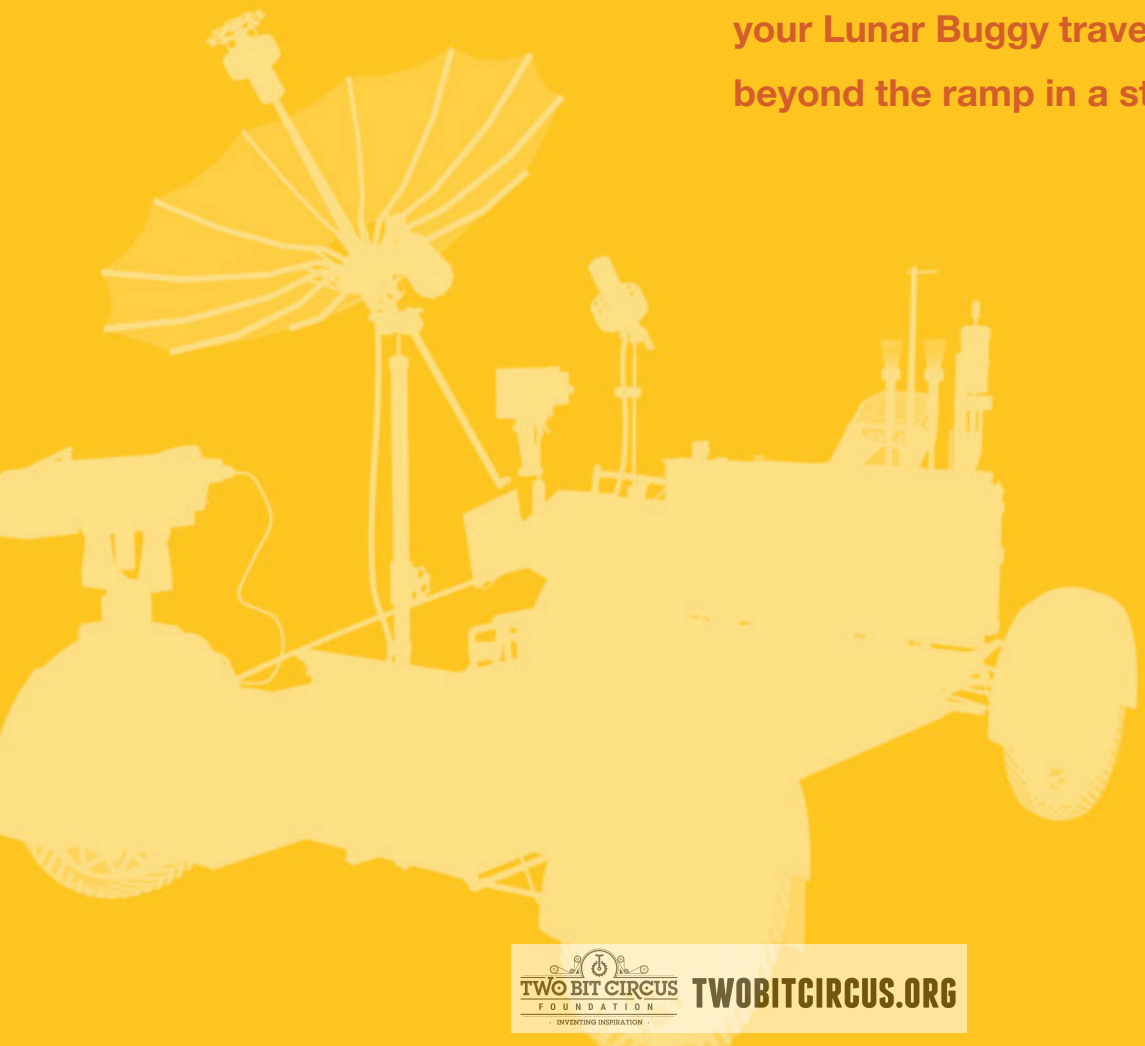
*To design and build a model of a Lunar Buggy that will carry equipment and astronauts on the surface of the Moon as well as determine the best slope of ramp for the rover to travel the farthest distance.*

Design a Lunar Buggy
**Student page**

lunarbuggy

# Experiment & Record

After you have created your model Lunar Buggy based on your drawings, test your vehicle on the ramp and record how far the Buggy travels beyond the ramp. Indicate the changes your team makes to the design to get the best performance for your Lunar Buggy. Remember, the challenge is to have your Lunar Buggy travel at least 100 cm beyond the ramp in a straight line!



## Lunar Buggy Distance and Modification Data Table

| Trial | Distance Traveled (cm) | Modification to make to design |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |

**Use the space below to draw the updated plans for your newly designed Buggy.**

**DESIGN** challenge

*To design and build a model of a Lunar Buggy that will carry equipment and astronauts on the surface of the Moon as well as determine the best slope of ramp for the rover to travel the farthest distance.*

Design a Lunar Buggy **Student page**

lunarbuggy

**Now that you tested your Buggy at a constant slope of 1 over 3, what slope do you think would make your Lunar Buggy travel the farthest? Write your hypothesis below in a complete sentence.**

_____

_____

_____

_____

**Set up your ramp with different slopes and record how far your Lunar Buggy travels beyond the end of the ramp each time.**

**Lunar Buggy and Ramp Data Table**

| Trial | Rise-Over-Run | Distance Traveled (cm) |
|---|---|---|
| 1 | 1 over 3 | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

**At what slope did the buggy no longer roll, but slid or fall off the ramp?**

# Science Pop Question

**What force is acting on the Lunar Buggy to get it to roll down the ramp?**

## DESIGN challenge

*To design and build a model of a Lunar Buggy that will carry equipment and astronauts on the surface of the Moon as well as determine the best slope of ramp for the rover to travel the farthest distance.*

Design a Lunar Buggy **Student page**

lunarbuggy

# QUALITY ASSURANCE FORM

**Each team is to review another team's design and model, then answer the following questions.**

**Name of team reviewed:** _____

**How far does the Buggy roll on a ramp with slope of 1-over-3?**
_____ **cm**

**Did the egg or astronauts fall out from the Buggy with slope of 1-over-3?**

**Using a digital scale, measure the mass of the Lunar Buggy (without the penny cargo).** _____ **grams**

**Do you think the mass has an impact on the Buggy's performance? Explain your answer.**

**List the specific strengths of the design.**

**List the specific weaknesses of the design:**

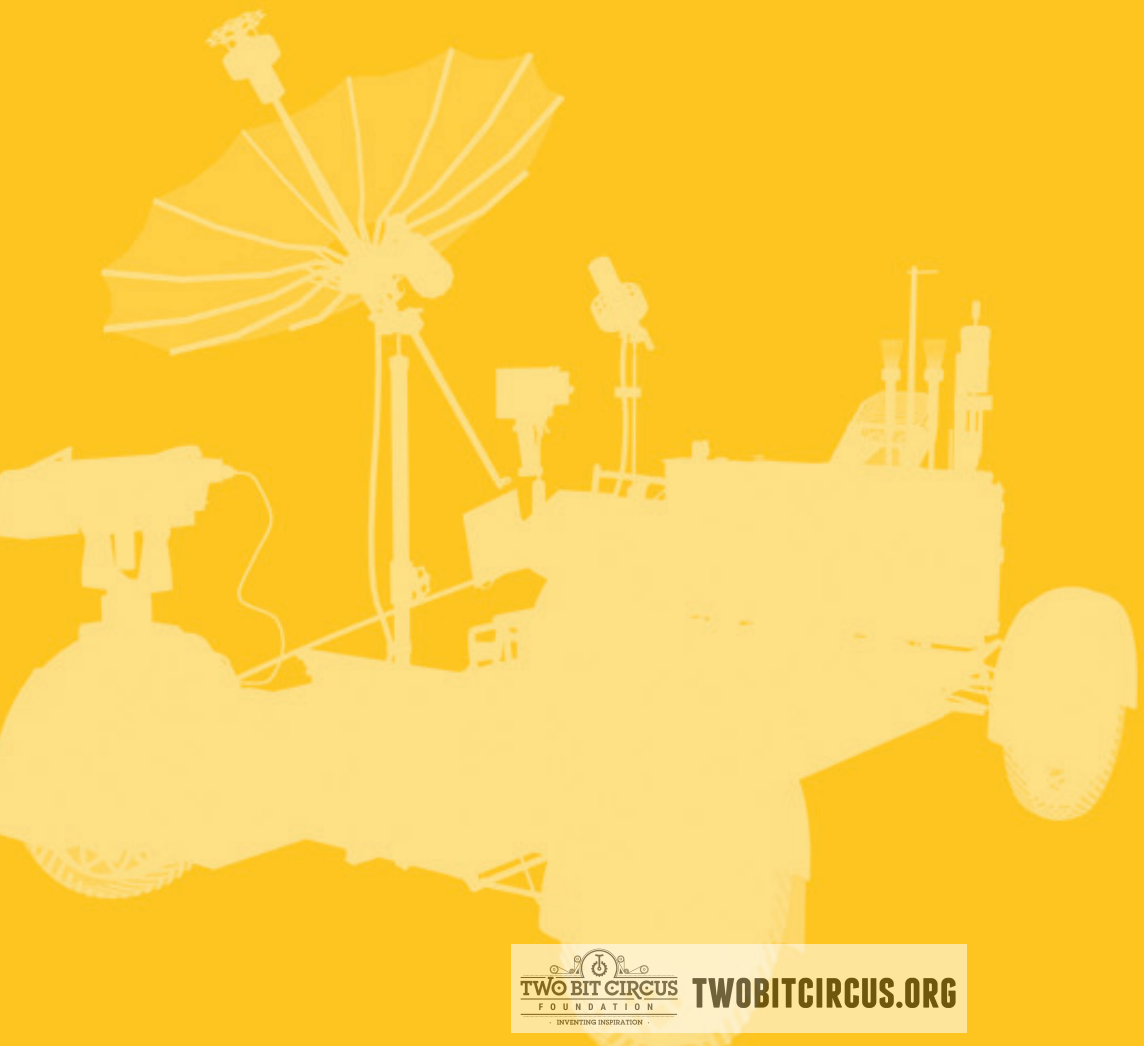
**Inspected by:** _____

_____

_____

_____

# Fun with Engineering at Home



Today you designed and built a Lunar Buggy model to transport astronauts and cargo on the Moon. Before humans can travel to other planets, they first must send robotic rovers to these remote locations to investigate the surface of that planet. While at home, see what you can learn about the robotic rovers that NASA has already built and used to investigate other planets. For example, you can learn about the challenges in building the Mars Exploration Rovers from this website:

http://marsrover.nasa.gov/gallery/video/challenges.html

Here are some questions to discuss with your family members:

1. What Apollo mission used a Lunar Buggy and how was it delivered to the Moon's surface for that mission?
2. Using the imagery from the Lunar Reconnaissance Orbiter, can you locate any remnants of the Apollo missions? www.nasa.gov/mission_pages/LRO/multimedia/index.html
3. What is the most important consideration when designing a vehicle that will carry astronauts and cargo?
4. What kind of cargo might a vehicle need to carry on the Moon for future missions?

## *YOU BE THE TEACHER!*

Explain to your family why the PLAN step in the Engineering Design Process is so important. Use your latest experiment with the Lunar Buggy as an example.

## DESIGN challenge

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Design a Lunar Buggy **Student page**