

## Activity Title: Design a Lunar Transporter Rover!

**Activity Objective(s):** The teams' challenge is to design and build a model of a Lunar Transporter Rover that will carry equipment and people on the surface of the Moon. It must be able to roll down a ramp. Next week they will design and build a landing pod for this rover, and the week after that, they will simulate a lunar landing. The goal is that the rover survives the landing so that it can roll down a ramp.



*Artist conception of a Rover: Courtesy NASA  
Two rovers that look like this are on Mars NOW!  
See <http://marsprogram.jpl.nasa.gov/> for more  
information on the Mars Exploration Rovers*

**Grade Levels:** 3 - 5

**Lesson Duration:** One 60-90 min session

**Process Skills:** measuring, calculating, designing, evaluating

### Materials and Tools (per group of three students):

- General building supplies and tools
- (2) small plastic people (approx 2 cm each)
- (1) plastic egg
- (2) Tootsie Roll Candies (or regular size candies that will be used to simulate a cargo weight of 5 grams)
- (4) plastic wheels
- Something to use as a ramp (a book would work – but preferably a flat surface that would enable the rover to roll for 50 cm or more)
- Metric Ruler for making distance measurements

### Club Worksheets: (Make copies for each student to put in binder)

1. Lunar Transporter Rover Design Challenge
2. Lunar Transporter Rover Imagine and Plan Sheets
3. Experiment Sheet and Data Table
4. Fun With Engineering at Home
5. Quality Assurance

## Club Facilitator or Teacher Notes by Stage:

(Based on those running 60-minute Clubs)

### Stage 1: Set the Stage, Ask, Imagine, Plan (Approx 10 minutes)

- Share the **Design Story** (in the Unit 2 Overview) and **Challenge** (provided in teacher pages) orally with the students. The story provides the context and motivation for trying to accomplish the challenge. This is the **ASK** phase of the Engineering Design Process.
- Show the Mars Rover Entry, Landing and Descent video called “Six Minutes of Terror.” (Available on Blackboard Site) Ask them to pay attention to the ways NASA slowed the rovers down as they entered the atmosphere. Tell them to keep in mind that some of the techniques will work on the Moon, and some will not. They should think about what the difference would be (no atmosphere on the Moon which means a parachute device won't work).
- The NASA website with more video on the Mars rovers is: <http://marsrover.nasa.gov/gallery/video/challenges.html>  
The “Six Minutes of Terror” video is near the bottom of the page in the **Entry, Descent and Landing (EDL)** section.
- Put the students in teams of 3 around the room – try to separate the teams so they are not working “on top” of one another.
- Hand out the **Lunar Transporter Rover Design Sheet** (1 of each of these worksheets per team).
- Let the challenge begin - Encourage them to **IMAGINE and PLAN** before building. Ask them to use their worksheets to capture their design ideas.

### Stage 2: Create (Approx 20 minutes)

- Challenge the teams to **CREATE** or build their Lunar Transporter Rovers based on their designs. Remind them to keep within specifications.
- Create a ramp for the lunar rover to roll down. Each team will be responsible for determining the correct height of the ramp to allow their rovers to roll down successfully.

### Stage 3: Experiment – (Approx 10 minutes)

- Students will let their rover roll down the ramp and record measurements of the distance the rover travels, the height they used for their ramp, and any observations for three trials. An average of these distances should be calculated by each group. They will need their rover to travel an average distance of at least 50 cm.

### Stage 4: Re-Design and Re-Build - Improve (Approx 10 minutes)

- Students **IMPROVE** (Re-Design and Re-Build) their Lunar Transporter Rover models based on results of the EXPERIMENT phase.

### **Stage 5: Challenge Closure – After week 3**

The Summary of this activity will come after the simulated lunar landing.

### **Stage 6: Previewing Next Week (Approx 5 minutes)**

- Ask teams to bring back their Lunar Transporter Rover model for use in next week's club challenge. You may want to store them in the classroom or have one of the facilitators be responsible for their safe return next week.
- Ask teams to think about potential landing pods during the next week. Tell them they will be building the landing pod out of the standard materials that have been available to them. The pod will be dropped from as high as possible (out a second story window? at least off a tall ladder, or the top of a staircase).

<b><i>Special Notes: For Those with 90 minute Clubs</i></b>
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### **Quality Assurance - (Approx 15 minutes)**

- Discuss how important FEEDBACK is for engineers. Hand out the **Quality Assurance** worksheets (1 per team) and ask them to fill out the section with team name and participants' names.
- Ask each team to put their Lunar Transporter Rover model together with their **Quality Assurance** worksheet around the edges of the room. Ask each team to move one notch clockwise to offer feedback to the neighboring team, using the Quality Assurance Test worksheet. The Quality Assurance Teams will test the average distance traveled down the ramp to meet the 50 cm guideline.
- Teams then return to their stations and discuss the comments from the Quality Assurance Team. What changes were suggested? Do they make sense?

## **Design Challenge:**

The Lunar Transporter Rover must meet the following Engineering Design Constraints:

- Carry one plastic egg snugly. The egg may NOT be taped or glued into place. (The egg will be what materials are carried in around the Moon.)
- Have room for two plastic people. (The people do not land with the rover. They will get in the rover on the Moon and drive it around.)
- Roll on its own down a ramp for an average distance of 50 cm or more.
- Be strong enough to hold approximately 5 grams of cargo weight, represented by two Tootsie Roll or other candies inside the egg.
- Survive the “landing.” This means it should be able to roll down the ramp after the landing, and the plastic egg should not have popped open.

## 1. Lunar Transporter Rover Design Challenge



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- Roll on its own down a ramp for an average distance of 50 cm or more.
- Be strong enough to hold approximately 5 grams of cargo weight, represented by two Tootsie Roll candies inside the egg.
- Survive the “landing.” This means it should be able to roll down the ramp after the landing, and the plastic egg should not have popped open.

## **2. *Imagine and Plan Worksheet***

**Page 1**

What parts do you need to make your rover roll?

What will hold the egg in place?

How will the height or rise of the ramp affect the roll of the lunar rover?

**Imagine and Plan Worksheet**

**Page 2**

Sketch of our Lunar Transportation Rover



### 3. Experiment Notes and Data Table

Observation Notes

Ramp Attempts	Distance	Ramp Height
Trial 1	_____ cm	_____ cm
Trial 2	_____ cm	_____ cm
Trial 3	_____ cm	_____ cm
Total Distance:	_____ cm	_____ cm
Average of Trials:	_____ cm	_____ cm

#### Sketch of Ramp Design:

(Label height of ramp in cm)



Team Name: \_\_\_\_\_

## Fun with Engineering at Home

### Activity 5: Design a Lunar Transporter Rover!

Today we designed and built a Lunar Transporter Rover model to transport people and cargo on the Moon. We used the same process that engineers use when they build something. We had to **ASK**: what is the challenge? Then we thought, talked and **IMAGINED** a solution to the challenge. Then we **PLANNED** with our group and **CREATED** our model Lunar Transporter Rover. Finally, we **EXPERIMENTED** or tested our model by having other groups look at it and give us feedback. Last, we went back to our team station and tried to **IMPROVE** our rover. These are the same 6 steps engineers use when they try to solve a problem or a challenge.

**Home Challenge:** During this week, see what you can learn about rovers that NASA has already built and used. 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 talk about with your parents, grandparents, brothers or sisters:

NASA used a parachute to slow the descent of the Mars rovers onto Mars. Why can we not use a parachute to land a spacecraft on the Moon?

They also used a heat shield on the Mars entry spacecraft. Why do we not need one of those on the Moon?

What is the most important consideration when designing a rover that will carry people and cargo?

What kind of cargo might the rover need to carry on the Moon?

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**Quality Assurance**

**Checking Each Other's Lunar Transporter Rovers**

Team Name: \_\_\_\_\_

Participants' Names: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

***To be answered by the Quality Assurance team:***

Does the rover roll an average distance of 50 cm? \_\_\_\_\_

At what height was the ramp placed to allow the rover to roll 50 cm? \_\_\_\_\_

Did the egg fall out of the rover while on the ramp? YES or NO

Specific Design Strengths

Specific Design Weaknesses

How would you improve this design?

Inspected by Team: \_\_\_\_\_

Participant Signatures \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_