UBC Geering Up
Engineering Outreach

Mars Lander

Grade levels:	This activity can be modified to be suitable for all grades K - 9.

Concepts at a Glance

1. Understand the basic structure of the Engineering Design Cycle
2. Use Inquiry-based learning to solve a design problem
3. Understand how to build a narrative around STEM activities

Curriculum Ties

Applied Design, Skills, and Technologies

- 4 - 5
  - Designs can be improved with prototyping and testing
  - Skills are developed through practice, effort, and action
  - The choice of technology and tools depends on the task
- 6 - 7
  - Design can be responsive to identified needs
  - Complex tasks require the acquisition of additional skills
  - Complex tasks may require multiple tools and technologies

Science

- 4
  - Energy can be transformed
- 5
  - Machines are devices that transfer force and energy
- 6
  - Newton's three laws of motion describe the relationship between force and motion

Core Competencies

- Communication; Thinking; Personal & Social

Safety and Mess Concerns

- As with any design challenge, there are a lot of materials that could end up all over the classroom! Making sure to allocate time to cleaning up at the end of the workshop is essential!
- For the younger grades use of scissors can be a safety concern.
- Glue gun use should be supervised or done by an adult.

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Engineering Design Process/Cycle:

Engineers follow something called the engineering design cycle, where they **Identify** a problem, **Research** and brainstorm, **Build,** then **Test.** After they test their invention, they find ways to **improve** it and continue to go around the engineer design cycle over and over again until their test is a success! Not all experiments run perfectly the first time. In this way, all engineers must **FAIL** in order to eventually create a working invention and thus, **succeed!**

For example, who knows what a mars rover is?
(*explain that it's a robot that is specially built by engineers to be sent to explore the planet Mars)*

Do you think the engineers working on the Mars Rover mission were able to accomplish their objective on the first try? What sort of things might have gone wrong? Do you think they failed while working on the project? How do you think they dealt with failing?

Examples of mars missions (*don't have to mention all- adjust language use depending on age group ie. kindergarteners won't understand what "NASA" or "deployed" means and would better comprehend the information with the use of simpler language*):

- **First ever successful Mars mission was in 1964 NASA's Mariner 4, after 6 failed missions!**
- 1999- NASA's Mars Polar Lander: Failed to land
- 2003 - European Space Agency's Beagle 2: Deployed from Mars Express. Successful landing, but two solar panels failed to deploy, obstructing its communications.
- **2007 - NASA's Dawn Lander: Most recent successful Mars mission, all the ones following it were unsuccessful for various reasons!**
- 2016 - European Space Agency's Schiaparelli EDM lander: Lander crashed, but test declared successful

Segue: Now let's put on our engineering hard hats and build our very own mars rovers!

Design Challenge: Mars Rover Challenge

Canada has a long history of exploration and research in space (Chris Hadfield, Canada arm) and as technology advances your tiny bubble in the universe is expanding. One of the most exciting new frontiers of exploration is Mars.

The Red Planet has recently been the focus of intensive research, leading to the discovery of liquid water! (https://www.bbc.com/news/science-environment-44952710). A lake has been discovered buried under 1.5 km of ice (like an Antarctic Lake), but a real lake nonetheless.

Liquid water is what astrobiologists look for when searching for life outside of our planet. Where there is water there MIGHT be life!

But how will scientists determine if there is life under the ice? What kind of life will it be? The first step will be to land a new martian robot on Mars! Your mission is to design and build a shock-absorbing lander to protect the rover cargo (an alien figurine) during impact on a faraway planet. Only the supplies available on the spacecraft can be used.

What kind of things do you see that have shock absorption? (Bikes and cars have suspension so the bike absorbs some of the shock from riding over a ditch or a rock, so that the bike doesn't break and whoever is using it doesn't get hurt).

The Mars Rover mission involved sending robots to explore the surface of mars, and collecting rocks, soil samples, and photographs and using tools to determine what makes up the rocks on the surface of Mars. The rovers were also trying to find water to see if one day far in the future, life could be sustained on Mars.

However, the Mars Rover first had to land on Mars, after travelling through space for 7 months. Let's see some NASA engineers talk about what went into making the Mars Rover safe for landing!
(show video: **https://www.youtube.com/watch?v=Ki_Af_o9Q9s**)

What was the objective of the Mars Rover mission?
Find geological samples, take pictures, communicate this information to NASA, find water, see if life could be supported on Mars.

YOUR MISSION: (*Vary the limitations depending on the age group*)

K-2: Try and keep the alien safe during the fall (they can modify the cup, add padding etc) but you can't cover the top of the cup, because the instructors have to be able to come and put an alien into your cup. (parachutes etc.). Let them choose materials but control how much they are taking! Materials can only be used to build the rover!

3-5: How can you slow down and stabilize your cup? Can modify the cup but try to lead them to other conclusions other than adding padding or just parachutes.

6-8: Try and keep the cup upright after it lands so that the alien stays inside safely. The top of the cup cannot be covered, (even if the parachute falls over the top of the cup, that is not allowed) and nothing can hold the figurine inside, the cup itself cannot be modified at all. Use different mechanisms to stabilize the spacecraft, and absorb some of the impact of the landing (shock absorption). Encourage "springs", big bases etc, try and get them to move away from parachutes! Could say "no parachutes allowed".

(*Grade 3 & up only*): We are giving you a budget because in real life, engineers don't always get to have endless access to whatever amount of the best supplies, they have to decide what is really important for their design to function well, and what maybe isn't so important and budget their spending accordingly.

Materials:

Non-consumable

- alien figurines
- Scissors
- Fake money (*for grades 3 and up*)
- Ruler/Measuring Tape

Consumable (Suggested)

- Foam sheets
- Dixie cups
- Straws
- Cotton balls
- Foam marshmallows
- Construction paper

- Tape
- Coffee filters
- Paper plates
- Cardboard
- Index cards
- Rope
- Construction paper

Prep *(for grades 3 and up)*
Give each kid about $50 of fake money and free Dixie cup to hold alien. Set out the supplies in the "NASA supplier".

Write up a price list

Suggested price list:
Cardstock - $10
Plate - $10
Foam sheet - $10
Coffee filter- $5
Extra Dixie cups - $5
4 cotton balls- $5
2 pipe cleaners - $5
2 straws - $5
2 popsicle sticks - $5
Arm length of masking Tape- $5
Index Card - $5
1 foot of rope - $10
Cardboard - $10
Construction Paper - $5

Suggested Rules for the activity:

- Not allowed to cover the cup
- Nothing allowed inside, the cup (The Alien has everything she needs in there!)
- No parachutes (depending on the age group)
- Extending the cup in any way is not allowed
- Only materials purchased with the $50 budget can be used in the design
    - Scissors and markers may be used for free! But can't be used IN the rover
- Alien MUST Stay in the cup!

Procedure:

1. Talk through intro section written above/Watch the NASA video (7 minutes of terror). Discuss the Mars Rover mission's objective and what they have found on Mars.

Link to video: **https://www.youtube.com/watch?v=Ki_Af_o9Q9s**

2. Ask the kids to write a shopping list and draw a blueprint of their design (make sure it adds up to fit their budget)
3. Allow them to purchase materials and build their rover
4. Test out the rovers, seeing how well they land from varying heights. Start from arm height and get taller and taller until the rover falls over and spills the cargo. Optional: launch from a balcony.

5. After testing, discuss with the class what worked well and what didn't. If something didn't work, what would an engineer do? Try again! Have the students modify their designs (could give extra money to do so) and re-build their rover.
6. Re-test the rovers.

Modifications:
Have kids launch from varying heights, up to a balcony.
Auction off special items (hot glue).
After launching, discuss what troubleshoot they could use to further improve their designs (weighting the bottom, larger bases etc)

About UBC Geering Up

UBC Geering Up Engineering Outreach is a non-profit organization dedicated to promoting science, engineering and technology to the children and youth of British Columbia through fun, innovative and hands-on experiments and projects. Geering Up strives to reach all children and youth, regardless of gender, ethnicity, culture or socio-economic status, with special outreach for those groups traditionally underrepresented in the sciences. Geering Up provides valuable work experience to its employees, and enriches the University and community.

More information available at: https://geeringup.apsc.ubc.ca/