DESIGN challenge

To design and test a Reusable Launcher for the Crew Exploration Vehicle (CEV). The CEV should travel 5 meters when launched.

OBJECTIVE

To demonstrate an understanding of the Engineering Design Process while utilizing each stage to successfully complete a team challenge.

PROCESS SKILLS

Measuring, calculating, designing, evaluating

MATERIALS

Model CEV that was built last session

General building supplies

Meter stick or measuring tape

C-clamps

Rubber bands of various sizes and thickness

STUDENT PAGES

Design Challenge

Ask, Imagine and Plan

Experiment and Record

Quality Assurance Form

Fun with Engineering at Home

PRE-ACTIVITY SET-UP

See next page.

MOTIVATE

- Show the first two minutes of the video titled “Constellation: Flight Tests”. (if time permits, show all)

  www.nasa.gov/mission_pages/constellation/multimedia/index.html

- Ask the students what was the most important lesson learned from those images? (test, test and test again!)

SET THE STAGE:

ASK IMAGINE **& PLAN**

Share the *Design Challenge* with the students.

- Emphasize that the objective is to create a launcher producing repeatable results. It is more important for the CEV to reach the same distance each time than for the CEV to travel the farthest.
- Remind students to imagine a solution and draw their ideas. All drawings should be approved before building.

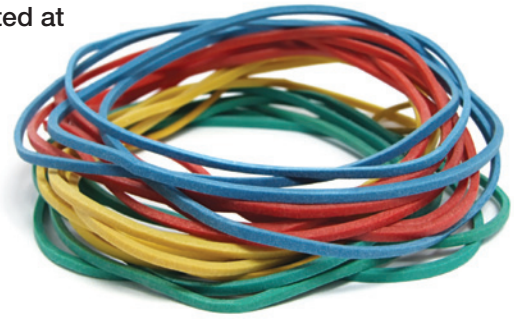
CREATE

- Challenge the students to build a Reusable Launcher based on their designs and ideas.

EXPERIMENT

- Students will test different rubber bands and different distances the rubber band is pulled back. One rubber band is used per experiment, but tested at three different “pull lengths”. All data is recorded in the data table.
- Students should graph the CEV distance results as a line graph and analyze. Feel free to share the BEST graphing video with your students as a refresher on how to build a graph:

  http://svs.gsfc.nasa.gov/goto?10515



IMPROVE

- Students *improve* the Reusable Launcher based on results of the tests.

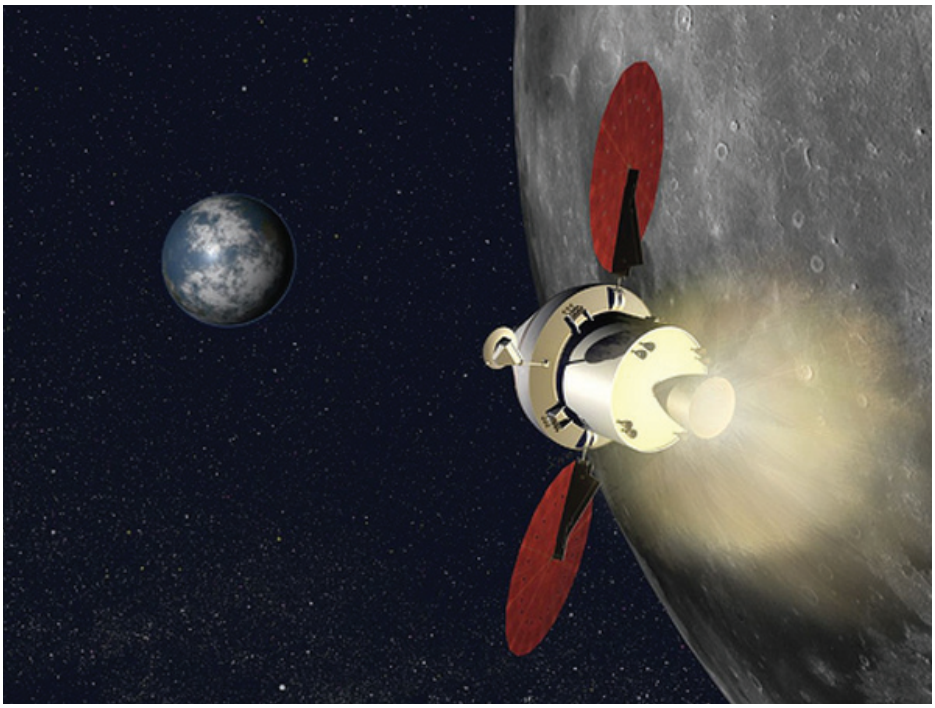
CHALLENGE CLOSURE

Engage the students with the following questions:

- *Why was it important that the launcher be reusable?*
- *Why was it important that your results were repeatable?*

PREVIEWING NEXT SET OF ACTIVITIES (SERIES 3)

The Moon is a very harsh environment. There is no atmosphere to protect astronauts and their equipment from solar radiation and the extreme temperature swings between night and day. Next session, we will begin to find ways to protect astronauts from those extreme temperature changes.



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Launch Your CEV
Teacher page

launch your CEV

It's Time to Launch into Space!

For years, NASA has been reusing launch components to send rockets and the Space Shuttle into space. For example, the solid rocket boosters (SRB's) on the Space Shuttle are often retrieved from the ocean, brought back to Kennedy Space Center, then cleaned and prepped for another Shuttle Launch. Why? The same reason we recycle our aluminum cans. It helps the environment and helps us save money for future launches. During this session, you must design and test a Reusable Launcher for your Crew Exploration Vehicle that will journey to the Moon. Therefore, your goal will be to launch your CEV into an orbit around the Moon.

THE CHALLENGE:

To design and test a Reusable Launcher with the following constraints:

1. ***Launch the CEV to reach a goal of 5 meters. See the drawing on the page 123 for an idea of how to set up your launch.***

2. ***The Launcher must be reusable for each trial. If your rubber band breaks because it was pulled too far, it is not reusable for another launch.***

3. ***The Launcher must consist of an effective combination of rubber band type and how far back it should be pulled. You will experiment with three types of rubber bands and try three different lengths to pull those rubber bands back (think of a sling shot, but attached to a table).***

4. ***The Launcher must produce a repeatable outcome. If you set up the Launcher the same way twice, the CEV should travel the same distance both times. It is more important that the CEV is launched the same distance using the same setup than it is to get the CEV to travel the farthest distance.***

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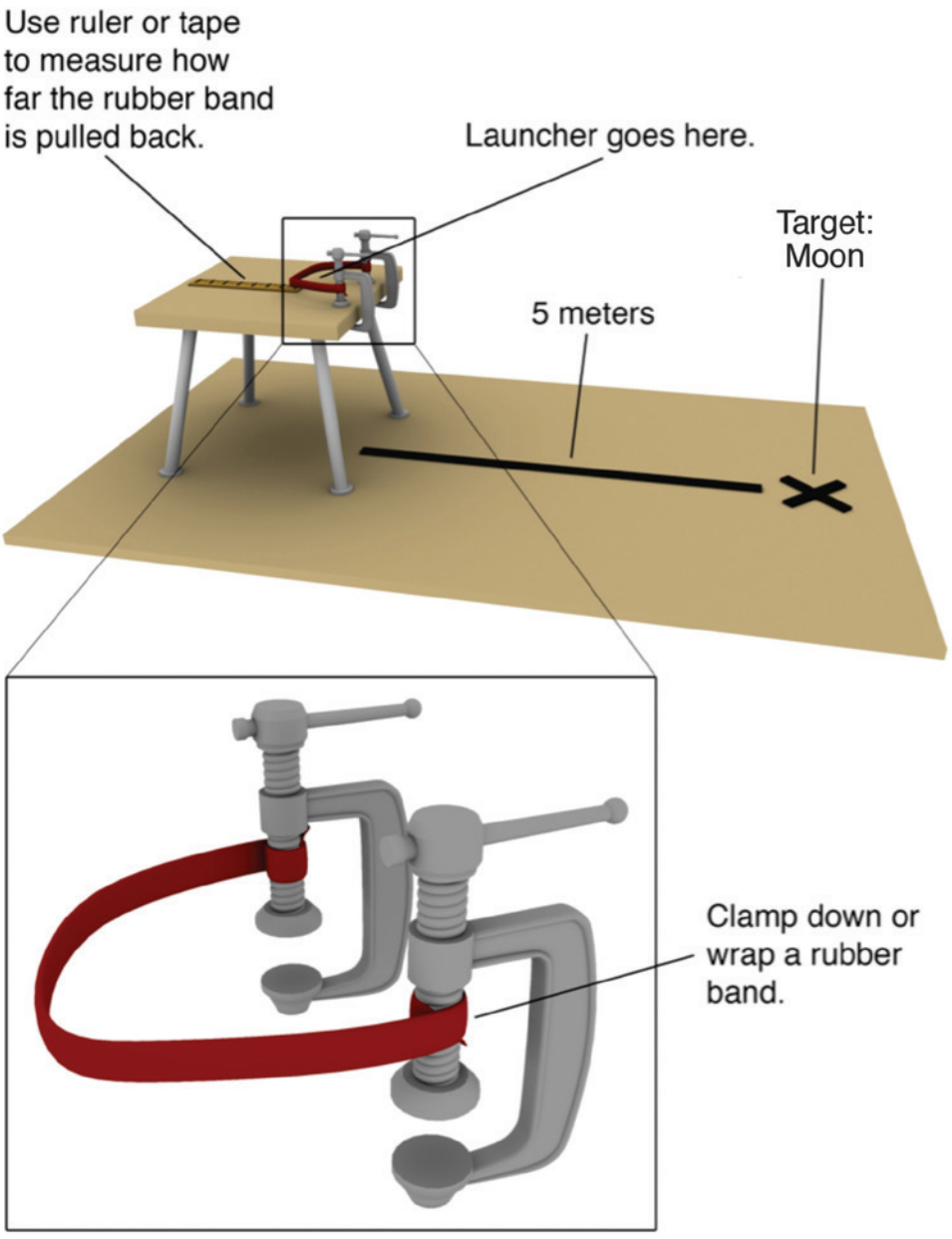
Launch Your CEV
Student page

launch your CEV

Launch Set-Up



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Launch Your CEV
Student page

launch your CEV

Draw a picture of your team's Reusable Launcher with your CEV.

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Launch Your CEV
Student page

Approved by: _____

ASK IMAGINE &PLAN

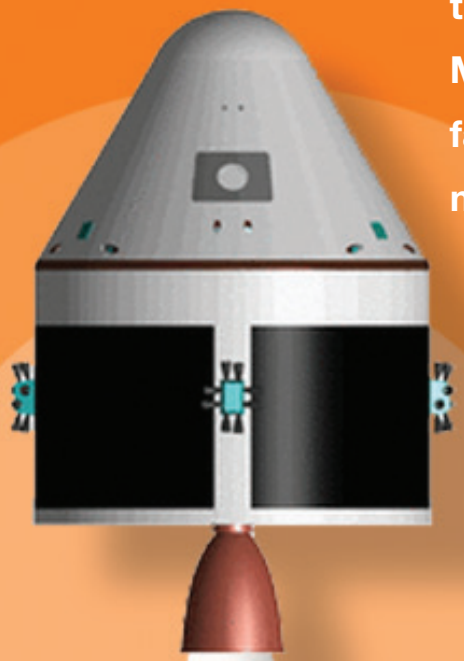
What questions do you have about today's challenge?

Describe the characteristics of the three rubber bands your team has chosen to use.

How will you test your rubber bands to see if they will work well as a "Reusable Launcher"?

Experiment & Record

Choose your three rubber bands and set up the Reusable Launcher for your experiment. Enter the independent variables into the table. Launch your CEV three times for each type of rubber band. Measure the dependent variables – how far your CEV travelled and how much it missed the 5 m target. Record your data.



CEV Launch Data Table

Trial	Independent Variables		Dependent Variables	
	Type of rubber band (description)	Rubber band pulled length (cm)	Distance traveled (m)	Distance from target (m)
1				
2				
3				
1				
2				
3				
1				
2				
3				

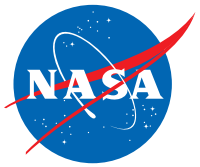
Did you get a repeatable outcome? If not, how will you improve your design to get consistent results?

Use the data recorded to make a line graph to show your results. The x-axis is the *independent variable* and the y-axis is the *dependent variable*. Label each axis with its measured units, and make tick marks on the graph with numbers so that you will be able to plot your data. Plot three sets of data, using a different color for each type of rubber band.

y

x

From your graph, can you determine if there is a relationship between the distance the rubber band is pulled and the distance that your CEV traveled? If so, describe that relationship.



QUALITY ASSURANCE FORM

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

Name of team reviewed: _____

What was the dependent variable tested by the team? _____

Did the launcher successfully send the CEV 5 meters out?

If no, what was the distance accomplished by the launcher?

Describe the rubber band that was used in the launcher.

Did the CEV sustain any damages from the launch?

List the specific strengths of the design.

List the specific weaknesses of the design:

How would you improve the design?

Inspected by: _____

_____

_____

_____

Fun with Engineering at Home

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TWOBITCIRCUS.ORG

Today you designed and built a Reusable Launcher to launch the CEV model that you built last session. You were designing the Reusable Launcher to get to a certain distance (5-meters). You used the same process that engineers use when they build something. Share with your family this movie and have a discussion about humans returning to the Moon:

www.nasa.gov/mission_pages/constellation/multimedia/index.html

YOU BE THE TEACHER!

Explain to your family why we cannot use a parachute for landing on the Moon.

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