Activity Title: Launch Your Crew Exploration Vehicle!

Activity Objective(s): The challenge is to design and build a Reusable Launcher for the *Crew Exploration Vehicle* (CEV) that they built last week. The CEV should travel 5 meters when launched. The Reusable Launcher should produce repeatable results.

Ares Rocket and Altair Lunar Lander, Courtesy NASA

Grade Levels: K - 2

Lesson Duration: One 60-90 min session

Process Skills: measuring, calculating, designing, evaluating

Materials and Tools:

- General building supplies and tools
- C-clamps and lots of rubber bands
- Model CEV that was built last week

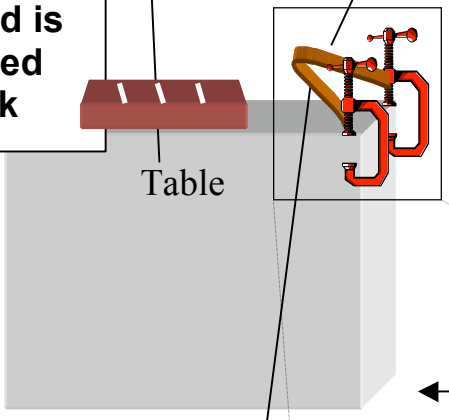
Club Worksheets: (Make copies for each student to put in binder)

1. Reusable Launcher Design Challenge: Imagine and Plan Sheets
2. Reusable Launcher Data Table
3. Summary Sheet - Questions/Discussions for Understanding
4. Fun With Engineering at Home

Launch Pad Set-Up: Place the Reusable Launcher in the sling-shot for launch.

Ruler or tape: To measure how far the rubber band is pulled back

Launcher goes here

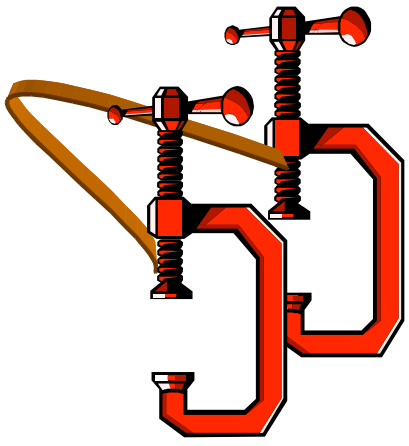


3 meters

Space Station:

X marks the spot

Rubber band



Rubber band clamped down or wrapped.

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 and Challenge** orally with the students. This story provides the context and motivation for trying to accomplish the challenge. This is the **ASK** phase of the Engineering Design Process. The story is the last item in the Teacher Pages (p. 5).
- Hand out the ***Reusable Launcher Design Challenge: Imagine and Plan Sheets*** (1 worksheet for each student).
- Keep the students together as a group to discuss how to approach this activity. They need to build the container that will hold their CEV. That container (plus the CEV) will be put into the sling-shot mechanism. Encourage them to **IMAGINE and PLAN** before building.
- Ask them to use their worksheets to capture their design ideas. Ask them to list the challenges they face in meeting the design constraints. It is important to emphasize that the objective is to build a launcher that gives repeatable results. It is more important that the CEV is launched the same distance using the same set-up than it is to get the CEV to launch the farthest distance.
- Students share their ideas. Record on chart paper.

Stage 2: Create (Approx 15 minutes)

- Break the students into groups of 2. **CREATE** or build a Reusable Launcher based on their designs and ideas.

Stage 3: Experiment – (Approx 10 minutes)

- Discuss how important **EXPERIMENTING** is for engineers. The *imagine, plan, create, experiment, improve* loop is key for engineers to be successful.
- Display the Reusable Launcher Data Table on the overhead projector or document camera.
- Conduct two sets of tests: 3 launches, each using three different set-ups. Record data.

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

- Students **IMPROVE** (Re-Design and Re-Build) the Reusable Launcher based on results of the EXPERIMENT phase.

Stage 5: Challenge Closure (Approx 10 minutes)

- Display the ***Summary: Questions/Discussion for Understanding*** worksheet on the overhead projector or document camera.
- In summary, discuss the questions. Ask them, "What was the greatest challenge for your team today?" Expect answers such as:
    - Figuring out how to design a Launcher that could be used again and again.
    - Getting repeatable results.
    - Landing near the 3-meter mark.
    - Working as a team, communicating
    - Imagine, plan, create, experiment, improve steps

  If you do not get these types of answers, try to facilitate an interaction where you put these thoughts in play and ask for feedback. Encourage all teams to offer thoughts.
- **Record their responses.** PLEASE SAVE IN A FOLDER FOR NASA.

Stage 6: Previewing Next Week (Approx 5 minutes)

- Next week we will switch gears from getting off the Earth to landing on the Moon.
- Ask teams to think about how a spacecraft might land on the Moon safely. Ask them to think about why it doesn't make sense to use a parachute on the Moon (There is no air to fill up the parachute!).

Here is a link to a great NASA animation of a lunar landing!

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

Design Story and Challenge:

This is the story you will tell the students to paint the picture or set the context for this first challenge. It is this story that makes the science, technology engineering and mathematics come to life.

It's Time to Launch into Space!

Last week, you built a model of a Crew Exploration Vehicle. This week, you must design and build a Reusable Launcher. You will then launch a CEV!

On the way to the Moon, the CEV is going to meet with the International Space Station to pick up some supplies. When you launch your CEV, the goal is to get into orbit close to the International Space Station.

This is a picture of the International Space Station (courtesy NASA). If you want to see real footage of people on the International Space Station, you can see videos from space on the ReelNASA YouTube channel:

http://www.youtube.com/reelnasa

There's a great shot of a shuttle launch there, too! Turn the sound up **LOUD**!

Design Challenge

Your Reusable Launcher must meet the following Engineering Design Constraints:

- Launch the CEV into orbit so that it may meet with the International Space Station. The goal is to launch the CEV 3 meters.
- Be reusable.
- Demonstrate 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 set-up than it is to get the CEV to launch the farthest distance.

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1. Reusable Launcher: Imagine and Plan Worksheet

It's Time to Launch into Space!

Last week, you built a model of a Crew Exploration Vehicle. This week, you must design and build a Reusable Launcher. You will then launch a CEV!

On the way to the Moon, the CEV is going to meet with the International Space Station to pick up some supplies. When you launch the CEV, the goal is to get into orbit close to the International Space Station.

Design Challenge

Your Reusable Launcher must meet the following Engineering Design Constraints:

- Launch the CEV into orbit so that it may rendezvous with the International Space Station. The goal is to launch the CEV 3 meters.
- Be reusable. It must not fall apart when you use it!
- Demonstrate 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 set-up than it is to get the CEV to launch the farthest distance.**

What job does a Reusable Launcher do?

What components must a Reusable Launcher have to do the job?

What do you need to build your Launcher?

Reusable Launcher Imagine and Plan Worksheet Page 2

A View of the Reusable Launcher:

2. Reusable Launcher Data Table

What might you be trying to learn by changing the distance that you pull the rubber band backwards before launching?

In the first column, write the distance the rubber band will be pulled in the first set of launches. Be sure to measure from the edge of the launching surface to the point of release. You would then change that distance, and enter the new distance in the second three boxes.

Distance the rubber band is pulled backwards prior to test launch.	**Trial Number**	**Dependent Variables**	
		Distance traveled (meters)	**Distance from target (meters)**
Set-up A: _____ cm	1		
Set-up A: _____ cm Should be the same as above	2		
Set-up A: _____ cm Should be the same as above	3		
Set-up B: _____ cm	1		
Set-up B: _____ cm Should be the same as above	2		
Set-up B: _____ cm Should be the same as above	3		

3. Summary: Questions/Discussions for Understanding

What was the greatest difficulty you and your team had today while trying to complete the Reusable Launcher challenge?

Tell how you solved your greatest team difficulty in 2-3 sentences.

Why was it important that the launcher be reusable?

Why was it important that your results were repeatable?

Team Name:_____

Fun with Engineering at Home

Activity 3: Launch Your Crew Exploration Vehicle

Today we designed and built a Reusable Launcher to launch the CEV model that we built last week. We were designing the Reusable Launcher to get to a certain distance (5-meters), so that the CEV could meet up with the International Space Station on its way to 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** and **CREATED** our Reusable Launcher. Finally, we **EXPERIMENTED** or tested our launcher by trying two different set-ups to see how that affected the distance that the CEV traveled. Last, we went back to our team station and tried to **IMPROVE** our Reusable Launcher. These are the same 6 steps engineers use when they try to solve a problem or a challenge.

Home Challenge: Next week we will switch gears from getting off the Earth to landing on the Moon. Here are some questions to talk about with your parents, grandparents, brothers or sisters:

How a spacecraft might land on the Moon safely?

Why it doesn't make sense to use a parachute on the Moon?

Here is a link to a great NASA animation of a lunar landing!

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

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