LCROSS (Lunar Crater Observation and Sensing Satellites) Design Challenge

(Adapted from NASA's "On the Moon" Educator Guide)

Objectives

Students will:

- Design a device that will drop a marble at a precise moment to make an impact crater.
- Learn how LCROSS impacted the moon and discovered water ice.

Suggested Grade Level

4th -12th

Subject Areas

Earth Science, Space Science, Engineering

Timeline

40 Minutes

Standards

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

21st Century Essential Skills

- Critical thinking/Problem solving
- Creativity/imagination
- Collaboration and Teamwork
- Carrying out investigations

Background

In 2009, the centaur rocket stage of the Lunar Crater Observation and Sensing Satellites (LCROSS) impactor hit the south pole of the moon at the Cabeus B crater. The main LCROSS mission objective was to confirm the presence or absence of water ice in a permanently shadowed crater near a lunar polar region. The shepherding spacecraft of LCROSS flew through the debris sent into space by the impactor. The data that was transmitted to Earth from LCROSS showed that water ice was found in the ejecta from the impact crater.

This challenge has students designing and building a system that will drop a marble from a cup on a zip line over a specific target at a specific time. Students will need to design a release system that will accomplish this task over a simulated lunar surface.

More background information can be gained from the NASA on the Moon educator guide.

Vocabulary

Impactor, ejecta, acceleration, Newton's Laws of Motion, trajectory

Materials

- 9 feet (3m) of smooth line (e.g., fishing line or kite string) (1 per group)
- 3" by 5"Index card (2-3 per group)
- Marble (1 per group)
- Masking tape (1 foot per group)
- Paper clip (2-3 per group)
- 1 medium-sized paper cup (1 per group)
- Scissors (1 per group)
- Large basting pan (1 per set up)
- Flour (enough to cover the bottom of each pan)
- Cocoa powder or Nesquik® (2-3 Tablespoons per pan)
- Plastic bags (1 under each pan)
- iPads (1 per group)

Lesson

1. Before the class arrives, set up a zip line or two. Tie approximately six feet of the smooth fishing line to two objects. Chairs will suffice. Make sure the line is pulled taut and the line slopes down. One end should be about 20 inches lower than the other.
2. Explain the LCROSS mission to the students and the discoveries made.
3. Explain the challenge to the students and break them into groups of 3.
4. Students must brainstorm the system that they will need to build to accomplish the task. Have them answer the following questions:
    a. How will you modify the cup so it can carry a marble down a zip line and drop it onto a target?
    b. How will you remotely release the marble from the cup?
    c. When do you need to launch the marble so that it will hit the target?
5. Have the students design the drop system.
6. Allow the students to do several practice runs to perfect their system. However, put a time limit on the design process.
7. Place a target (a basting pan with an inch of flour covered with the cocoa powder makes a great lunar surface) on the floor below the lower end of the string.
8. For easier clean up, place the plastic bags underneath the target area.

9. Have students explain their drop system to the rest of the class.
10. Perform the real drop tests.
11. If time allows and if desired, allow students to reengineer their system and test again.
12. As an optional extension, have students film their drop tests using the slow-mo camera feature on an iPad. This will allow students to really visualize just how far the debris went into space during the actual LCROSS mission.

Extensions

- Increase the challenge by making the drop steeper to increase speed and decrease the target area.
- Have students patent their design, and create a sales pitch to NASA to "buy" their device.

Resources

Dunbar, B. (2010, January 25). On the Moon Educator Guide. Retrieved May 22, 2019, from http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/On_the_Moon_Guide.html