

LCROSS DESIGN CHALLENGE

GRADE LEVEL

4th – 12th

TIMELINE

40 Minutes

NGSS STANDARDS

- 3-5-ETS1-1
- MS-ETS1-3
- HS-ETS1-2

INTRODUCTION

OBJECTIVES

Students will:

- Design a device that will drop a marble at a precise moment to simulate making an impact crater on the moon.
- Learn how the LCROSS mission impacted our knowledge of the moon and discovered potential water.

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 (Optional 1 per group)

TEACHER PREPARATION

- Before the class arrives, set up between two to four zip lines. Tie approximately six feet of the smooth fishing line to two objects, for example from a ceiling tile to a chair. Make sure the line is pulled taut and the line slopes down. One end should be about 20 inches lower than the other.
- At the bottom of each line, use the basting pan, flour, and cocoa powder to create a simulated lunar surface with layers of flour and cocoa powder. For easier clean up, place the plastic bags underneath the target area.

LESSON INSTRUCTIONS

ENGAGE (5 MINUTES)

- In 2009, the centaur rocket stage of the 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. More background information is available from the website listed under the resources section (NASA, 2024).
- Explain the challenge to the students and break them into groups of 3.
 - During this challenge, students will design and build 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.

EXPLORE (20 MINUTES)

- Students must brainstorm a system they can build to accomplish the task and be able to answer the following questions:
 - a. How will you modify your supplies so it can carry a marble down a zip line and drop it onto a target?
 - b. How will you use something other than just hitting the chair at the bottom of the line to “remotely release,” the marble from the cup?
 - c. When do you need to launch the marble so that it will hit the target?
- Have the students go through the Engineering Design process to create their drop system. Limit the amount of supplies they can use to make it more like a real-life design challenge – NASA must work within a budget, so do your students. Feel free to change the materials available to students depending on what you have easily available.
- Allow the students to do several practice runs to perfect their system. However, put a time limit on the design process.

EXPLAIN (10 MINUTES)

- Have students explain their drop system to the rest of the class.
- Perform the real drop tests.

ELABORATE (OPTIONAL ~15 MINUTES)

- If time and as desired, allow students to redesign their system and test again.
- Increase the challenge by making the drop steeper to increase speed and decrease the target area.
- Have students film their drop tests using the slow-motion 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.

EVALUATE (5 MINUTES)

- Have students review each other’s designs and decide which method or methods were most effective.

- Ask students follow up questions such as, “What supplies they wish they had to work with, was there any supply you did not use, which parts of the challenge were hard, and which were easy?” etc.
- Ask students to help you clean up any mess made by their marble impacts.

RESOURCES

NASA. (2024, November 3). LCROSS: Lunar Crater Observation and Sensing Satellite. NASA Science. <https://science.nasa.gov/mission/lcross/>

