

LCROSS Design Project

Introduction (10 minutes):

To see if there was water on the Moon, NASA sent the Lunar Crater Observation and Sensing Satellite (LCROSS) hurtling into the bottom of a crater near the moon's South Pole. The collision sent a plume of dust and gas. Analysis of the plume found water as well as other useful gases and minerals.

Watch the following video which explains the LCROSS mission:

<https://youtu.be/yaa2-gSdwsu>

Just as the success of LCROSS depended on hitting the crater exactly, today's activity depends on being able to hit a target precisely and consistently. Each team of students will turn a paper cup into a carrier that can slide down a line and drop a marble on a target.



Above is an artist rendition of the Centaur upper stage rocket approaching the moon with the LCROSS shepherding satellite attached.

Instructions – LCROSS Design Process

Materials:

- 9 feet (3m) of Smooth Line (e.g., fishing line or kite string)
- Index Card
- Marble
- Masking Tape
- Paper Clip
- 1 Medium-sized Paper Cup
- Scissors
- Target printed on a piece of paper (see end of instructions)

Instructions (50 minutes):

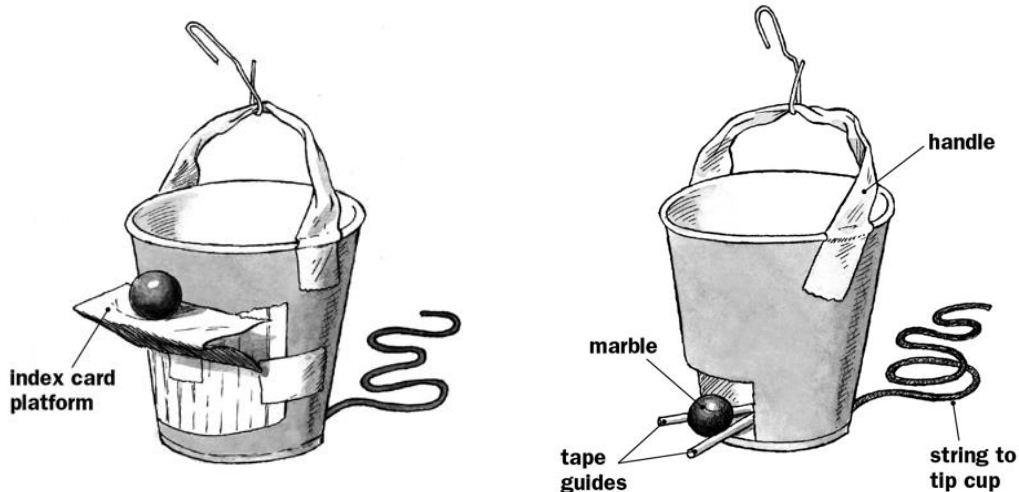
The goal is to modify a cup so it can slide down a line and drop a marble onto a target and make a precision landing much like the engineers at NASA had to do when they designed the LCROSS Spacecraft.



Basic Set-up

Instructions - continued:

- 1. Brainstorm and Design:** Think about how you might design a way to carry and launch a marble:
 - How will you modify the cup so it can carry a marble down a zip line and also drop it onto a target?
 - How will you remotely release the marble from the cup?
 - When do you need to launch the marble so that it will hit the target?



Above are two sample marble carrier solutions using the given materials, but let the teams come with their own design.

2. Build

- First, set up a zip line. Tie 6 feet (1.8 m) of the smooth line to two objects (e.g., two chairs or a table and chair). Make sure it's stretched tight and that one end is about 20 inches (50 cm) below the other.
- Next, figure out how to modify the cup to carry the marble down the zip line. Will it travel inside the cup? Outside the cup on a platform? Underneath?
- Then, add a remote release. Decide how you will tip the cup at just the right instant to launch the marble toward the target.
- Finally, clip the cup to the zip line. Figure out how to hook the cup onto the zip line so it slides easily.

Instructions - continued:

- 3. Test, Evaluate, and Redesign:** Ready for a test run? Place the target near the end of the zip line. Send down the cup and try to hit the target with the marble, using the remote release. How close did you get? See a way to improve your design? Engineers improve their designs by testing them. The steps they follow are called the design process. Try your idea and build an improved version.

Help the students troubleshoot any issues. For example:

- **If the cup moves too slowly**—Check that the zip line is steep enough. Also, make sure the cup slides freely.
 - **If the marble accidentally falls before being released**—Roll a small tube of tape to keep the marble from falling out accidentally. Also, adjust the tilt of the cup so it doesn't tip the marble out.
 - **If the marble isn't releasing cleanly**—Roll small tubes of tape and build a chute to funnel the marble toward the opening. If necessary, adjust the tilt of the cup so the marble can roll out more easily.
 - **If the marble misses the target**—Since the marble is already moving forward along the zip line, it keeps moving forward as it falls. Make sure to take this forward motion into account as you choose a release point.
- 4.** The teams that successfully hit their target will receive a prize.

