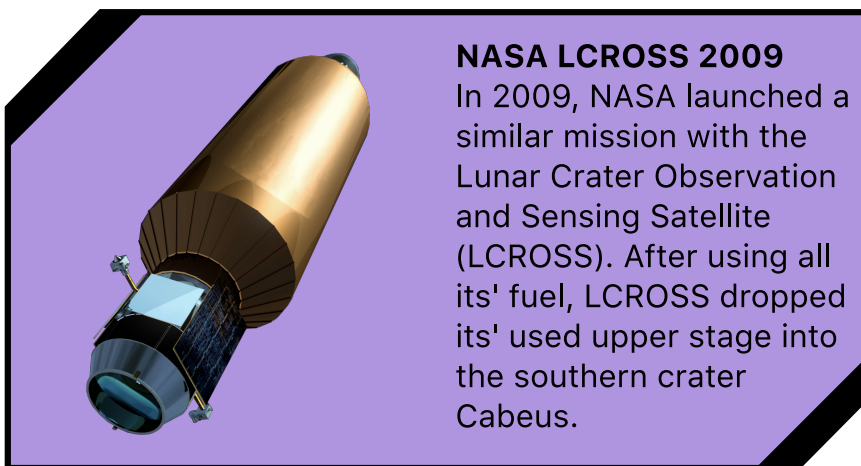


# Orbital Trajectories

Thanks to NASA, the Moon is getting a new crater! NASA is sending a spacecraft hurtling into the Moon's surface. Why? To see if there's water below the surface. This collision will send up a plume of dust and gas over 6 miles (10 kilometers) high. To tell if there's any water, scientists will look for ice crystals and water vapor in this plume.



## NASA LCROSS 2009

In 2009, NASA launched a similar mission with the Lunar Crater Observation and Sensing Satellite (LCROSS). After using all its' fuel, LCROSS dropped its' used upper stage into the southern crater Cabeus.

## MATERIALS

- Fishing line
- Paper cup
- Index card
- Paper clip
- String
- Toothpicks
- Marble
- Target
- Masking tape \*\*\*
- Scissors \*\*\*
- Chairs for zipline \*\*\*

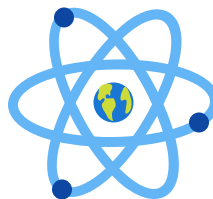
\*\*\* Materials found at home

## WE CHALLENGE YOU TO

Design, build, and test a spacecraft that will release a lander to hit its' desired target

## AND LEARN ABOUT

- Orbits
- Trajectories
- Momentum



## FURTHER EXPLORATION

**Academo Orbit Simulator** | <https://academo.org/demos/orbit-simulator/>

**PhET Orbit Simulator** | [https://phet.colorado.edu/sims/html/gravity-and-orbits/latest/gravity-and-orbits\\_en.html](https://phet.colorado.edu/sims/html/gravity-and-orbits/latest/gravity-and-orbits_en.html)

**How We Are Going to the Moon** | [https://youtu.be/\\_T8cn2J13-4](https://youtu.be/_T8cn2J13-4)

## DESIGN & BUILD

- 1) Brainstorm ideas about how you can create a spacecraft to release a lander (marble) to hit the desired target
  - a. Will the lander (marble) travel on the inside or outside of the craft?
  - b. How will the spacecraft release the lander?
  - c. At what point along its path do you need to release the lander?
- 2) Sketch your design
- 3) Build your spacecraft using the materials provided

## SAFETY TIPS



- Be careful with scissors!
- Do not stand in the path of the marble



## TEST

- 4) Set up the target and zipline
  - a. Use the fishing line to create a zipline about 10 feet long between two surfaces at different heights. For instance, you can connect one end to a chair or door handle and the other end taped to the floor.
  - b. Place the paper target under the zipline about 2 feet from the lower end.
- 5) Hang the spacecraft on the zipline
  - a. Use the paperclip to hang the paper cup spacecraft on the zipline
  - b. Make sure the paper cup and the paperclip can slide freely from the top of the zipline to the bottom.
- 6) Launch and release
  - a. Send the spacecraft down the zipline and try to land the marble on the target using the release system you designed.
  - b. Use the rings on the target to track your accuracy over several attempts.



## TIPS

- If the spacecraft goes slowly, try making the zipline steeper.
- If the lander doesn't stay in your spacecraft, try changing the list of the spacecraft or adding a small piece of tape to keep the lander from falling out early.
- If the lander doesn't come out, try adjusting the tilt of the spacecraft or building a chute with tape or toothpicks.
- If the lander misses the target, try releasing it earlier since the lander is moving forward along the zipline it will continue to move forward as it falls.



## DISCUSS

- A. How does the lander respond if you launch further down the zipline?
- B. What parts of your design were important to ensure the lander hit the target?
- C. What was the trajectory of the lander after being released?
- D. How can you improve the release mechanism?