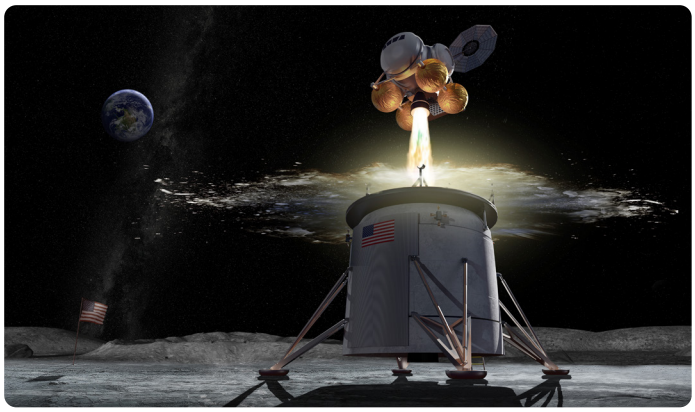
NASA STEM ACTIVITY

ON TARGET

National Aeronautics and Space Administration

The Artemis 3 mission will land astronauts on the south pole of the Moon. Our orbiting platform, Gateway, will allow us to land in almost any location we choose using an ascent/ descent vehicle – the human landing system. It is important that it lands in just the right spot for the safety of the astronauts and the success of the mission.

On Target is an engineering design activity that gives you the opportunity to design your own model to land on a target.



CHALLENGE

Modify a paper cup so it can zip down a line and drop a marble onto a target. Follow the engineering design process to:

1. Modify a cup to carry a marble down a zip line.
2. Attach a string to tip the cup and release the marble.
3. Test the cup by sliding it down the zip line, releasing the marble and trying to hit a target on the floor.
4. Improve your system based on testing results.

MATERIALS

- 9 feet (3m) of smooth line (e.g., fishing line or kite string)
- Index card
- A marble
- Masking tape
- A Paper clip
- 1 medium-sized paper cup
- Scissors
- Target drawn on a piece of paper

BRAINSTORM AND DESIGN

Brainstorm and decide how you want to carry and launch the marble. Ask yourself:

- 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?

CHALLENGE YOURSELF

How would you modify your cup? Be creative with what you have around the house.
Where is the best place for the marble?
If you don't have a cup, what else can you use? How about a paper tissue roll?
Take a look at the drawing for some inspiration and try something new!

BUILD

1. 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 is stretched tight and that one end is about 20 inches (50 cm) below the other.
2. 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? It's up to you!
3. Add a remote release. Decide how you will tip the cup at just the right moment to launch the marble toward the target.
4. Clip the cup to the zip line. Modify and decide how to hook the cup onto the zip line so it slides easily.

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.

WHAT YOU LEARNED

- **Newton's First Law**: As it travels down the zip line, the marble builds up a forward speed. Once launched, it will keep going at that speed until a force acts on it, such as hitting the ground.
- **Acceleration:** Due to Earth's gravitational pull, the marble's speed increases as it falls.
- **Vectors:** The marble's motion has both a horizontal and a vertical component, and these motions can be represented in a vector diagram.
- **Trajectory:** When an object that's already moving horizontally is dropped (like a marble dropped from a cup moving down a zip line), it travels in a curved path, called a trajectory.
- **Potential and kinetic energy:** The marble's stored (potential) energy changes to motion (kinetic) energy as it falls.
- **Measurement**: You measure to make the zip line. You also measure the height from which their marble is dropped and how far it lands from the target.

IMPROVE YOUR IDEA

For example, if your cup:

- **Moves slowly:** Check that the zip line is steep enough. Also, make sure the cup slides freely.
- **Can't keep the marble in**: Roll up a small amount 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.
- **Doesn't let the marble out**: 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.
- **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.

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