Subject: Engineering
Duration: 30 min - 1 hour
Location: Indoors or Outdoors

Roving on the Moon

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Overview

In this activity, students build a rubber-band-powered rover that can scramble across the room. Students will follow the engineering design process to design and build a rover out of cardboard, figure out how to use rubber bands to spin the wheels, and improve their design based on testing results.

Background

NASA plans to land astronauts on the moon by the year 2024. The astronauts will need moon cars—called rovers—to drive across the moon's surface, carry supplies, help build their outpost, and explore the area. Today you'll build and test a rubber band-powered rover.

First, you will make a rover prototype. Prototypes are used all the time in engineering. They give you a basic design to build, test, and evaluate. Once you understand a design's strengths and weaknesses, you can then find ways to improve it. Today, for example, as you test your rover prototype, you'll find ways to make it work better. Improving a design based on testing is called the engineering design process.

Materials (for one rover)

- corrugated cardboard body (6-inch/15-cm square)
- 2 corrugated cardboard wheels (5-inch/13-cm square)
- 1 sharpened round pencil
- 2 rubber bands
- ruler
- tape
- 2 round candies (the hard, white, mint ones with a hole in the middle) OR 2 round pieces of cardboard (2-3-inch diameter with a hole cut out in middle)
- 1 plastic drinking straw
- scissors

Brainstorm Questions

What do we have to make the rover move?
How can you make different types of wheels?
How do you think square wheels affect how the rover moves across the floor?

Procedure

1. **Make the rover body** - Fold the cardboard into thirds. Each part will be about 2 inches (5 cm) across. Fold along (not across) the corrugation (the tubes inside the piece of cardboard).

2. **Make the front wheels** - On the two 5-inch (13-cm) cardboard squares, draw diagonal lines from corner to corner. Poke a small hole in the center (that's where the lines cross). On the body, poke one hole close to the end of each side for the axle. Make sure the holes are directly across from each other and are big enough for the pencil to spin freely.
3. **Attach the front wheels** - Slide the pencil through the body's axle holes. Push a wheel into each end. Secure with tape.
4. **Make the rear** - Tape the straw under the back end of the rover. Slip a candy/small cardboard wheel onto each end. Bend and tape the axle to stop the candies/cardboard wheels from coming off.
5. **Attach the rubber band** - Loop one end around the pencil. Cut small slits into the back end of the body. Slide the free end of the rubber bands into the slits.

   Possible Problems & Solutions:
   - **Wheels don't turn freely** - Make sure they are firmly attached to the axles and are parallel to the sides. Also make sure the holes punched in the cardboard body are directly across from one another and are large enough to allow the pencil to turn easily.
   - **Won't travel in a straight line** - Make sure the axles are straight and the front wheels are the same size. If one wheel is smaller, the rover will turn in that direction.
   - **Doesn't go far** - You must wind up the wheels more. Also try using larger wheels. Bigger wheels have a larger perimeter (outer edge). As a result, one rotation of a large wheel will move the rover farther than one rotation of a small wheel.
   - **Wheels spin out** - Wheels spin in place when a rubber band delivers too much power at once or when there's not enough friction between the wheels and ground. To increase friction, add weight over the drive wheels or add more wheels to each axle. To reduce how quickly a rubber band releases its power, you can reduce tension by using a rubber-band chain or by cutting open a rubber band and using only a single strand of elastic.

<u>Discussion</u>

- ***Problems?***
  Talk about any problems that may have come up while building your rover. How were you able to overcome these problems?
- ***What kinds of Earth vehicles are similar to rovers?***
  Snowmobiles, tanks, dune buggies, and all-terrain vehicles are similar. They all have good traction, are very stable, have powerful engines, and don't require a roadway.
- ***The challenge sheet gave you a rover prototype to get started with. How did starting with a prototype help you end up with a rover that worked really well?***

With a prototype, we can quickly see what's working and what isn't. Then we know where to make improvements.

- ***How did friction affect your rover?***
  To be efficient, there needs to be minimal friction between the axle and the axle hole in the cardboard. To move, there needs to be lots of friction between the wheels and the ground.
- ***How did the rover use potential and kinetic energy?***
  Potential energy is energy that is stored. Kinetic energy is the energy of motion. Winding the front wheels increased the amount of potential energy stored by the rubber band. When the wheels spin, this potential energy is turned into kinetic energy, and the axle and wheels turn.
- ***How does the story about rover wheels on the back of the handout make you think about what it takes to design a wheel that can work on the moon?***
  We see that engineers face special design challenges when developing equipment to be used in space.