Balloon Rover

Overview:
In this activity, students will work in teams to design, build, and test a balloon powered rover.

Goals:
- Practice the Engineering design process.
- Explore Newton's Laws of Motion.
- Design, build and test a balloon powered rover.

Time Required: 1-1.5 hours

Materials:
- A base for the car (Small Cup, Plastic Bottle, Cardboard Box, etc.)
- Wheels (Plastic Bottle Caps, Cardboard Circles, CDs, etc.)
- Axle Hub (Straws, Tape, etc.)
- Axles (Wooden Skewers, Straws, etc.)
- Balloon
- Rubber Band
- Tape
- Scissors, wire cutters, hobby knife
- Hot Glue (use caution with younger students)
- Student worksheets

Procedures:
1. Tell students: The rovers on Mars are powered using solar panels. Today we are going to build rovers powered by balloons.
2. The instructions shown below provide just one way to build a balloon car, but you do not have to use the exact materials listed. Give your students a chance to improvise and use other materials.
3. 10-15 minutes: Talk about some ways you might build your car. Show students how to attach the balloon to a straw to power the car. Discuss the importance of wheels and axels. Encourage students to experiment with how they can use two different size diameter straws or a straw and skewer so the axels spin freely. Skewers can be easily trimmed using wire cutters. If desired, show students pictures of different balloon powered car designs (a quick google search will pull up several), or allow them a chance to do some research on their own.
4. 10-15 minutes: Have students begin by coming up with a plan to build their car. They should work with their groups to draw a sketch and make a list of materials they will need.

5. 30-45 minutes: Students should build and test their cars. What do they need to change? How can they make improvements? Can they get the car to go faster? Farther? Look cooler?
6. 10-15 minutes: Give each group a chance to present and demonstrate their cars to the rest of the class.

To build a car (an example):

1. Cut two straws so that they are slightly longer than the width of the base.
2. Tape the straws to the bottle. Make sure they are parallel.
3. Cut the skewers so they are slightly longer than the straws.
4. Use the hobby knife to make small holes in the center of all four bottle caps.
5. Push a skewer through one of the holes.
6. Thread the skewer through one of the straws, pointy end first.
7. Push a bottle cap onto the other end of the skewer. This makes an axle with two wheels.
8. Repeat steps 5-7 to make a second axle.
9. Make sure your axles spin freely. Put the car down and make sure it rolls smoothly. It might get stuck if the wheels wobble or the axles are not parallel. Adjust them if needed.
10. Slide the short end of the third straw into the neck of the balloon.
11. Tightly wrap a rubber band around the neck of the balloon.
12. Blow the balloon up through the straw to make sure there are no leaks.
13. Cut a small hole (big enough for the straw) in the top of the car.
14. Press the free end of the straw through the small hole and out the mouth of the bottle.
15. Tape the straw so it points backwards, not down.
16. Inflate your balloon, cover the tip of the straw with your fingertip to keep the air in the balloon until you put it down. Put the car down and release!

Troubleshooting your car:

- If your car does not move at all, or moves very slowly, inflate the balloon more and try again.
- Try adjusting the angle of your straw, a slight downward angle may work better.
- If the car still does not move, double check your axles to make sure they spin freely. If the wheels and axles are not aligned, the balloon might not be strong enough to push the car forward. Adjust as necessary.

Reflection:

- How would you build your car differently, using the knowledge you have now?
- How does this car reflect all of Newton's Laws of Motion?
  a) A body at rest persists in its state of rest, and a body in motion remains in constant motion along a straight line unless acted upon by an external force.
  b) Force is equal to Mass times Acceleration.
  c) To every action, there is an equal and opposite reaction.

Common problems / Additional guidance:

- Modify materials as needed for the ages/abilities of your group. For younger students, restrict the use of hot glue and hobby knife to adult facilitators.
- Use hot glue only with adult supervision. A low-temp glue gun could be a good alternative.
- Legos, k'nex or other building sets could be used as well.
- Set up a race to see which car is the fastest or see which car will travel the farthest.
- Design your car to use a different power source, like the wind, rubber bands, or a mousetrap.

Adapted from the following lessons:

- Science Buddies Build a Balloon Car (provides video instructions on building a car in both English and Spanish, and a good explanation of Newton's Laws): https://www.sciencebuddies.org/stem-activities/balloon-car
- Science Teaching with Lynda R. Williams, STEM Challenge: Making a Balloon Car (shows some simpler designs that may work better for younger students): https://teachingscience.us/stem-challenge-making-a-balloon-car/