Mars Rover Wheels

This lesson is adapted from “Reinventing the Wheel (for Mars)” by Xochitil Garcia a Science Friday. **https://sciencefriday.com/educational-resources/redesigning-the-wheel-for-mars/**

Overview: Today we will be building model rovers built of wooden dowels and powered by a rubber band motor. The students will build their rovers and begin by testing plain cardboard wheels. After learning the testing course, students are encouraged to design and build more advanced wheels and test them. These wheels must meet a maximum weight requirement.

Purpose:

- Learn about the number of rover missions that have been sent to Mars
- Understand desireable characteristics for rover wheels: durability, ability to travel long distances under a given amount of power, high traction
- Understand design constraints on Mars rovers: weight

Background: Pull up “Mars Rover Background” Doc

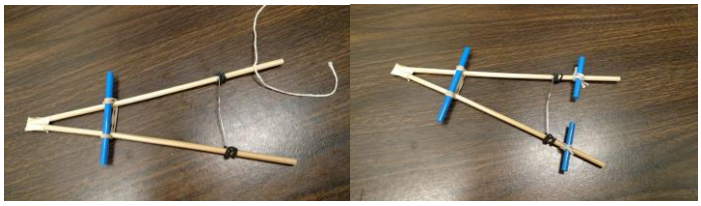
- What are we seeing in this picture? *Mars Rovers.*
- How did they get there? *We sent them there, they landed, etc.*
- Why did we send them there? *To study our neighboring planet, specifically to look for evidence of liquid water.*
- Why did we choose to send Curiosity to the Gale crater? *The Gale crater is home to Mt. Sharp, a layered mountain thought to have previously contained liquid water. Analyzing the composition of these layers may tell scientists about the ways in which the climate/geology of the whole planet changed over time.*
- How does Mt. Sharps compare to Mt. Rainier? *They are almost the same size.*
- After viewing the timelapse video from Curiousity, ask about the terrain over which the rover is driving. *It is rocky and sometimes steep.*
- With the terrain in mind, what sort of wheels should a rover have? *Durable with high traction.*
- Finally, how easy is it to land a rover on Mars? *NOT EASY. The Atlas V rocket the launched Curiosity into space is very powerful but can only lift so much weight into space. Every single component of the rover has to be built to weigh as little as possible!*

Today we are building model rovers and will design, build and test several different types of rover wheels. First you are going to build the rover chassis and install some standard cardboard wheels. Then we will test the wheels in a variety of ways. We will test how far it can go on flat grounds; how it deals with rough terrain; how it deals with climbing an hill. After analyzing the cardboard wheels, we will work together to design better wheels and test them as well.

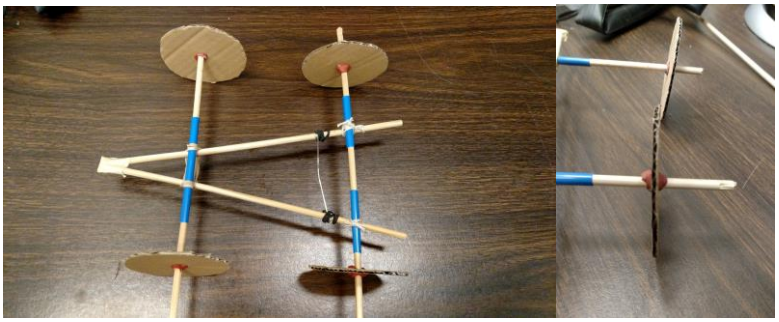
Procedure:

1. BUILD THE CHASSIS: Trim two dowels at the tip to make a miter (cut it at angle so that the two dowels sit flat against each other at an angle) and secure with one or two pieces of tape. This is the rover chassis. Use a straightened paper clip to shape the chassis into a triangle by wrapping each end of the paper clip around each dowel, close to the end of the dowel. You may want to secure the paper clip from slipping with a rubber band. The taped part of the chassis is the front and the paperclipped part is the back.

2. ADD THE BEARINGS: Cut your straw as shown below. Discard the bendy part. The large straw piece is the front bearing. Attach this to the chassis by holding the straw in place, looping on end of the rubberband over one side of the straw, passing the rubber band under the chassis and looping the other end over the other side of the straw. To attach the rear bearings, use the string to tie a very tight square knot to the dowel at the back the chassis. Then pass the string crosswise across the straw a few times and tie a looser square knot around the dowel. Do not compress the straw with an overtight knot. Repeat for the second rear bearing.

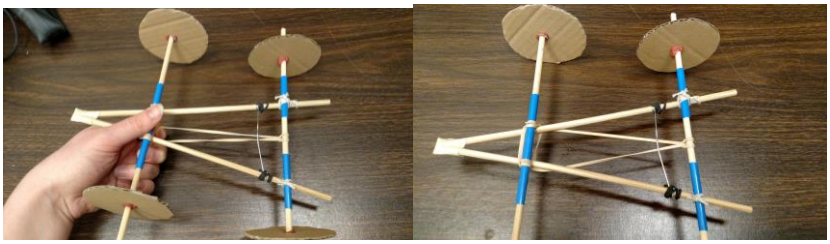


3. INSTALL AXLES: Slide the two remaining dowels into the front and back bearings.
4. INSTALL STOCK WHEELS: Use the axles the poke holes in the provided cardboard wheels. Slide the wheels onto the axles and secure with putty.

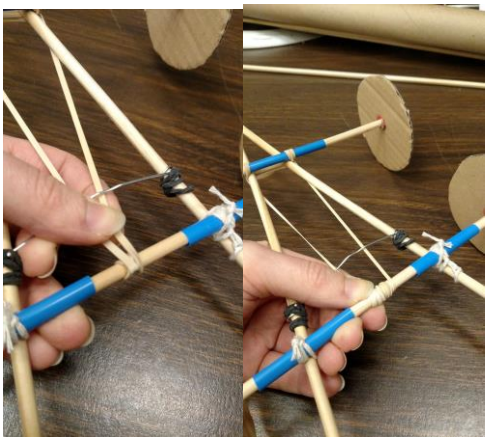


5. INSTALL MOTOR: Take the 7 inch rubber band and pull it around the rear axles between the two rear bearrings. Pull one end of the band through the loop at the other

end and pull tight. Pull the free end of the rubber band along the bottom of the chassis and loop it around the front axle.



6. START YOUR ENGINE: Holding the chassis in one hand prepare the manually turn the rear axle in reverse. Make sure the rubber band has folded over itself and begins winding up as your turn the axle. Turn until the rubber band is very taut but not so much that the bearings start to slip.



7. GO: Release the year axle for the first test run.

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8. TEST YOUR STOCK WHEELS:
    a. Determine how far your rover can travel with one winding on flat ground (flat carpet). Measure the distance traveled and record.
    b. Attempt to drive your rover up a hill (a cardboard incline). Note whether or not the rover is capable of maintaining control on an incline.
    c. Attempt to drive your rover over rough terrian. Note if the wheels stuck or suffered damage.
    d. OPTIONAL: attempt to drive your rover over ice (plastic sheet).
9. DESIGN NEW WHEELS:
    a. Survey the provided materials for alternate wheel designs.
    b. Remind students of the weight limit.
    c. Ask the students some leading questions: Which materials would help with durability? Which with traction? Can you use shapes other than circles? How does the size of the wheel affect the distance travelled?
    d. Depending on the size of the group, have the students sketch designs for new wheels.
    e. Have the students weigh the materials they will use before building them
    f. Build and install new wheels.
10. TEST NEW WHEELS: Repeat step 8.

Discussion:

Refer to “Mars Rover Wheels Background” Doc