West Virginia University EXTENSION SERVICE | 4-H
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STRAW ROCKETS

A WVU Extension Service STEMCARE Lesson

Audience:
Grades 3-12

Time:
45 to 55 minutes

5 minutes introduction; 25 minutes to design, construct and test slingshot straw rocket; 15 minutes of discussion, reflection, redesign and improvement of design.

Materials:
For each student: 1 large straw; 1 metal fastener; 1 craft stick; 1 pencil eraser; 1 large $7 \times \frac{1}{8}$ inch rubberband; cardstock or index cards to make fins; paper to plan and draw designs; scissors; masking tape

Safety Precautions:
This activity should be completed with adult supervision.

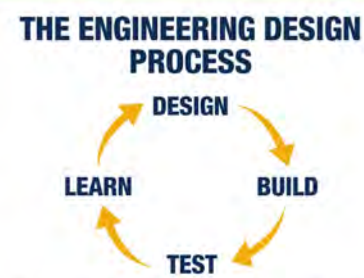
Vocabulary:
Drag, momentum, resistance, potential and kinetic energy

Goal:

To understand motion and forces as applied to a slingshot straw rocket and to use the engineering design process to improve the straw rocket.

Introductory Activities

When a rubber band is stretched, potential energy is stored in the stretched elastic. When the elastic is released this potential energy is converted into kinetic energy.



Source: http://www.thunderboltkids.co.za/Grade5/03-energy-and-change/chapter3.html

1. Explain to students that they will harness that energy to power a slingshot straw rocket that they customize.
2. Review the engineering design process.

Core Learning Activity

Students will create a rocket and launcher, then redesign the rocket as needed.

1. Ask students to describe a typical rocket in detail. Use leading questions: What does the top look like? What is it called? (Answer: nose cone) Does it have wings or fins? (Answer: fins)
2. Draw a prototype design on paper for a straw rocket. The design should incorporate an eraser cone, straw and two to four fins.
3. Cut fins for the rocket by cutting rectangles and then cutting diagonally from corner to corner. If time allows, color the rocket fins.
4. Place a piece of masking tape lengthwise over the fin such that half of the tape hangs over the edge. Place the fin on the bottom edge of the straw with about 1.5 cm of the straw exposed at the bottom (Figure 1). Wrap the remaining tape around the straw. Take another piece of tape and wrap on the other side of the fin.
5. Repeat this step for all fins. Be sure the fins are straight and symmetrical (Figure 2).
6. Bend the head of the metal fastener so that it is flat.
7. Tape the fastener 1 cm from the top edge of the straw (opposite end of the fins), with the tails of the fastener pointing toward the fins (Figure 3). Do not tape over the head of the fastener.

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Creating Your Rocket and Launcher

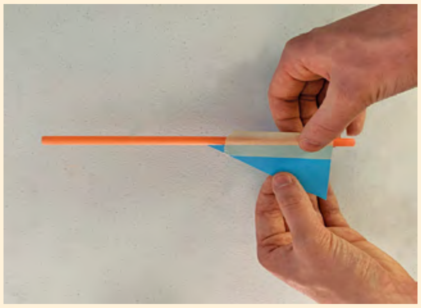

Figure 1. Tape fin to straw leaving 1.5 cm of the bottom of the straw exposed.

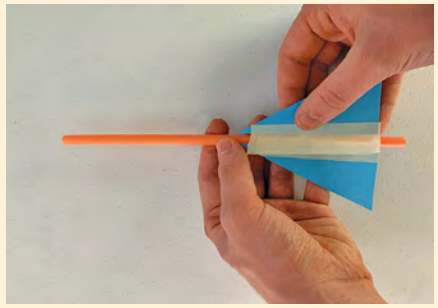

Figure 2. Tape remaining fins to straw.

Figure 3. Metal fastener should be approximately 1 cm from top edge of straw.

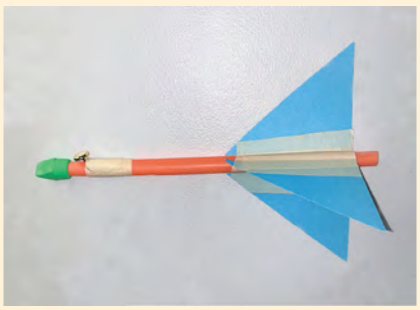

Figure 4. Completed rocket.

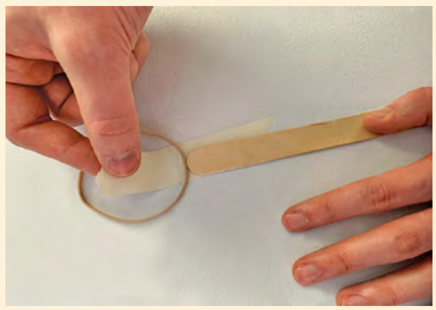

Figure 5. Fold double layer of tape over rubber band and onto craft stick to make launcher.

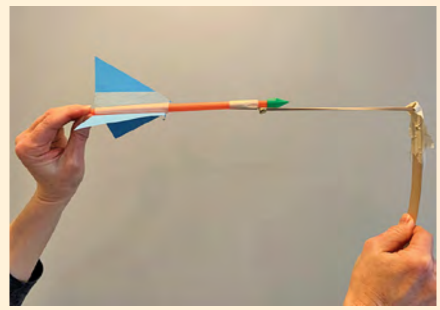

Figure 6. Launching the rocket.

8. Secure the pencil eraser to the top of the straw (Figure 4).
9. To make the launcher, cut two pieces of tape 10 cm long and lay them on top of each other in the same orientation so that one sticky side is still exposed.
10. Stick the inside loop of the rubber band to the tape so that they are perpendicular to each other.
11. Lay the craft stick on the tape so that the tip of the stick is touching the rubber band. The flat side of the stick should be on half of the whole length of tape (Figure 5).
12. Fold the other half of the tape over the craft stick and make sure it is firmly secured.
13. Launch the rocket in a safe space with adult supervision. To launch the rocket, hold the launcher in front of you in one hand and hold the bottom of the rocket in the other hand. Hook the metal brad of the rocket on the top of the rubber band launcher. Pull the rubber band back (AIM AWAY FROM PEOPLE, ANIMALS OR OBJECTS) and flick the launcher forward as you release the rocket (Figure 6). 3-2-1 Slingshot!
14. Redesign and test modifications.

Background: The Science Behind Straw Rockets

The energy the rocket needs for flight comes from the rubber band. Rubber bands are elastic, meaning that, when stretched, they return to their original shape. When you let go of the rocket, the rubber band returns to its original shape, pulling the rocket with it. This transforms the stored energy (potential energy) into the rocket's motion (kinetic energy). As the rocket moves through the air, forces such as gravity and air resistance, slow the rocket down. An upward angled straw will move up and forward. All directions of motion are resisted and slowed by air resistance (drag). At maximum height, the upward momentum is reduced

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to zero by gravity and drag. The rocket then travels downward due to gravity and continues forward due to the remaining forward momentum.

Safety Tips and Troubleshooting

- Always aim rocket away from others.
- Long rubber bands or two short rubber bands tied together work much better than one short rubber band.

Extension

Have youths work in teams to design and create several variations on the rockets (vary the size of the straw, type of eraser or size and shape of fins). Once rockets are completed, launch rockets and identify which rocket went the longest distance. Record on data sheet, have students graph results and analyze data to draw conclusions as to which type of rocket flew the best. Students should also discuss any interferences that may have caused certain rocket configurations and/or students to not do well. Additional supplies needed include long tape measure, tape, protractor, data collection sheets, protractors, graph paper or flip chart, and pencils or markers.

Resources

Akiyama, Lance, and Akiyama, Ali. Straw Rocket, STEM Inventions. https://www.stem-inventions.com/

“Educator Guide: Soda-Straw Rockets.” NASA. NASA, January 22, 2020. https://www.jpl.nasa.gov/edu/teach/activity/straw-rocket/.

West Virginia Next Generation Standards

General Science

- S.4.GS.4 – Apply scientific ideas to design, test and refine a device that converts energy from one form to another.
- S.5.GS.11 – Support an argument that the gravitational force exerted by Earth on objects is directed down.
- S.7.PS.7 – Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.
- S.HS.PS.17 – Design, build and refine a device that works within given constraints to convert one form of energy into another form of energy.

Engineering

- S.3-5.ETS.1 – Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost.
- S.3-5.ETS.2 – Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- S.3-5.ETS.3 – Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- S.6-8.ETS.1 – Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- S.6-8.ETS.2 – Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- S.6-8.ETS.3 – Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- S.6-8.ETS.4 – Develop a model to generate data for iterative testing and modification of a proposed object, tool or process such that an optimal design can be achieved.

WVU STEMCARE Straw Rockets Demonstration Video: https://youtu.be/DvshPvzwvWU

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