Puff Mobiles

Time
45 minutes or less

Careers
Environmental

Grades
3–5 • 6–8

Leader Notes

Renewable energy sources are in focus as participants build a wind-powered car using straws, Life Savers candies, paper, and tape, and get their car to the finish line using as few puffs of air as possible.

Materials

Per Whole Group:

- Scissors
- Ruler or tape measure
- Optional: Markers, colored pencils, and other craft supplies

Per Team:

- Drinking straws
- 4 Life Savers candies
- A few sheets of paper
- tape

Getting Ready

1. Use masking tape to create a starting line and a finish line 6 feet apart. Tables, hard floors, and countertops are good surfaces to test a puff mobile. Avoid thick-carpeted or tiled floors.

2. If you have access to 3D printers and design software, you can make your own reusable wheels instead of using Life Savers. If you use Life Savers, be sure to caution participants not to taste or eat any of the materials during this activity unless you have necessary consent.

Introduction

Ask questions to get participants thinking about how we can harness the power of wind:

- What is wind? (Moving air) What causes it? (The sun warms the air, hot air rises, and cool air moves in to take its place.)
- What are some ways that we use wind power to do work? (Wind turbines generate electricity; windmills pump water or grind grain.)
- How can we use wind power for transportation? (Sailboats, sail cars)

Instructions

Introduce the Design Challenge

1. Participants will build a wind-powered car using straws, Life Savers candies, paper and tape. The car should travel from the starting line to the finish line using as few puffs of air as possible.

A paper sail is one possible way to propel your puff mobile. Credit: Phil Noel, Connecticut Post.

2. Distribute materials to each group or participant. Encourage groups to talk about their design ideas before building.
   - What is the best size and shape for the sail?
   - Is it better to have one large sail or several small sails?

3. Participants build their puff mobiles. Test the cars to make sure they can be propelled by breath.
   - Measure how far the car can travel on a single puff of air.
   - How many puffs would it take to cross the finish line?
   - Is there anything you could change to make your car better?

4. Evaluate the success of each design.
   - Did you succeed in building a car that could roll along the ground?
   - How far could your car go on a single breath?

Activity Variations

1. Work in groups of three and assign a role to each person. One person is the designer, who draws a sketch of the car. One is the builder, who builds the puff mobile from the sketch. The tester tests the design and provides feedback to the designer for the next iteration.

2. Provide a variety of materials to use for wheels, like bottle caps, spools, CDs, or Lego wheels.

3. Use fans instead of breath to propel the cars. Set up the fans behind the starting point and have a race.

Troubleshooting

If the car has trouble moving, make sure the wheels can spin freely.

Relevant Terminology

- **Kinetic energy:** Energy of motion. Cars moving from the wind are using kinetic energy.
- **Renewable resource:** A natural resource that can't be used up. Solar energy and wind are both renewable resources.

Guiding Questions

Guidance for Younger Children

Questions To Ask After The Activity

- What were the challenges in trying to move your car with the power of breath?
- What shape did you use for your sail and why?
- Does changing the size of your sail or the number of sails change your results?
- Do you think using a different material for the wheels would have improved your design? If yes, what material would you have used?
- Why do you think the car moves when you blow on the sail?

Guidance for Older Youth and Adults

Questions To Ask After The Activity

- What factors did you consider when designing your car?
- What factors did you consider when designing your sail?
- What forces do you think are acting on your car?
- If you were given a variety of materials to choose from, what material would you use for your wheels and why?
- What modifications did you make to your design while testing and why?
- What ideas do you have for how this technology could be used in real-world applications?

STEM Connections

Guidance for Younger Children

Engineering Connections

Land sailing on a French beach.
Credit: Jean-Noël Lafargue/Wikimedia Commons.

The flow of air results in what we call wind power. It comes from the energy that exists because of the motion of the air. Wind power has been used by people around the world for thousands of years. Ancient engineers built ships that used the power of wind to push them to points around the globe. The Dutch began to build windmills nearly 600 years ago that could crush and process grain. Today, engineers are looking to use wind even more to meet global energy needs. Large wind turbines are being used to generate clean electricity, which is electricity that doesn't create pollution. Wind is even being used to power a new generation of cars on land. The Greenbird vehicle broke the land speed world record for a wind-powered vehicle in 2009. The sail-powered car achieved a top speed of over 125 miles per hour without the assistance of a conventional engine!

Science Connections

Sails have been used to power boats for thousands of years. But since the wind is always blowing in only one direction, how is it that sailboats can go in any direction they want? The answer lies in two main ways that a sailboat is designed. Both of the ways rely on angles. The first part of the design that enables a sailboat to move in different directions is the sail. Rather than be fixed in one position, the angle of the sail around the mast (which is the pole that the sail is attached to) can be changed. This allows sailors to adjust the sail to always catch the wind and propel the boat forward, regardless of which way the wind is blowing. The second way comes from two parts of the sailboat that are under water, so you can't see them: the rudder and the keel. The difference in angle between the keel and the rudder directs the water to one side or the other, steering the sailboat.

Guidance for Older Youth and Adults

Engineering Connections

Moving air has been used for ages to move boats, and now it is even being used to move cars on land. But is the top speed of these vehicles limited by how fast the wind blows? The answer seems like it should be yes, but it's not. A professor at the Massachusetts Institute of Technology (MIT) believed that a car could actually sail downwind faster than the wind is

blowing. That same year, two engineers built a vehicle called Blackbird to see if they could make it happen. The Blackbird uses a propeller rather than a sail. The wind starts by pushing the vehicle forward, and the wheels cause the propeller to turn. The turning propeller pushes the wind backward, which pushes the car forward. Upon testing the vehicle, they proved that the idea was correct. Blackbird was able to sail more than twice the speed of the wind. After making additional modifications for a second test the following year, Blackbird traveled at more than three times the speed of the wind that was powering it.

Science Connections

Vectors are quantities that have both magnitude (size) and direction. Examples of vectors are velocity and acceleration. Velocity is similar to speed, but what makes it a vector is that it is measured in a specific direction. For example, the speed of a sailboat could be measured as 15 knots, but its velocity would be measured as 15 knots north. Vectors are key to understanding how sailboats can sail in directions that are different from the direction the wind is blowing. Imagine the wind is blowing directly south, but a sailboat wants to travel to the east. The sailors on the boat rotate the sail so that it catches the wind and begins to move east. As the boat accelerates, the wind speed from the perspective of the sailors will seem to increase. In order to keep the boat accelerating, the sails need to be trimmed (pulled in or let out so that tension is the same across the sail). Eventually, the boat can accelerate no more and reaches a state of equilibrium with the wind, speeding across the water even faster than the wind is blowing.

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