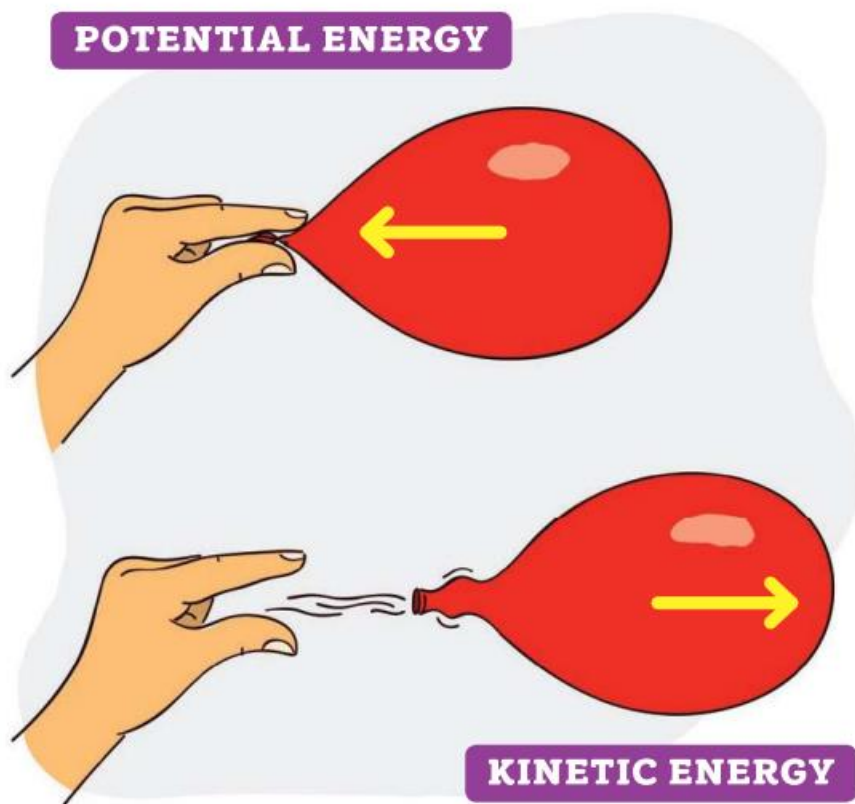


## Jr. Mechanical Engineering Paddle Boat Design Challenge

| <u>Activity</u>                                                                                                                                                                       | <u>Supplies Needed</u>                                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Discuss Potential and Kinetic Energy –<br>See diagram below.                                                                                                                          | None                                                                      |
| Make a Paddle Boat<br><br><a href="https://www.sciencebuddies.org/stem-activities/rubber-band-paddle-boat">https://www.sciencebuddies.org/stem-activities/rubber-band-paddle-boat</a> | 1. Cardboard<br>2. Duct Tape<br>3. Scissors/Box Knives<br>4. Rubber Bands |
| Test the Paddle Boats                                                                                                                                                                 | Body of Water                                                             |
| Discuss the Results                                                                                                                                                                   |                                                                           |
| Brainstorm ways to make the paddle boat better.                                                                                                                                       |                                                                           |

If an engineer wants to make an invention that moves, she has to know about potential and kinetic energy. There are lots of ways to store potential energy—in batteries, in springs, and even in your muscles. No matter how it is stored, when potential energy gets converted to kinetic energy, things MOVE! For example, when you bend your knees, they store potential energy that turns into kinetic energy that lets you launch up and jump!

How can you use air as your car's source of energy?



# WOMEN INVENTORS

What do windshield wipers, disposable diapers, and paper bags have in common? They were all invented by women.



The paper bag with a flat bottom was invented by **Margaret Knight** in 1868. Before she changed the design, paper bags were shaped like envelopes and couldn't stand up on their own.

**Mary Anderson** invented the first windshield wipers for cars in 1903. Her version had a lever to pull that would clear rain or snow from the windshield. At first, people didn't think it was a good idea, but by the 1920s, cars had automatic windshield wipers.



No more soggy diapers! **Marion Donovan** invented a waterproof cover for cloth diapers out of a shower curtain in 1951 and sold it at Saks Fifth Avenue, a fancy clothing store. A few years later, she invented the first completely disposable paper diaper.

## Women Inventors?

### Answer Sheet

|                                |                         |
|--------------------------------|-------------------------|
| Disposable Diapers             | Marion Donavan          |
| Windshield Wipers              | Mary Anderson           |
| Flat Bottom Grocery Bag        | Margaret Knight         |
| Circular Saw                   | Tabitha Babbitt         |
| Dishwasher                     | Josephine Cochrane      |
| Monopoly                       | Elizabeth Magie         |
| Invisible Glass                | Katharine Burr Blodgett |
| Solar Powered Heating System   | Maria Telkes            |
| Computer Software              | Grace Hopper            |
| Closed Circuit Television      | Marie Van Brittan Brown |
| Bullet Proof Vest              | Stephanie Kwolek        |
| Aquascope                      | Stephanie Kwolek        |
| Hand Cranked Ice Cream Freezer | Nancy Johnson           |
| Barbie Doll                    | Ruth Handler            |
| Bra                            | Mary Phelps Jacob       |

# WORDS TO KNOW

- ▶ An **axle** is a bar or spindle on which things can rotate, such as a rod passing through the center of each paddle.
- ▶ **Ballast** is weight that is used to keep a boat upright.
- ▶ **Buoyancy** is the force or pressure that pushes back on an object in the water. When an object is placed in water, it causes the water to push against it with the same force as the weight of the water it displaces. This is called Archimedes' Principle.
- ▶ The **Design Thinking Process** is the way engineers solve problems and build solutions. They define the problem, brainstorm and plan, build, test, and improve.
- ▶ **Engineers** are people who solve problems. They use their imaginations to invent new things like self-driving cars. They also come up with new and better ways to build things such as bridges, buildings, and planes.
- ▶ **Force** is the strength or energy that creates movement. Push and pull are examples of forces.
- ▶ **Kinetic energy** is when potential energy is released. Kinetic energy makes bodies and objects move.
- ▶ **Potential energy** is the energy stored in your body and everything else in our world.
- ▶ A **prototype** is a quick way to show your idea to others or to try it out. It can be as simple as a drawing or it can be made with everyday materials like cardboard, paper, string, and rubber bands.

## Build a Rubber Band Paddle Boat

### Summary

#### Active Time

20-30 minutes

#### Total Project Time

20-30 minutes

#### Key Concepts

Buoyancy, energy

#### Credits

[Ben Finio, PhD, Science Buddies](#)

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### Introduction

Build your own bathtub or pool toy from simple craft materials in this fun activity! You will build a rubber-band-powered boat that can zip across the surface of the water after you wind up the rubber band.

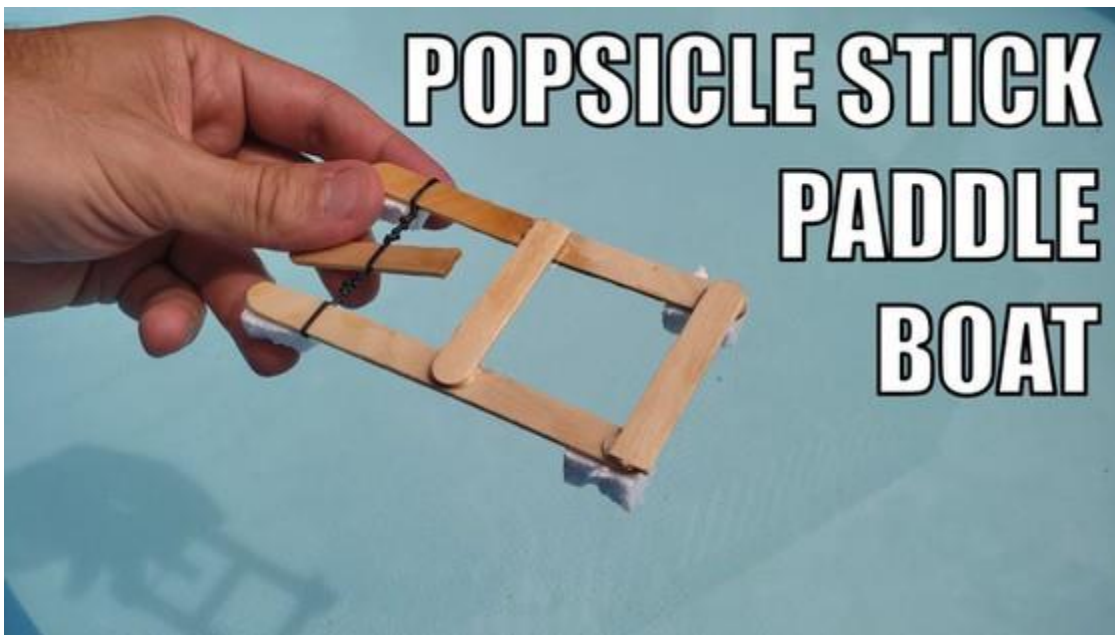
### Materials

- Rubber band
- Materials for the boat, such as:
  - Cardboard (requires duct tape for waterproofing)
  - Balsa wood
  - Popsicle sticks (requires hot glue gun for assembly)
- Optional: Small pieces of foam to make the boat float better

- Pencil
- Ruler
- Hobby knife or scissors
- Bathtub or kiddie pool

### Prep Work

1. Fill your kiddie pool or bathtub so you are ready to test your boat!
2. Depending on which materials you are using, you can watch video instructions on how to build your boat, or keep scrolling for written instructions.



# CARDBOARD & DUCT TAPE PADDLE BOAT



## Instructions

1. Make the hull of your boat.
  - a. If you are using balsa wood or cardboard, start with a rectangular piece that is about 3 by 5 inches. Cut corners or round off one end of the boat. This will be the front.
  - b. If you are using popsicle sticks, first score one by etching a line with the end of the scissors so you can more easily snap it in half, then glue the sticks together to make a frame, like the one pictured.



Image Credit: [Ben Finio, Science Buddies / Science](#)



[Buddies](#)

Image Credit: [Ben Finio, Science Buddies / Science Buddies](#)

2. Cut out a section for the paddle, approximately a 2-by-2-inch square (this step is not necessary if you built your frame from popsicle sticks).



Image Credit: [Ben Finio, Science](#)

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3. Make the paddle.
  - a. If you are using cardboard or balsa wood, cut the piece you removed from the hull so it is *narrower* than the gap. This will ensure it has room to spin without getting stuck.
  - b. If you are using popsicle sticks, cut another popsicle stick in half.

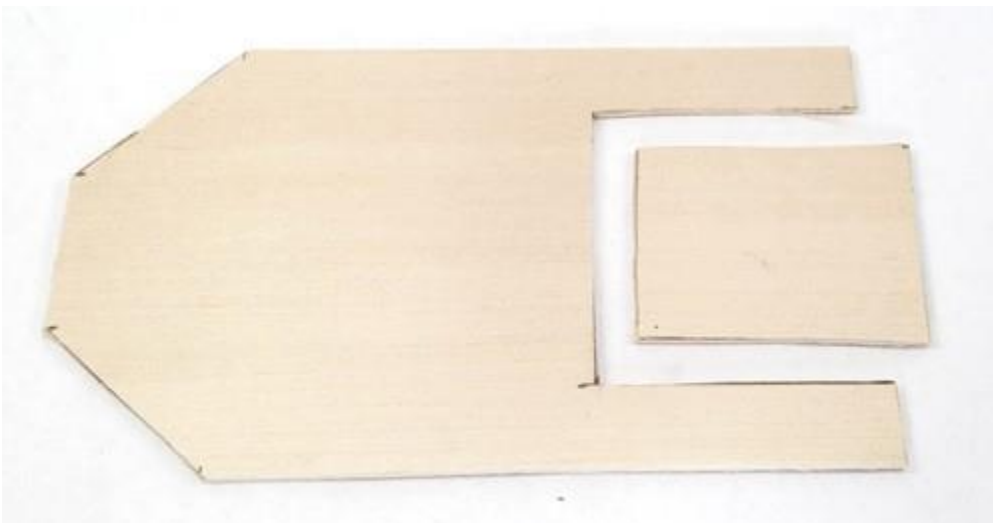


Image Credit: [Ben Finio, Science](#)

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4. If you are using cardboard, completely cover and seal both the hull and the paddle with duct tape to prevent them from getting wet.



Image Credit: [Ben Finio, Science](#)

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5. Stretch a rubber band across the gap in the hull. Slide the paddle through the rubber band, and twist it at least 20 times to wind it up. Hold the paddle in place so it does not unwind.

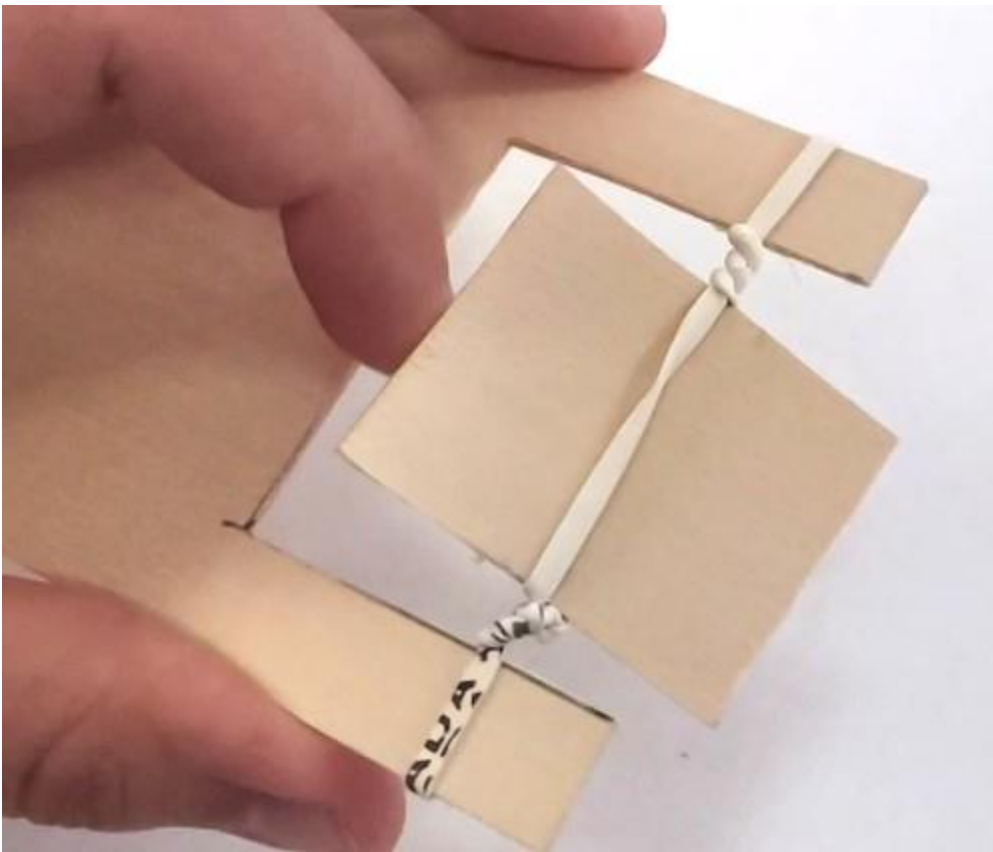


Image Credit: [Ben Finio, Science](#)

[Buddies / Science Buddies](#)

6. Put your boat down in the water, release the paddle, and watch it go!



How far does your boat go before it stops? If you wind the paddle up more, does the boat go farther?

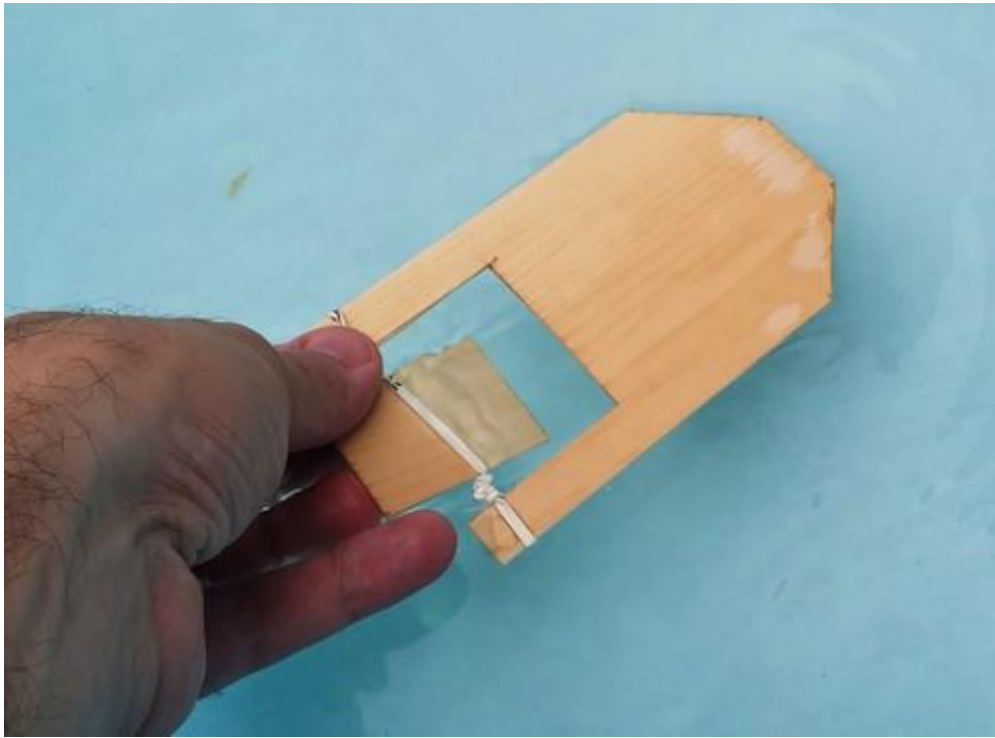


Image Credit: [Ben Finio](#),

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- 7.
8. Optional: Glue some small pieces of foam to the bottom of your boat to make it float better. This is especially useful for boats made from popsicle sticks.

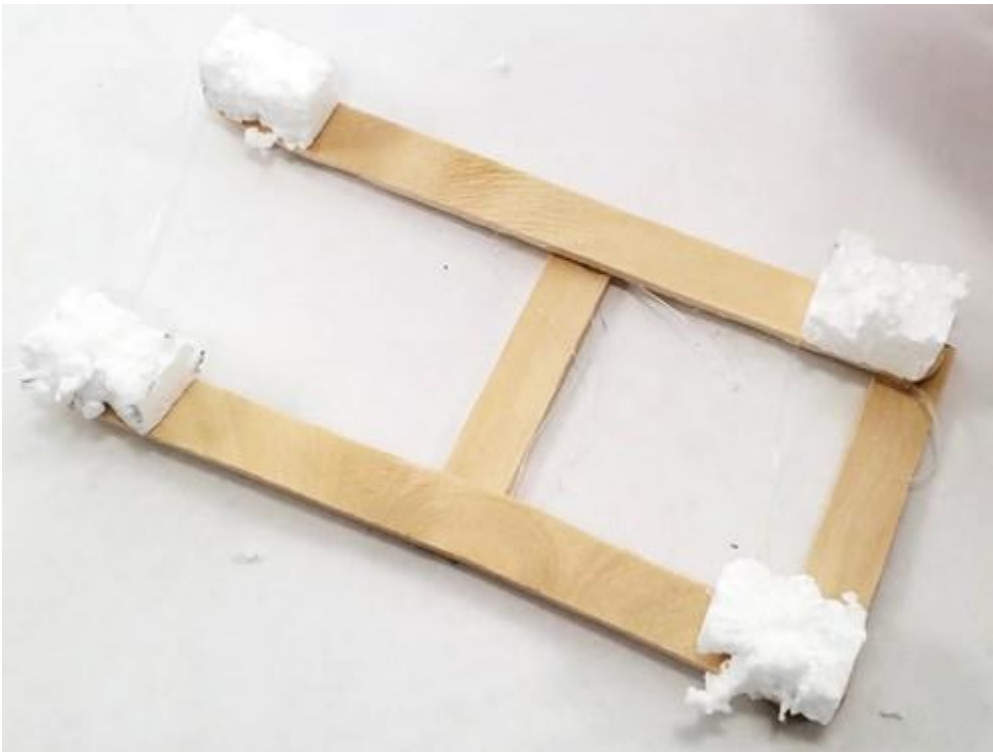


Image Credit: [Ben Finio, Science](#)

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### **Cleanup**

Do not leave your boat in the water for long periods of time or it may start to fall apart. Remove the boat from the water when not in use so it can dry.

### **What Happened?**

When you put the boat down in the water and released the paddle, the paddle should have spun, propelling the boat forward! The more times you wound up the paddle, the farther the boat should have gone.

### **Digging Deeper**

In this project you built a miniature version of a paddle boat. In the 1800s, large steam-powered boats that could carry lots of people were propelled by large paddles. Today, smaller recreational boats are powered by people, who sit and use *pedals* to turn the *paddles*, just like riding a bike.

The paddle boat is a good way to demonstrate two different laws of physics. First, it demonstrates conservation of energy. When you twist up the rubber band, it stores elastic potential energy (the energy stored in a stretched material). When you release the rubber band, this potential energy is converted to kinetic energy (the energy of motion), and the boat moves forward.

Second, when the paddle spins, it pushes on the water, pushing the water backward. According to Newton's third law of motion, for every action there is an equal and opposite reaction. This means that the water pushes back on the paddle, pushing the entire boat forward.