

Propeller Boat

Discover the mechanics behind propulsion by engineering a propeller-powered boat. Explore how mechanical energy can be transformed to create different forces that give boats power to propel through water!

TEKS:

SCI 6.8A: The student is expected to compare and contrast potential and kinetic energy.

SCI 7.2D: The student is expected to construct tables and graphs, using repeated trials and means, to organize data and identify patterns.

SCI 8.6A: The student is expected to demonstrate and calculate how unbalanced forces change the speed or direction of an object's motion.

SCI 8.6C: The student is expected to investigate and describe applications of Newton's three laws of Motion, such as in vehicle restraints, sports activities, amusement park rides, Earth's tectonic activities, and rocket launches.

Materials:

- Cardboard milk carton
- Hot glue gun and hot glue sticks
- Paperclip
- Permanent marker
- Rubber bands
- Scissors
- Straws
- Twist cap from plastic bottle (e.g. water, soda, Gatorade, etc.)
- 6-inch wooden skewer

How To:

1. Using scissors, cut the rounded sides off a plastic twist cap from a plastic drinking bottle. You want to keep the flat, round top of the cap to create your propeller.
2. With a permanent marker, divide the cap into three equal sections and shade in a small triangle in each section.

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3. Cut out the shaded triangle sections, making sure not to cut all the way to the center.
4. Use a wooden skewer to push a hole through the center of the cap. **Safety: Be careful pushing the wooden skewer through the cap. Make sure to keep your hands away from the backside/area of the hole as it is being made.**
5. Push the plastic propeller onto a wooden skewer about 0.5 inches from the end. Take each wing of the propeller and twist to a 45° angle. Be sure to bend all the propeller wings the same direction. (The direction does not matter here, just make sure they are all the same.)
6. Hot glue the twisted propeller onto the wooden skewer. We do not want the propeller to move from the skewer. **Safety: An adult should assist when using hot glue.**



7. Choose an object to use as a base for your boat. If using a cardboard milk carton like us, cut it open along the vertical center line. If using Styrofoam or other materials, try to create a base that has a flat bottom and an open area on top.



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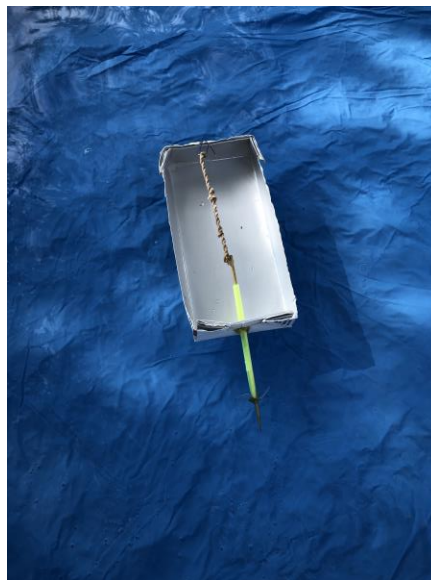
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8. Use a skewer to push a hole through one end of the boat base. This should be one of the shorter edges of the boat base. The hole should be centered (left to right) and about 0.5-1 inch from the bottom. **Safety: Be careful pushing the wooden skewer through the boat. Make sure to keep your hands away from the backside/area of the hole as it is being made.**
9. Cut a straw in half. Push one straw piece through the hole in the back of the boat.
10. Only the tip of the straw should hang below the bottom of the boat. Angle the straw at about a 45° angle with the boat. Once in place, hot glue the straw so that it cannot move in the boat's hole. You can also use the hot glue to seal the hole, so water does not flood the boat. **Safety: An adult should assist when using hot glue.**



11. Push the wooden skewer with the propeller through the straw so that the propeller hangs below and behind the boat. Test that you can spin the skewer inside the straw.
12. Attach a rubber band to the end of the wooden skewer that is protruding from the straw into the boat. Fasten the rubber band any way you think is best (e.g. tying it around the dowel, hot glue, etc).
13. Engineer a way to fasten the other end of the rubber band in the center of the front end (opposite the propeller) of the boat. You do not want the fastener to move; it should hold the rubber band in place when wound up. Examples include pushing a skewer through the boat horizontally or poking a paperclip through the front of the boat to fasten the rubber band to.
14. Stretch the rubber band or create a chain of rubber bands to stretch from the propeller skewer to the fastener at the front of the boat. The goal is to have the rubber band(s) extending through the center of the boat from the propeller to the front.



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15. Test the boat by winding up the rubber band/propeller and releasing the ship in water! This can be done in a kiddie pool, bathtub, sink, etc.

Note: The direction you wind-up the propeller can affect the forward push of your boat. Test the propeller by winding it up in both directions to see which direction gives your boat a stronger forward push!

STEM Explanation:

Let's think about wind-up toys! As you wind up the toy, energy is being transferred from potential energy (during wind up) into mechanical energy (to turn the wheels) into kinetic energy to move the car forward. How could we use the same concept to move a cruise ship or boat? Propellers! The potential energy of the boat is stored in the elastic material of the rubber bands. As the rubber bands wind up when you turn the propeller, it builds more potential energy. As the rubber bands unwind, it spins the propeller, and the energy changes to mechanical energy. Finally, the energy changes into kinetic energy as the boat moves forward. This is the law of conservation of energy! Energy is never created nor destroyed, it just transforms into different types of energy.

A propeller is a type of fan that transmits power by converting rotational motion into thrust. The rotational force is called torque. Ship propellers have torque, which then creates an acceleration of the fluid around the propeller. The propellers work to accelerate/give force to water, and then the force from the accelerated water pushes the ship forward. When you wind up the rubber band, set your boat in the water, and let it go, mechanical energy spins the propeller causing propulsion. Propulsion means to thrust or push forward. The principle at work is Newton's Third Law of Motion, which states that for every action, there is an equal and opposite reaction. In the case of the propeller powered boat, the action is the propeller pushing water away (backward) from the boat. The reaction is the movement of the boat forward!

Career Connection:

Propulsion engineers design, construct, and test structures like propellers that drive and push through fluids and air. They are a specific type of mechanical and aerospace engineer that studies the force and dynamics of powering structures to move through different fluid mediums. Propulsion is used to power many forms of transportation like airplanes, cruise ships, rockets, and helicopters.

Resources:

https://www.youtube.com/watch?v=FB2g_q0n8ml

<https://www.youtube.com/watch?v=YSqj1c8fBns>

<https://www.youtube.com/watch?v=qISFwFSpejA>

<https://adventure.howstuffworks.com/cruise-ship3.htm>

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