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West Virginia University EXTENSION SERVICE

RUBBER BAND HELICOPTER

A WVU Extension Service STEMCARE Lesson

Audience:
Grades 3-8

Time:
45 to 55 minutes

10 minutes to review the engineering design process, explain science behind rubber band helicopters and distribute materials; 15 to 25 minutes for students to design and construct a rubber band helicopter; 15 to 20 minutes for testing rubber band helicopters (outdoors preferably) and reflection; 5 minutes to recap the science behind rubber band helicopters.

Materials:
For each student: 6-inch hook nose propeller; wooden craft sticks; paper clips; rubber bands; cardstock for cutouts; masking tape; scissors

Vocabulary:
Potential and kinetic energy, flight, drag

Goal:

To investigate components that alter the flight of a rubber band helicopter and understand the forms of energy involved.

Introductory Activities

1. Review potential, elastic potential and kinetic energy.
2. Demonstrate the rubber band helicopter and discuss the energy unwound on ground, wound in hand, unwinding in flight and fully unwound in air.

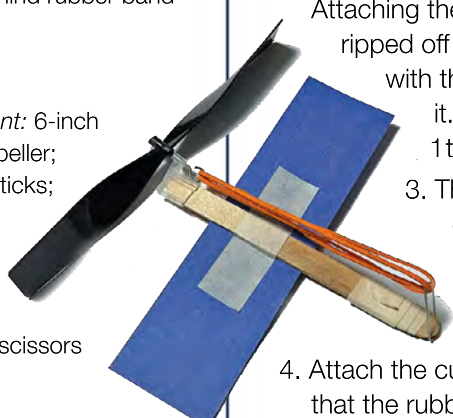
THE ENGINEERING DESIGN PROCESS

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

Core Learning Activity: Building a Rubber Band Helicopter

Students will build their own rubber band helicopter and explore variations in design with the class.

Building the Helicopter



1. Fit the propeller onto the end of the craft stick.
2. Bend and attach the paper clip to the end of the craft stick using masking tape. Attaching the paper clip can be tricky. If it's not properly attached, it can be ripped off from too much tension. Hold the paper clip flat against the craft stick with the tip of the thumb, then tightly wrap a piece of masking tape around it. (This is usually the most challenging step for young kids in grades 1 through 3.)
3. The paper cutout is crucial for flight. If it's too small, it won't create enough lateral drag and too much of the energy in the rubber band will be diverted to the craft stick. If the cutout is too large, it'll simply be too heavy. Cutouts that are about 1.5 inches by 7 inches made from cardstock work well.
4. Attach the cutout on the opposite side of the exposed paper clip to help ensure that the rubber band won't rub against it.
5. Attach two rubber bands onto the propeller hook and the paper clip.
6. After students test their prototype, remind them of the revision stage of the engineering design process. Have them design another shape or extend the craft stick as they wish.
7. Test new designs and reflect on the changes in performance.

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STEMCARE
TURNING POSSIBILITIES INTO OPPORTUNITIES

Flying the Helicopter

For some students, flying the helicopter is more challenging than building it. The helicopter must be wound up enough. The number of turns will be different depending upon what brand of rubber band you use.

1. Twist the rubber band until it becomes completely coiled and keep going. You'll notice that the rubber band begins to form a second set of twists that are bulkier. If you fill up the whole length of the rubber band with a double-twisted rubber band, then it probably has enough energy.
2. To fly, hold the top of the propeller with one hand and the bottom of the craft stick near the paper clip with the other hand. For a stable and high-reaching flight, you must let go of the top first and then the bottom within a half second of each other. This can be difficult for young students to coordinate, so tell them to verbally say "tick tock." As they say the words "tick tock," they should respectively let go of the top and bottom of the helicopter.

Safety Precautions

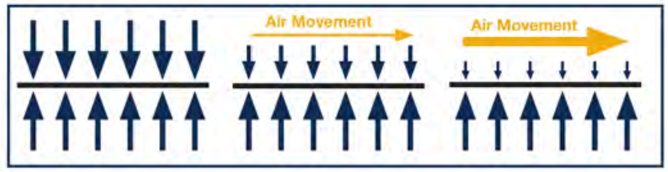
- Always fly your helicopter in the presence of an adult.
- The rubber bands will snap if overwound.
- Check your surroundings before flying:
  - Point the helicopter away from yourself and others.
  - Spinning propellers can get caught in long hair or can scratch the eye/face.
  - Helicopters can fly high enough to get caught in trees, power lines or on rooftops.

Background: The Science Behind Rubber Band Helicopters

Energy is stored (potential) in the rubber band by winding the propeller. When flown, the rubber band rapidly releases its energy (kinetic) by unwinding, which turns both the propeller and the paper cutout.

The paper cutout pushes against the surrounding air, which creates horizontal air resistance, or drag. This makes it harder for the cutout to spin. Because the cutout does not spin as easily, more energy from the rubber band is released into the propeller, which is much easier to turn. In this way, the paper acts like the rear rotor of a real helicopter.

As the propeller spins rapidly, air is moving faster over the curved blades causing greater pressure to be exerted from beneath the blades, creating lift. This is due to Bernoulli's principle, which states that the faster a fluid moves over a surface, the less pressure it exerts on that surface. The air pressure above the blade decreases due to air movement, but the air pressure below the blade is still the same. With greater pressure below the blades than above, the helicopter rises! With enough energy, the helicopter will fly in whatever direction it is pointing. Can you predict what happens if you wind it in the opposite direction?



The influence of air movement on air pressure. (Credit: Geoffrey Hill, College of Engineering, University of Colorado, Boulder)

Resources

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

Rutkowski, Tom; Conner, Alex; Hill, Geoffrey; Zarske, Malinda Schaefer; Yowell, Janet. "Can You Take the Pressure?" Teach Engineering STEM Curriculum for K-12, University of Colorado, Boulder. https://www.teachengineering.org/lessons/view/cub_airplanes_lesson01.

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. NGSS 4-PS3-4
- S.7.PS.5 – Construct, use and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. NGSS MS-PS3-5

Engineering Design

- S.6-8 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. NGSS 3-5-ETS1-1

WVU STEMCARE Rubber Band Helicopter Demonstration Video: https://youtu.be/KccY6G5dcVQ