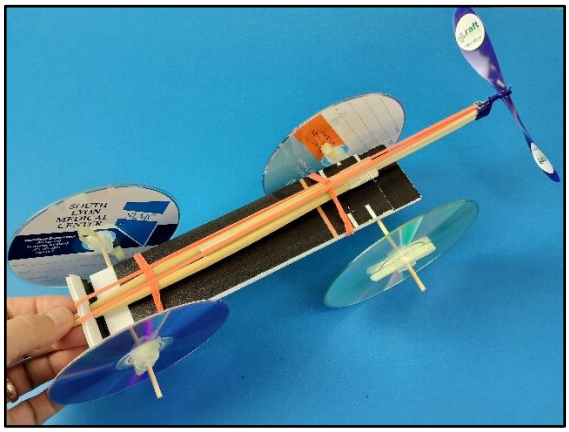
PROPELLER POWER

Propel the platform car using stored energy!



Curriculum topics

- Potential (stored) energy
- Kinetic (moving) energy
- Energy conversions
- Science investigations

Subjects

- Engineering
- Physical Science

Grade range: 4 – 12

Who we are: Resource Area for Teaching (RAFT) helps transform the learning experience by inspiring joy through hands-on learning.

Creating a propeller power unit requires combining five different sections, listed in the table below, each satisfying a different engineering design requirement.

Design Requirements	Possible Solutions
1. Move air in one direction	Curved plastic blade and pivot
2. Connect solution in #1 to a power source	Bent metal hook
3. Resist the compression forces of the power source	Interlaced chopstick sets forming a wooden beam
4. Securely connect above solutions to the car chassis	Elastic band at one end. Utilize a punched hole on the other end
5. Store potential energy	Twist an elastic band

The interlaced chopstick sets are the only items that need to be prepared to create the required wooden beam (see #3 in table above).

On the next page are the detailed steps for making the beam and for attaching the beam to the platform car chassis.

Before doing the beam building, take a closer look at the propeller unit. What did the manufacturer mold into the plastic and add to meet the following design requirements?

1. Connect the propeller to an elastic band?
2. Ensure the propeller can be made to rotate in only one direction?
3. Allow the propeller to be mounted on a stick?

(Answers can be found in the material list on the next page)

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http://bit.ly/RAFTkitsurvey

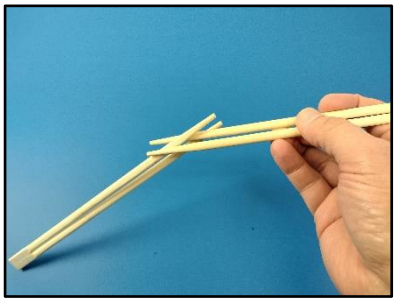
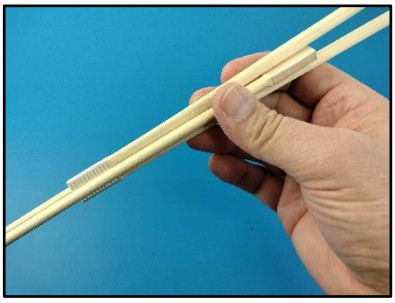
Materials

Materials in the kit may vary but generally, this kit contains the following:

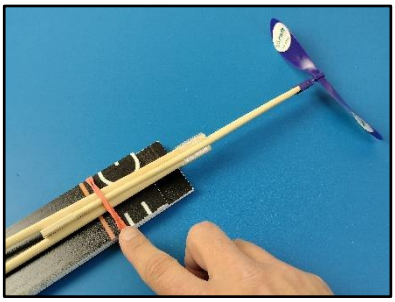
- Propeller with:
  - Bent metal wire with hook
  - Molded ridges that engage the metal wire only when turning in the one direction
  - A “pocket to insert a stick”
- Wooden chopstick pairs, connected, wrapped w/ filament tape (2)
- Elastic band, latex free, 7” x 1/8” (1)
- Elastic bands, latex-free, 3” x 1/8” (2)

To Do and Notice

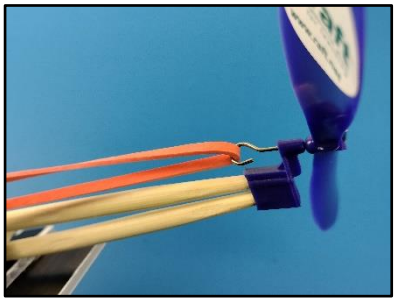
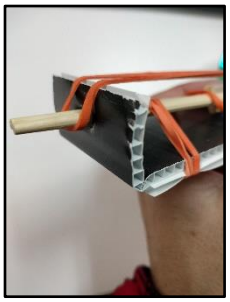
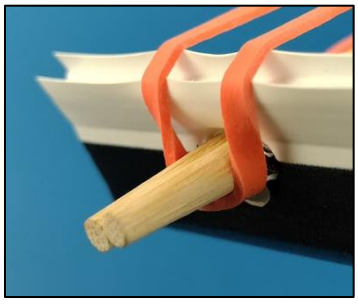
1. Open the ends of the chopstick pairs slightly and interlace them (see below, left). Slide the interlaced chopsticks together until they are wedged together, making a beam (below, middle). Squeeze the ends of one chopstick pair together and insert them tightly into the propeller “pocket”, as shown below (right).


2. For installing the beam with propeller onto a RAFT Platform Car (sold separately), first remove the wheels and axles from the car chassis. Squeeze the non-propeller ends of the chopstick beam together, insert them into the punched hole in the chassis, and use the beam as a lever to bend the chassis upward as shown below (left). Remove the chopstick beam from the hole, slide it through both elastic band loops that are around the chassis, and reinsert the beam into the punched hole (see below, right).

3. Rotate the beam, if needed, so the propeller’s bent metal hook faces upward with respect to the chassis (see below, left). Loop the included 7” elastic band onto the hook and stretch it over the end of the beam that is protruding through the chassis, as shown below. Adjust items as needed.



Rubber band around chopsticks


4. Reinstall the wheels and axles onto the Platform Car. The propeller-powered Platform Car is complete!

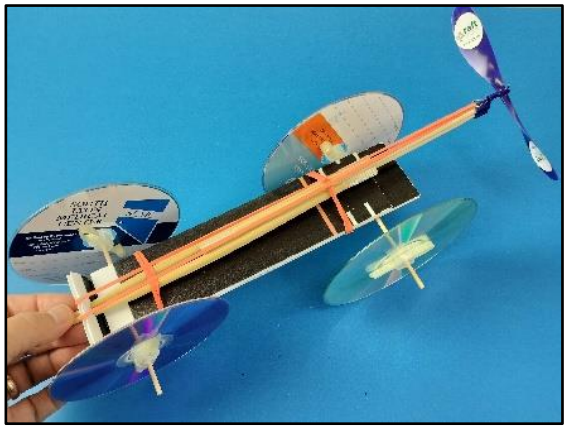
5. Rotate the propeller to twist/wind up the elastic band. Place the Platform Car on a flat surface while holding the propeller to keep it from turning. Release the propeller and observe. Investigate the factors that affect and/or explain your observations (below are some examples)!

    - How does the number of twists in the elastic band affect the distance the car travels?
    - How does the achieved distance relate to the energy stored in the elastic band?
    - Which part(s) of the assembled car and propeller experience friction? How might this affect your observations?

    Below is an example data table you can use, or you can create your own!

Trial	# of Twists	Distance (d) (cm)	Time (t) (sec)	Ave. Speed (d/t)
Ex.	*15*	*550*	*30*	*18.33 cm/sec*
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

6. **Share** your learning with RAFT! Submit photos/video via email at education@raft.net or on social media (Facebook, Twitter, Instagram).



Core Content Skills:

Science & Engineering (NGSS)

Developing and using models, planning and conducting investigations, forces and motion, types of interactions, definitions and conservation of energy, collecting and interpreting data; cause and effect; constructing explanations and designing solutions, optimizing design solutions

Social Emotional Learning

- Self-awareness
- Self-management
- Responsible decision-making

Reuse

This kit includes reusable materials designed for other purposes. To continue making a positive impact in reducing waste, reuse these materials in other projects. Any unused materials can be collected and delivered back to RAFT.

The Science Behind the Activity

A model airplane propeller works like a simple machine called the "screw". A screw shape is an inclined plane, like a ramp, that is twisted around a center post, like a spiral staircase. The edges of the screw are called the threads.

A screw shape can convert turning (rotary) motion into straight (linear) motion. In a sense a rotating propeller pulls a plane forward like the turning of a screw can pull the screw inward. The tilt of the propeller blades acts like the tilted (angled) threads of a screw to create forward motion.

The rotating tilted propeller blades push air backwards making the plane move forward. Adding a propeller power to the platform car provides forward motion just like the rotating propeller blades on a swamp boat.

The rotating energy is provided by the twisted (torsional) energy stored in the elastic band. That stored energy was added by rotating the propeller in the opposite direction by hand. You will notice that the elastic band must be twisted many times for the propeller to spin fast enough to make the car move forward. The rotational energy provided by a twisted elastic band unwinding is not constant. The propeller will spin fastest when the propeller is first let go. As the elastic band unwinds the propeller will gradually slow down until it stops turning. The elastic band may then still be slightly twisted as the remaining stored energy is not enough to overcome the propeller's rotational friction. Even an elastic band with many twists may not unwind fast enough. The static friction of the car may not or just barely be overcome, providing little or no forward motion.

A modern airplane propeller is more like a spinning wing which can also provide lift, but in the forward direction. The science involved is also much more complex. More details can be found at https://www.grc.nasa.gov/www/k-12/airplane/propth.html

History: The screw shape was used in early Roman and Greek olive and wine presses. Rotating a wooden screw would cause a beam to move downward to crush the olives or grapes. Over 2,000 years ago the mathematician Archimedes used a rotating spiral shaped blade inside an enclosed tube to move water forward.

An early screw shaped propeller was used in place of a paddlewheel to move a ship. The screw shapes were replaced by propellers with 2 or more separate blades connected to a center shaft.

Moving through the air is very different from moving through the water. The Wright Brothers figured out how to control the flight of a glider and the best shape for a wing, but they needed a way to make it go, to be powered. At first, they thought they could just add a ship's propeller to their small gasoline engine. They soon realized a propeller for an aircraft needed to be shaped like a wing. They made a wind tunnel to develop the best shape for a wing and correct past mistakes in how wings work.

Feedback

Please comment on this kit by taking this short survey: http://bit.ly/RAFTkitsurvey. Let us know of any material concerns (missing, broken, or poorly fitting parts) as well as any suggestions for improvement.

Resources

- Newton's Laws of Motion - https://bit.ly/2RPnV6z
- Khan Academy, Balanced & Unbalanced Forces - https://bit.ly/3a7bElr