

Topics: Simple Machines, Potential and Kinetic Energy, Experimentation

Materials List

- ✓ 2 Cups and lids
- ✓ Rubber bands, 3 mm (1/8") wide
- ✓ Bead, 8 mm (~1/3") diameter, with a hole ("pony" bead)
- ✓ Straw
- ✓ Paperclip, small or jumbo
- ✓ Tape, masking or equal
- ✓ Scissors
- ✓ Spacer (washer, bead, or lid for a small portion cup (1 oz. or less in size) might be needed)
- ✓ One hole punch, or equal, might be needed

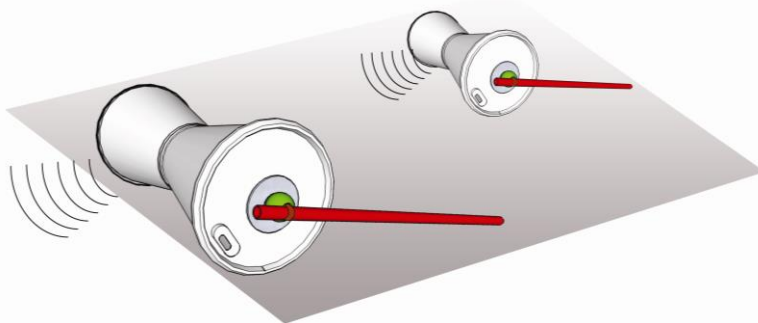
This activity can be used to teach:

Next Generation Science Standards

- Forces & Motion (Physical Science, Grade 3, 2-1, 2-2; Middle School, 2-2; High School, 2-1)
- Kinetic and Potential Energy (Physical Science, Grade 4, 3-1; Middle School, 3-2, 3-5)

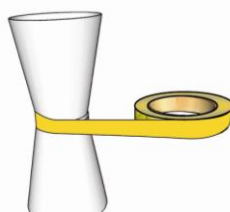
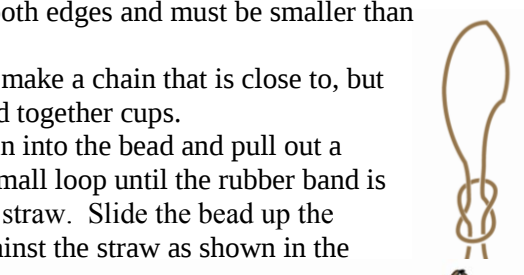
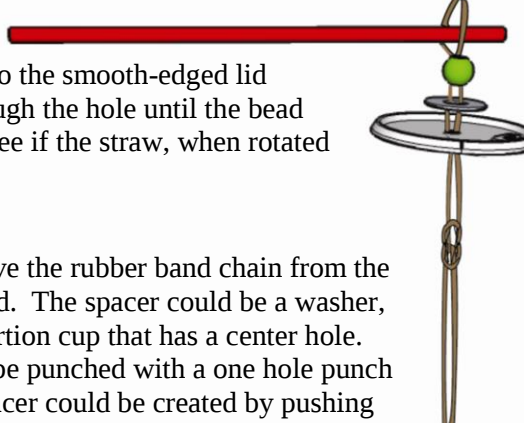
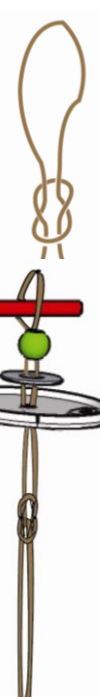
Racing Cups

Exploring the Conversion of Stored Energy into Motion!



The Cup Racer is a modern version of a classic toy that turns potential energy, stored in a twisted rubber band, into kinetic energy - the motion of the Cup Racer.

Assembly

1. Poke, then cut, a 2 cm (3/4") or larger opening in center of the bottom of two paper or foam drinking cups. Place the bottom of the cups together and wrap tape around where the bottoms meet to hold the cup bottoms together. 
2. Poke or punch 5 mm (3/16") holes in the center of two cup lids. At least one of the holes needs to have relatively smooth edges and must be smaller than the outside diameter of the bead. 
3. Link several rubber bands together to make a chain that is close to, but not longer than, the length of the taped together cups.
4. Insert one end of the rubber band chain into the bead and pull out a small loop. Insert the straw into the small loop until the rubber band is about 2 cm (3/4") from the end of the straw. Slide the bead up the rubber band until the bead is flush against the straw as shown in the illustration below. 
5. Starting from the top insert the other end of the rubber band chain into the smooth-edged lid hole. Pull the rubber band chain through the hole until the bead is pressing against the lid. Check to see if the straw, when rotated around, touches the lid. 
6. If the straw touches the lid then remove the rubber band chain from the lid and add a spacer to the rubber band. The spacer could be a washer, another bead, or a lid from a small portion cup that has a center hole. The hole in the portion cup lid could be punched with a one hole punch or a leather punch. An extra thick spacer could be created by pushing out the center of the portion cup lid from the inside to create a domed shape. Repeat step 5, and then 6, if needed.
7. Insert the rubber band chain from the lid through the holes in the bottom of the cups. Pull out and insert the end of the rubber band chain into the 2nd lid, starting from the bottom of the lid. (To help insert the rubber band use a paperclip bent to form a hook.) 

8. Insert a paperclip halfway into the loop of the rubber band that is protruding from the 2nd lid. Snap the lids onto the cups. The paperclip will prevent the rubber band from being pulled back through the hole in the lid. Taping the paperclip to the lid will help to keep the paperclip from turning when the rubber band is twisted.

To Do and Notice

1. Wind the Cup Racer by holding the cups and repeatedly spinning the straw around the bead (pivot point) with a finger. Next, while holding the straw in place, set the Cup Racer down on a table or floor and let go.
2. Conduct several trials with the same number of turns of the rubber band. Measure the distance traveled and/or the time need to travel a certain distance. Create a chart; calculate the average distance and time.
3. Conduct additional trials varying the number of turns of the rubber band that are used.
4. Create a challenge to make the Cup Racer travel at least a minimum distance, stay on a set path for a set distance, stop within a set range, overcome an obstacle, or hit a target.

The Science Behind the Activity

Turning the straw, which acts as a lever, will wind up the rubber band and store elastic potential energy. This energy is the result of the mechanical work done by a moving finger rotating the straw (work = force x distance). When the rubber band is allowed to unwind, the stored potential energy is turned into the energy of motion, kinetic energy, and a small amount of heat that is generated by the friction of the lids rolling on the surface below as well as friction from the cups travelling through the air. The narrowness of the edges of the lids creates a very small area of contact with the surface below and thus very little rolling friction.

Taking it Further

The cups can be decorated with water based or permanent markers, depending on the cup material. Variations of the Cup Racer can be made using a pair of CD's as wheels. A CD-based design can cover distances of over 100 feet on a smooth, level surface!

Web Resources (Visit www.raft.net/raft-idea?isid=567 for more resources!)

- Information on energy and energy transformation - <http://www.eia.gov/kids/index.cfm>
- Conservation of energy simulation - http://phet.colorado.edu/new/simulations/sims.php?sim=Energy_Skate_Park
- Levers - <http://www.citytechnology.org/stuff-that-works/levers-have-a-lot-of-class>

