Bottle Racer

Exploring the conversion of stored energy into motion!

Topics: Simple machines, Stored Energy, Motion and Experimentation

Materials List

- ✓ Small plastic bottle
- ✓ Rubber band
- ✓ Bead, "pony" size
- ✓ Straw
- ✓ Square of stiff paper, 2.5 cm x 2.5 cm (1" x 1")
- ✓ Straw section, 3 cm (1¼") long, coffee stirrer size
- ✓ Paperclip, unbent to form a hook
- ✓ Method to make a small hole in plastic bottle (nail or drill)

This activity can be used to teach:
Next Generation Science Standards

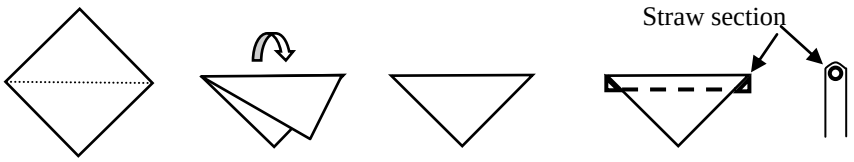
- Forces & Motion (Grade K, Physical Science 2-1, 2-2; Grade 3, Physical Science 2-1, 2-2; Middle School, Physical Science 2-2)
- Kinetic and Potential Energy (Grade 4, Physical Science 3-1; Middle School, Physical Science 3-2, 3-5)

Enjoy the hands-on experience of building and using the Bottle Racer, a modern adaptation of an old favorite. Explore the application of simple machines, energy conversion and investigate how changes in design affect performance.

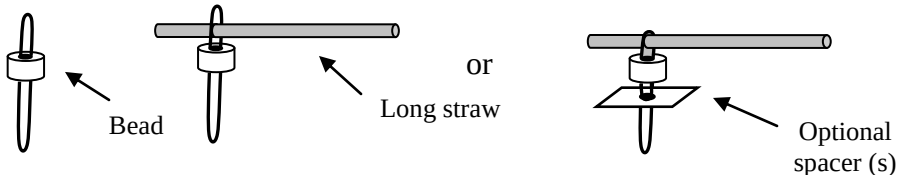
Assembly

1. Drill or punch a hole in the center of the bottom of the bottle. A roofing or similarly thick nail will make about a 3 mm (1/8") diameter hole which is just big enough for a thin rubber band 1.5 mm (1/16"). A drilled 4.5 mm – 6 mm (3/16 - ¼") diameter hole will make it easier to insert and to pull out the rubber band from the inside of the bottle.

2. Fold the 2.5 cm (1") square of stiff paper in half, along a diagonal, creating a triangular shape. Insert the 3 cm (1¼") straw section into the fold. Save for step 6.



3. Insert the rubber band into the bead and then pull out a small loop. Insert the straw into the small loop until the rubber band is about an inch from the end of the straw. Slide the bead along the rubber band until it is flush against the straw.



4. **Optional:** You could add a spacer on the rubber band of a 20 mm (¾") square of stiff paper, alone or in combination with a 13 mm (½") square of slipperier plastic, with a 3 mm – 4.5 mm (1/8"-3/16") hole in the center. The spacers will go between the bottom of the bottle and the bead. These will reduce the friction of the rotating bead as well as create a flatter surface over any molded lettering on the bottom of the bottle. Students could add the spacers and see if they make the bottle roll straighter and/or farther.

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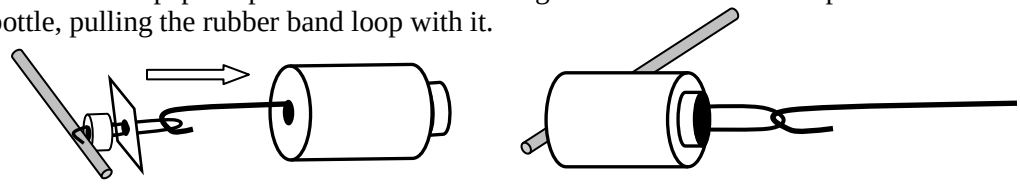
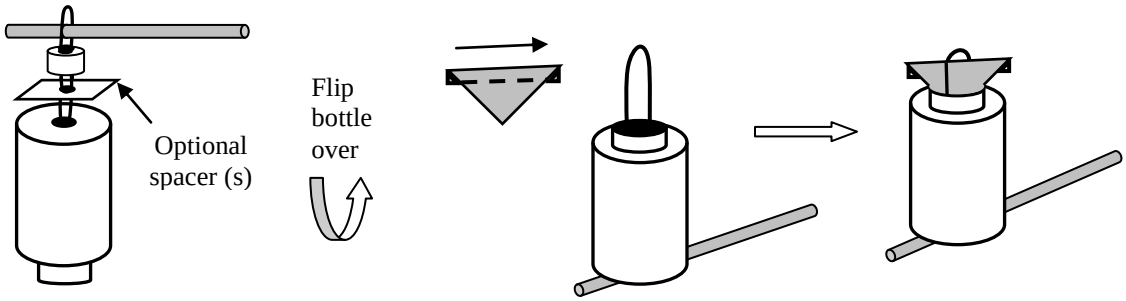
5. **For a 3 mm – 4.5 mm (1/8" – 3/16") hole** insert the rubber band and keep feeding it into the hole as much as possible. Use a partly unbent paperclip with a hooked end to help pull the rubber band loop out from inside the bottle.

   For a 6 mm (¼") hole it is possible to hook a partly unbent paperclip over the rubber band and **then** insert the straightened end of the paperclip into the hole. The straightened end can then be pulled out from the inside of the bottle, pulling the rubber band loop with it.



6. Put the stiff paper triangle with a straw section made in step 2 into the loop of the rubber band that was pulled out from inside the bottle. Orient the triangle so its right angle (90°) corner is pointing into the mouth of the bottle. The triangle will jam in the mouth of the bottle, holding the rubber band in place.



To Do and Notice

1. Wind the racer by holding the bottle and repeatedly spinning the straw around the pivot point with your finger. Set the racer on a table or floor, while holding the straw and bottle, and then let it go. If the rubber band was twisted too tight the released bottle may spin rapidly. It may not go far but it sure is fun to watch!
2. You can experiment with different amounts of winding and adding spacers between the bead and the bottle to reduce friction and/or create a flatter pivoting surface.
3. Data can be collected as to distances traveled and the time it takes to cross the finish line.
4. The Bottle Racer may consistently curve in one direction rather than travel in a straight line. Students could be challenged to find a way to make the Bottle Racer travel a straighter path. Hint: try bending the straw so it touches down behind the bottle as shown at the top of the first page.
5. Challenges for students can also include trying to make the Bottle Racer travel a minimum distance, stay on a set path for a set distance, stop within a set range, overcome an obstacle, hit a set target, travel a curved path to a target, etc.

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 as it applies a force over a certain 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 bottle with the surface it touches as well as the air it moves through.

If the rubber band is wound too tightly the bottle will spin with enough force to lift it from the floor or table. This reduces the friction between the bottle and the surface underneath it. The bottle will then rotate rapidly, often spinning around in a circle rather than moving in a straighter, linear, direction.

Taking it Further

Cover the bottle with a strip of paper the student has decorated or decorate the bottle using permanent markers. Make variations of this design using a pair of CD's as wheels. A CD wheeled design can cover distances of over 100 feet on a smooth, level surface!

Web Resources (Visit www.raft.net/raft-idea?isid=313 for more resources!)