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www.raft.net

Curriculum topics:

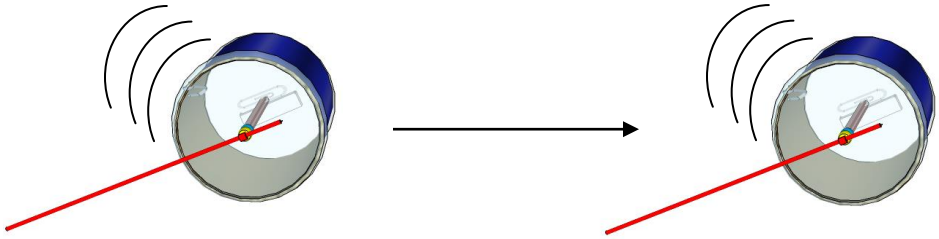
- Potential Energy
- Kinetic Energy
- Energy Conversion
- Motion
- Simple Machines
- Stored Energy
- Experimentation

Subject:
Physical Science

Grade range: 2-12

ROLLER RACER

Explore the fun of energy conversion



Enjoy the hands-on experience of building and using the Roller Racer, a modern variation of an old favorite. Explore the application of simple machines and energy conversion and investigate how changes in the amount of stored energy can affect performance.

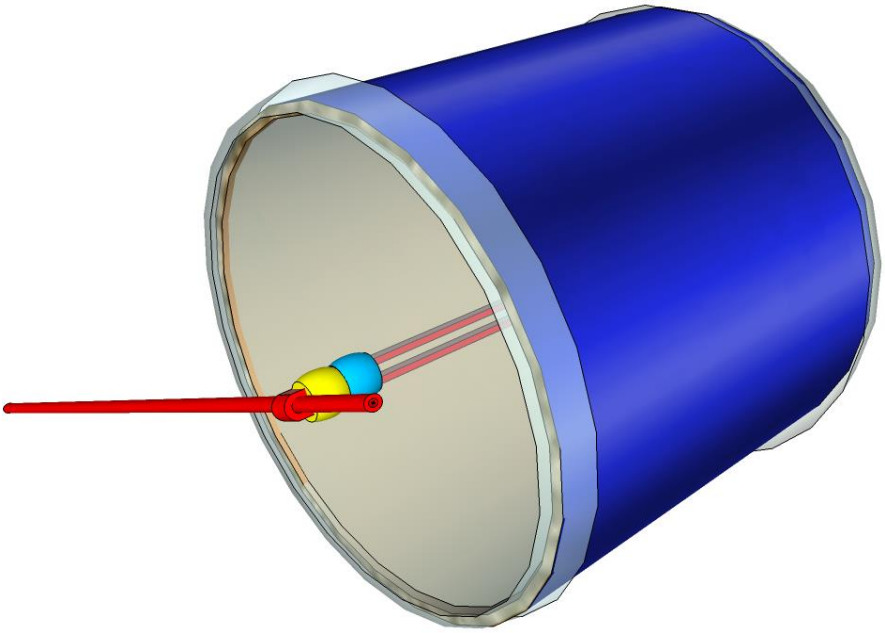


Figure 1

Who we are:

Resource Area for Teaching (RAFT) helps educators transform the learning experience through affordable "hands-on" activities that engage students and inspire the joy and discovery of learning.

For more ideas and to see RAFT Locations

www.raft.net/visit-raft-locations

Materials required

Per Roller Racer:

- Clear lids, 93 mm (1.66”) diameter with a 4 mm (5/32”) indented rim (DART 12CLR) each with a 5 mm (3/16”) center hole punched or drilled, 2
- One-sided corrugated sheet, flute size E, flutes parallel to the short side 7.5 cm x 27.3 cm (3” x 10.75”)
- Rubber band, 7.5 cm long x 1.6 mm (3” x 1/16”) (#18), 2
- Pony bead, 8 mm (5/8”) diameter, 2
- Straw, thin, stirrer 17.7 cm (7”) long, 2.4 mm (3/32”) diameter
- Paper clip, regular (#1), 2
- Adhesive foam block, single sided, 2.3 cm x 4.6 cm (½” x 1”), 5 mm (3/16”) thick

Safety Tip: Wearing eye protection is advisable as the twisted rubber band can cause the tip of the straw to spin rapidly.

Rubber bands contain Natural Rubber Latex which may cause allergic reactions.

How to build it

1 Interlock the two rubber bands as shown below. Pull the knot tight.

2 Insert the end of one of the rubber bands into and through each of the 2 beads until a small piece of rubber band sticks out. The two beads should lie next to each other. See figure 2.

Insert into beads Figure 2

3 Insert the straw through the small loop in the rubber band created by the two beads until about 1/10 of the straw is through the loop. Pull on the other end of the rubber band to tighten the loop around the straw so the straw lies next to the beads. See figure 3.

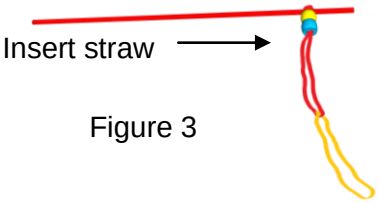
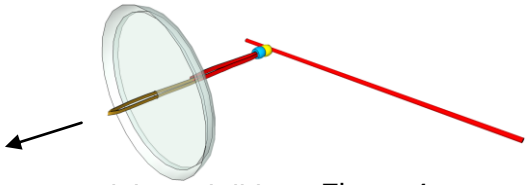
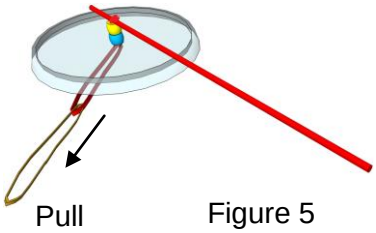


Figure 3

4 Insert the free end of the rubber bands into the hole in the first lid starting from the top side of the lid (groove is on the bottom side). Pull the rubber band through until the last bead is snug against the lid. The two beads and the straw secured by the small piece of rubber band will sit on top of the lid. See figures 4 and 5.



Free end through lid Figure 4



Pull Figure 5

5 Place the lid on a flat surface with the groove upward.

6 Insert the long edge of the single sided corrugated sheet into the groove of the lid, shaping the corrugated sheet to form a circle. Overlap the ends when the groove is filled. See figure 6.

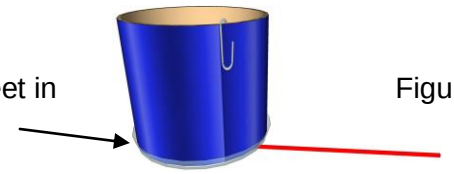


Figure 6

7 Place a paperclip over the overlapped ends, opposite the lid, see above.

8 Hold the second lid, groove side down, above the cylinder. Pull the end of the rubber band up out of the cylinder and insert the end of the rubber band into the hole in the second lid. See figure 7.

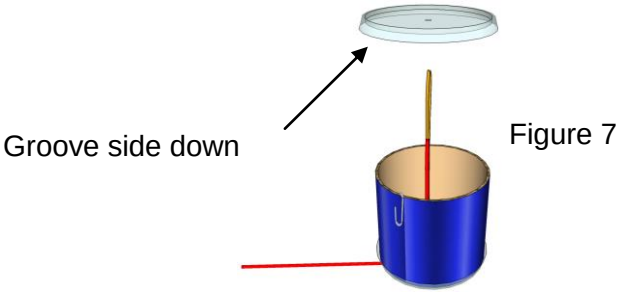


Figure 7

9 Put the lid on the cardboard cylinder, fitting the cardboard edge into the lid. Hold the lid in place while pulling the rubber band up until the knot between the rubber bands, and the top of the second rubber band comes through the lid. See figure 8. Insert the paperclip into the loop between the knot and the lid. See figure 9.

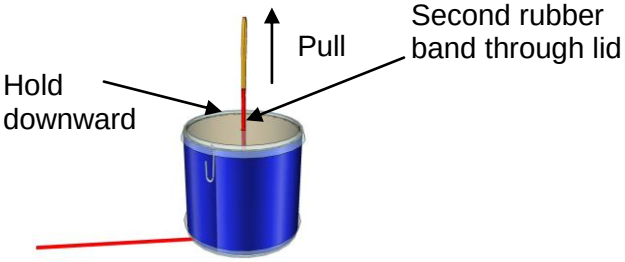


Figure 8

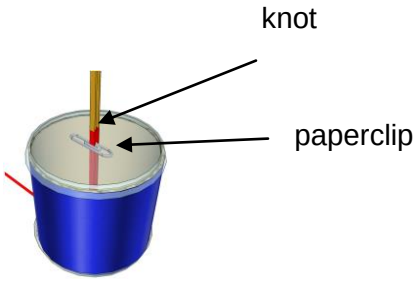


Figure 9

10 Remove the release paper from the piece of adhesive foam. Place the foam on the lid next to the paperclip. See figure 10. Keeping the paperclip parallel to the foam, press down on the foam to secure. The foam will keep the paperclip from rotating when the straw on the other end is rotated.

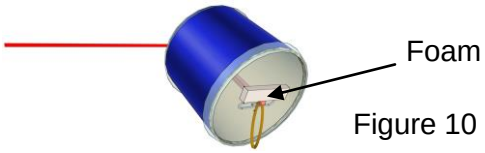


Figure 10

11 Wrap the excess rubber band around the foam. See figure 11.

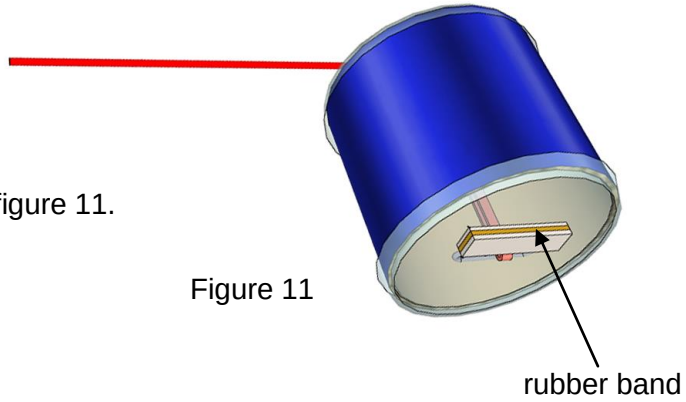
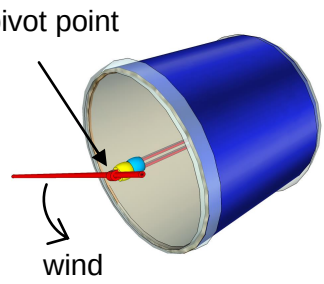


Figure 11

To do and notice

1 **Wind the Roller Racer.** Hold the Roller Racer in both hands. Using the finger of one hand rotate the straw around the pivot point (above the beads) a set number of times (10 to 20).



2 Being careful to keep the straw still, set the Roller Racer on a smooth surface, see figure 1. If the 2 beads have become tilted, move the straw so that the beads are at a right angle to the lid.

3 Aim the Roller Racer in a direction clear of obstacles and let go! Note the direction and distance of travel.

Curriculum Standards:

Forces & Motion (Next Generation Science Standards: Grade 3, Physical Science, 2-1 & 2-2; Middle School, Physical Science, 2-2; High School, Physical Science, 2-1)

Kinetic and Potential Energy (Next Generation Science Standards: Grade 4, Physical Science 3-1; Middle School, Physical Science, 3-2 & 3-5,)

Compare Multiple solutions & Test variables (Next Generation Science Standards: Engineering Design, Grades K-2, 1-3; Grades 3-5, 1-2 & 1-3; Middle School, 1-2 & 1-4)

Combine designs for a better result (Next Generation Science Standards: Middle School, Engineering Design 1-3)

Science & Engineering Practices (Next Generation Science Standards: Grades 2-12)

Additional standards at: http://www.raft.net/raft-idea?isid=358

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 potential energy (stored energy) is turned into kinetic energy (energy of motion), and a small amount of heat that is generated by the friction of the Roller Racer with the surface it touches, as well as the air it moves through.

Learn more

- Vary the number of times the straw is rotated when winding the Roller Racer and measure the distance travelled. The results can be plotted on a graph to show distance variations over trials; and distance versus number of winding-rotations. Data could also be collected on the times needed to travel a set distance.
- Challenges for students can include making the Roller Racer stop within a set range of distances, staying on a set path for a set distance, rolling over an obstacle, hitting a target, traveling a curved path to a target, or finding a way to make the Roller Racer travel in a straighter path.
- Make variations of this design using a pair of CDs as wheels. (A CD design can cover distances of over 30 m (100 feet) on a smooth, level surface!)
- Create a Design Challenge with this activity. See the RAFT Idea Sheet ***Designing Design Challenges*** for ideas.

Related activities: See RAFT Idea Sheets:

Variations on the Roller Racer: (stored energy):

Bottle Racer -
http://www.raft.net/ideas/Bottle Racer.pdf
Racing Cups -
http://www.raft.net/ideas/Racing Cups.pdf
Retractor Car -
http://www.raft.net/ideas/Retractor Car.pdf
Rollback Can -
http://www.raft.net/ideas/Rollback Can.pdf
Rolling Explorations -
http://www.raft.net/ideas/Rolling Explorations.pdf

Catapults: Motion (force, push or pull):

Craft Stick Catapults -
http://www.raft.net/ideas/Craft Stick Catapults.pdf
Flingy Thingy -
http://www.raft.net/ideas/Flingy Thingy.pdf
Staple Remover Catapult -
http://www.raft.net/ideas/Staple Remover Catapult.pdf

Resources

Visit www.raft.net/raft-idea?isid=358 for “how-to” video demos & more ideas!
See these websites for more information on the following topics:

- **The science of elastic energy storage** – http://www.ftexploring.com/lifetech/flsbws2.html
- **How much energy can a stretched elastic band supply?** – http://www.practicalphysics.org/go/Experiment_475.html