BioEd℠

Think like an Engineer

TEACHER'S GUIDE

Wind-up Racers

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Baylor College of Medicine

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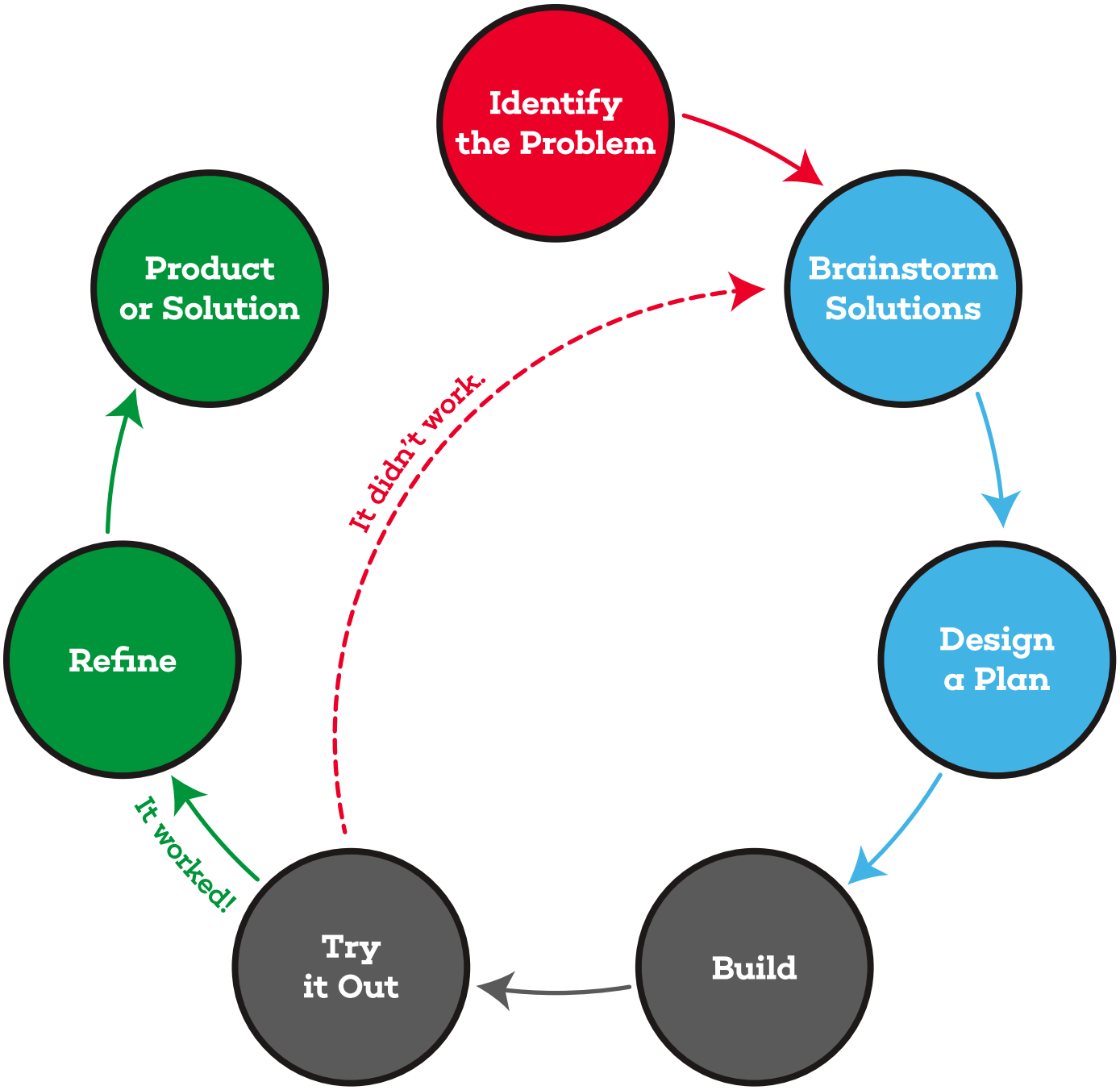
An Engineer's Approach



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Wind-up Racers
The Potential for Speed

Time
1–2 sessions

Before You Start
Collect and clean 24 empty soft drink cans. Punch a hole in the bottom of each can with a large nail or a screwdriver.

You Need This Stuff
Teacher Materials
- Tape measures or metersticks

Per Student
- 4 #32-size rubber bands
- Pencil or dowel
- Masking tape
- Metal washer
- 2 large paper clips
- 2 small paper clips
- Safety goggles
- Thread spool (large) or empty soft drink can
- Wooden or plastic bead (large)

Extra Materials for Modification
- Different sizes of rubber bands
- Sandpaper
- Variety of large and small washers

A toy car's winding mechanism adds energy to a spiral spring, which releases energy to gears that control speed and force.

What It's About
Students will construct and test a self-propelled wind-up racer to investigate how vehicles use potential and kinetic energy. After testing their racers, students will be challenged to improve them using the engineering design process.

What's the Question?
Does the number of turns on the rubber band influence the amount of energy stored? How does energy storage affect the racer's motion?

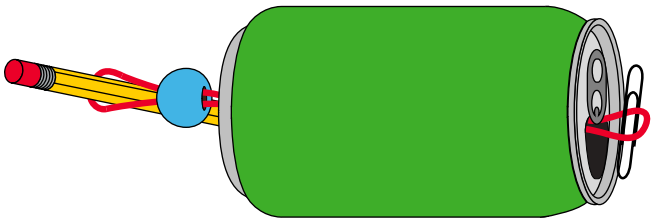
What to Do: Part 1
1. Ask students, *Do rubber bands have energy?* Distribute rubber bands and have students use them to investigate potential and kinetic energy. Ask, *What is the difference between these two kinds of energy?* If students are uncertain, demonstrate a rubber band's (1) potential energy by stretching it and (2) kinetic energy by shooting the stretched rubber band toward a target. Ask, *Where did the rubber band get its potential energy?* (From "muscle power," as you stretched the rubber band.) Have students repeat the exercise, taking great care not to shoot rubber bands at each other.

   Note: All participants should wear safety goggles.
2. Challenge students to devise a way to improve their accuracy in shooting rubber bands at the target. Discuss how the amount of stretching (potential energy) affects the distance a rubber band travels (kinetic energy) when released. Ask, *Can the rubber band be stretched too far?*
3. Explain that students will be making cylinder racers propelled by rubber bands. Follow the instructions below to demonstrate how to make

a racer from a soft drink can and a large sewing spool. Then, have students construct their own racers.

How to Build a Wind-up Racer Using a Can

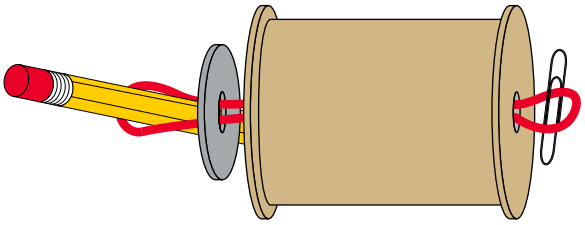
1. Bend a large paper clip into a long hook.
2. Loop one end of the rubber band around the pencil and push the other end of the rubber band through the bead (see illustration below).



3. Push the end of the rubber band through the hole in the can bottom. Using the paper clip hook, reach inside the top of the can and capture the loose end of the rubber band.
4. Making sure the bottom loop of the rubber band does not slip off the pencil, pull the top loop up through the mouth of the can. To secure the top of the rubber band, slip it through the small paper clip, and then tape the paper clip securely on top of the can. The racer is ready for testing.

How to Build a Wind-up Racer Using a Spool

1. Slip a rubber band through the center of a spool. Be sure one end of the rubber band is sticking out from either side of the spool.
2. Insert a paper clip through one loop of the rubber band. Use tape to secure the clip to the end of the spool.



3. Slip the other end of the rubber band through a washer. Then slide the pencil through the rubber band loop (see illustration above). The spool racer is ready for testing.

What to Do: Part 2

1. Designate a clear area of the floor for testing the racers.
2. Have students wind up their racers by turning their pencils 10–15 times. Ask, *What happens when you wind the rubber band?* (Adds potential energy to their racers. More turns means more potential energy.) Direct students to place their racers on the floor and release the pencils (to produce kinetic energy).

   Note: If the racers do not travel in a straight line, have students adjust where the rubber band holds the pencil (move the rubber band from the middle of the pencil to one end, etc.).
3. After all students have tested their racers, Ask, *How could you improve the design of your racer to make it travel further?* As a prompt, ask, *Why are automobile tires made from rubber?* (Produces better friction with the road.) Follow by asking, *What could you do to increase friction and help your racer travel a greater distance?*
4. Have students redesign, rebuild and retest their racers. Remind them that it is important to control their tests by winding the rubber band the same amount each time. Using the same number of winds makes it possible to evaluate how well the changes work.
5. Clear the racing area once again. Mark a starting line on the floor and lay a tape measure to track distance. Have groups of four student competitors race "qualifying heats." Then have the winner of each group race in a "final" to determine the Racer Champion!
6. Have students compare their racers and draw conclusions. Ask, *What made the best racer? Why?*

Extras

- Construct a ramp to test the racers' climbing power. Alternately, test the racers' steering by laying a narrow corridor of books on the floor to see if racers can travel from one end to the other without hitting the books.
- A video from The Children's Museum of Houston shows how wind-up toys work and how to make a wind-up spool racer. To view the video, visit http://vimeo.com/46440675/.