Kicking Machine

OBJECT

This activity will demonstrate the engineering design process. Students will consider both potential and kinetic energy while they plan, design, build, test, and redesign.

GRADE LEVEL

Middle school.

THE CHALLENGE

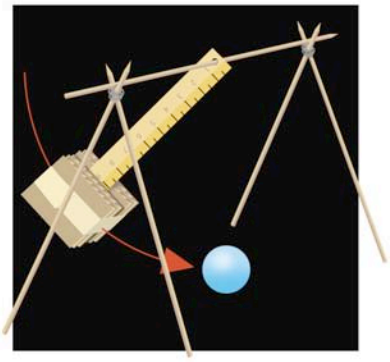
Build a machine that kicks a ping-pong ball into a cup lying on its side 12 inches away. Use either (1) a pendulum, (2) a rubber band, or (3) a combination of the two to do this.

DISCUSSION

When you lift a pendulum or stretch a rubber band, you increase its potential energy. Potential energy is energy that is stored. When you release the pendulum or rubber band, its potential energy is turned into kinetic energy, the energy of motion. Many machines have this in common—they turn potential energy (e.g., fuel, electricity, muscle power, springs, or weights) into kinetic energy that can be used to do a task (in this case, launch a ball).

MATERIALS

- Balls (Ping-Pong and golf)
- Corrugated cardboard
- Paper clips
- Paper cups
- Popsicle sticks
- Rubber bands
- Ruler
- Scissors
- String
- Tape (masking or duct)
- Thin metal wire (optional)
- Wooden skewers



Estimated time to complete: 60 minutes

BRAINSTORM AND DESIGN

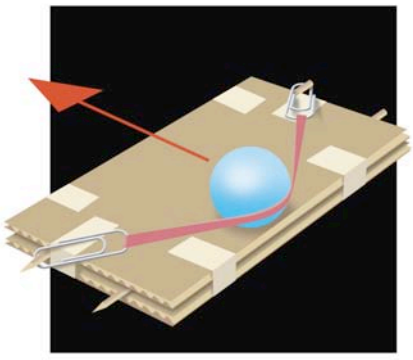
Before the students begin designing their machines, have them brainstorm answers to the following questions.

- Will their machine use a pendulum or rubber band (or a combination) to send a ball into the cup?
- How will they stop the machine from launching the ball before they're ready to release it?
- How will the machine be triggered when launch is ready?
- How will they ensure the pendulum or rubber band launches the ball straight enough and with the right amount of force so it goes into the cup?

Ask the students to think about how to create different release points for the pendulum or rubber band in order to have more control over a launched ball. Also have them consider how to determine the right amount of energy to store up (potential) before making the launch (kinetic).

BUILD, TEST, AND REDESIGN

As students build their machines, take turns testing them. Lay a cup on its side 12 inches away and see if the ball is kicked in. Some problems to look for:



- the stretched rubber band might bend the frame.
- the pendulum and rubber band might slip and not stay pulled back.

Tell the students they must redesign to fix the problem so the machine works every time.

FURTHER EXPLORATION

- Move the cup so it's 24 inches from the kicking machine.
- Build a ramp and see if the machine can shoot the ball up and over the ramp.
- Build a machine that can launch two balls at once or that can launch balls at different speeds.

INSIDE THE ENGINEERING

Building machines that make tasty—and sometimes far-out—ice cream flavors is just the kind of challenge Pete Gosselin loves. He's head engineer for Ben and Jerry's® ice cream. Pete's the guy who designs the machines that make different flavors and mix the right

amounts of candy, filling, or swirl into each container. And you thought getting a ball into a cup was a challenge! Some days, it's, "We want every container to have half a pint of cherry ice cream with cherries and fudge flakes and half a pint of chocolate ice cream with fudge brownies. Now on the brownie side, make sure there are at least three but no more than four brownie bites. Oh and by the way, these babies need to roll off the production line at 200 pints a minute." His biggest challenge: to design a machine that makes a flavor with a core of fudge and caramel wedged between chocolate and caramel ice cream. The way Pete sees it, "The world is full of problems and possibilities. And technology has a huge influence on making our lives better, whether the challenge is addressing global warming or making delicious food."

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