Soda Can Steam Engine | A Demonstration

Summary

In this demonstration, students consider the concepts of energy transformations and conservation as they observe a simple steam engine made from an aluminum soda can.

Objective

Students learn about energy transformations and the concept of conservation of energy.

Safety

- Be sure you and the students wear properly fitting goggles.
- Handle the hot soda can with tongs. Steam from the can could scald your hand and skin.

Materials

- Unopened 12-oz aluminum soda can (using diet soda will help avoid potential stickiness)
- Thumbtack
- Access to a sink
- Wash bottle
- Water
- 10-mL graduated cylinder
- String
- Ring stand
- Ring
- Bunsen burner or hot plate
- Tongs

Time Required

Part of one class period, approximately 10–15 minutes.

Integrating into the Curriculum

This demonstration could fit into a unit on phase changes, thermochemistry, or technology.

PREPARATION

1. Working over a sink, create a hole in the middle of the side of an unopened soda can using a thumbtack. Continually shake the can, using the pressure generated by carbonation to force the soda out through the hole.
2. When the can is empty, create a second hole on the side opposite the first.
3. Rinse the can with a wash bottle, squirting water into one of the two holes.
4. Once you have emptied and rinsed the can, use the wash bottle to add about 10 mL water (or enough so you hear it sloshing around inside the can).
5. Use the thumbtack to slant each of the two holes in the same direction, tangential to the can's surface. These holes act as "jets" in order to propel the can.

DEMONSTRATION

1. Shake the can so that students can hear the water sloshing around inside the can. Allow them to observe that the pull tab is unopened and that there are two holes in opposite sides of the can.
2. Tie a string to the can's unopened pull tab and secure the can to a ring attached to a ring stand at a height that allows a Bunsen burner or hot plate to warm it.
3. While waiting for the can and water to heat, ask students to predict what will happen.
4. Gently warm the can and water. Water vapor will eventually exit both holes and should result in a net force that sets the can spinning.

DISCUSSION WITH STUDENTS

1. Ask students to describe any energy transformations present in the demonstration.
2. Challenge students to explain why the can behaves as it does. As long as the water is heated gently, no condensed water vapor is visible as steam exits the can.

EXPLANATION

Energy may go through several conversions before we actually use it to do work. Energy is not "used up" in any conversion; it is simply changed from one form to another. Like matter, the total energy is conserved.

Several energy conversions are involved in the demonstration. Chemical energy from the fuel used in the Bunsen burner or the source that produced the electricity (some possibilities are hydroelectric, solar, wind, geothermal, nuclear, and petroleum energy sources) powering the hot plate is used to warm the water and can. Some of the energy goes to overcoming the attractions among the liquid water molecules so they vaporize to produce warm water vapor. The molecules

of the warm water vapor have high kinetic energy, which increases the pressure inside the can and thus forces some of the gas out through the holes in the sides of the can. As these jets of gas leave the can, they push on the air outside the can and create an opposite push on the can, which then is partially converted to kinetic energy as the escaping water vapor causes the can to rotate. Some of the energy from the escaping water vapor is also partially converted to potential energy as the string attached to the spinning can twists.

EXTENSIONS

Instructors may also wish to discuss the idea that no energy conversion is 100% efficient in transforming one form of energy to another desirable form. Thus, some useful energy is always "lost" whenever energy is converted from one form to another. The energy itself is not destroyed, but becomes unavailable to do useful work. For example, some of the electrical energy used in the operation of a hair dryer is converted to sound energy, which does not help to perform the work of drying your hair.

Students can investigate energy conversions in everyday items. Some suggestions are light bulbs, batteries, toys, car engines, etc.

Students could research the early steam engine invented by Hero of Alexandria in the first century A.D. and compare it to the soda can steam engine.

ADDITIONAL RESOURCE

"Demonstration Idea," *Chemistry in the Community*, 6th ed., Teacher's ed., New York: W. H. Freeman and Company/BFW, 2012, p 361.

