What is Energy?

A laboratory experiment from the Little Shop of Physics at Colorado State University

Overview

We often think about energy in personal terms. People comment on the energy young children seem to possess. Others mention that they don't feel they have enough energy to make it through the day. We've heard that the world is running out of certain types of energy.

In spite of all of our everyday use of the word *energy*, it remains an abstract concept, and students may have developed quite a few misconceptions about it.

So, just what *is* energy?

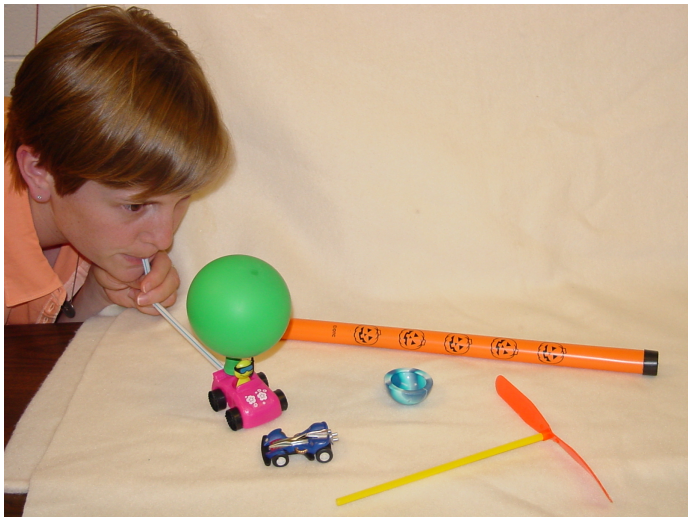
Necessary materials:

- 1 balloon car
- 1 pull-back race car
- 1 popper
- 1 groan tube
- 1 physics flyer

These toys are a great way to start your students' exploration of different energy forms and energy conversions. You can certainly use other toys or examples from the classroom or home as well. All the toys for these activities can be found at the following website: www.orientaltrading.com

Theory

Rather than *define* energy, it's easier to talk about *examples* of energy. When you walk up a set of stairs, you are using energy. When you turn on a light bulb, it is using energy. When you heat up a pot of water on the stove, you are using energy. Basically, *energy is something that lets us do things.*



Using simple toys to explore changes in energy.

Whenever you move or talk, you use energy. Any device or appliance in your house that does something uses energy too; lamps use energy, so does your television, so does your washing machine.

The weather on Earth is driven by the transfer of energy and the conversion of energy from one form to another, but this will be a difficult concept for students if they don't truly understand energy—its different forms, how it can be converted from one form into another, and the fact that it can't be created or destroyed. We believe the best way to teach students about energy is to simply let them do a variety of experiments with energy, and let them figure out what it is by themselves. In fact, all of the basic energy concepts are perhaps best discovered by exploration. The concepts are abstract,

but relate nicely to commonsense notions of how the world works.

Doing the Experiment

This activity is meant to be an exploratory activity where students experiment, observe, and determine how various toys change energy from one form of to another. If this is your students' first time discussing energy, you may want to discuss types of energy, and model with other toys or materials prior to this activity.

You may introduce the toys in any order you prefer. The lesson plan is the same for each toy:

- Allow students to work with the toy.
- Have the students discuss with their neighbors what the toy does and what energy changes it illustrates.
- They should determine what form the energy starts out in, what energy changes occur while using the toy, including what form it is in when the toy stops. (Note: there are a lot of energy changes for each toy, so this can be somewhat open-ended. For instance, for the balloon car shown above, the energy starts as chemical energy in your body, which turns into motion energy of your body, which is stored as potential energy in the balloon. . .)
- It is important to follow this activity with a class discussion, to help students finalize and formalize their findings.

Guide for Specific Toys

Toy: Pull-back Race Car

1. What does the toy do? (You can nudge it forward by hitting it with your finger or you can push down on it and pull it backwards. When you let go, it races forward and you can hear a little mechanical sound.)
2. What energy change/s happen as this toy operates? (As you push down on the car and pull it backwards, you are applying a force to the car and putting some of your energy into elastic potential energy in the car, as a spring is tightly wound during this process. As you release the car, the spring extends, and the potential energy is converted into kinetic energy of the moving car. During this process, friction is at work, and some of the kinetic energy is converted to heat and sound energy.)
3. What form does the energy start out in? (After you've pulled it back, before releasing it,you've given it elastic potential energy, by winding the spring.)
4. What form does the energy turn into? (Kinetic energy of the moving car, plus some sound energy.)
5. What form is the energy in when it stops? (Heat energy. Ultimately, friction between the moving parts turns the kinetic energy into heat.)

Toy: Groan Tube

1. What does the toy do? (When you turn it upside down, a noisemaker inside the tube travels down to the bottom of the tube making a noise as it descends.)
2. What energy change/s happen as this toy operates? (When you flip the tube over in the air, you raise the noisemaker to the top of the tube. When the noisemaker is at the top of the tube, it has gravitational potential energy. As the noisemaker responds to gravity pulling it down, the potential energy is converted to kinetic (moving) energy causing air to move through the noisemaker converting some of the kinetic energy into sound energy. The noisemaker doesn't speed up as it falls, as the lost potential energy turns into sound energy. When it hits the bottom, the remaining kinetic energy is turned into heat in the collision.)
3. What form does the energy start out in? (Gravitational potential energy)
4. What form does the energy turn into? (Kinetic energy and sound energy)
5. What form is the energy in when it stops? (Heat energy)
6. Why do you think one end is open and one end is closed? (There are two reasons for this. The noisemaker makes noise via a reed in the center when there is a pressure difference across it. One side of the tube is open, the other is closed. When the noisemaker falls, air in one side is compressed —and so air is forced through the reed. If both ends of the tube were open, there would be no

compression. If both ends of the tube were closed, you would get a pressure difference—but the tube needs one side to be open so the vibrations inside the tube can be coupled with the air and our ears can perceive them as sound. When both ends are closed (try this with a piece of tape) you can barely hear a sound as the noisemaker falls. When both ends are open (replace the closed end with an open end from another tube), the air doesn't compress, vibrations are not created, so there is no sound.

Toy: Popper

1. What does the toy do? (When you turn the popper inside out and place it on a flat surface, it pops-up in a second or two and falls to the ground.)
2. What energy change/s happen as this toy operates? (You are putting some of your energy from your muscles into the toy initially. When you turn the popper inside out, you are giving the toy elastic potential energy. When the popper reverts back to its original shape the potential energy is converted into sound energy and kinetic energy. It pushes away from the surface, causing it to fly up into the air. Gravity is pulling down on the popper, causing the kinetic energy to convert to gravitational potential energy by the time it reaches its highest point. Then as it is pulled down by gravity, it converts its potential energy into kinetic energy again. When it finally hits the surface and stops, the kinetic energy has been converted into heat energy and sound energy.)
3. What form does the energy start out in? (Elastic potential energy)
4. What form does the energy turn into? (Sound energy, kinetic energy, gravitational potential energy)
5. What form is the energy in when it stops? (Heat and sound energy)

Toy: Physics Flyer

1. What does the toy do? (You hold it between your two hands and launch it by pushing your right hand past your left hand. The physics flyer starts spinning and lifting higher in the air. It keeps moving forward but starts slowing down and dropping.)
2. What energy change/s happen as this toy operates? (When you move your right hand past your left hand, you are putting energy into the Physics Flyer from your muscles. By moving your hands that way, you cause the fl yer to spin in one direction (to the left) so you're giving it rotational kinetic energy. It moves forward but climbs to a higher height due to the tip of the blades on the propeller. They are tipped upward when moving to the left. Gravity is pulling down on the flyer, so some of the rotational kinetic energy is converted to gravitational potential energy, but not all of it, as it continues to spin.
3. The gravitational potential energy converts to kinetic again, but its spin starts to slow down and it eventually starts dropping to the ground, dealing with friction and buoyancy of the air. By the time it stops, its energy has converted to heat energy.)
4. What form does the energy start out in? (Rotational kinetic energy)
5. What form does the energy turn into? (Gravitational potential energy and then kinetic energy again)
6. What form is the energy in when it stops? (Heat energy)

Toy: Balloon Car

1. What does the toy do? (After you have blown up the balloon, you cover the hole where the straw was attached. When you let the car go, it moves forward and you can hear the sound of the air pushing out the back of the car and a sound of the tires spin.)
2. What energy change/s happen as this toy operates? (As you blow up the balloon, you are putting some of your energy into potential energy as you've created an area of high pressure in the balloon. As you release the car, the air under high pressure in the balloon moves to an area of lower pressure outside the balloon, thrusting the car forward. The potential energy is converted into kinetic energy of the moving car. During this process, friction is at work, and some of the kinetic energy is converted to heat and sound energy.)
3. What form does the energy start out in? (You've given elastic potential energy, by increasing the pressure in the balloon.)
4. What form does the energy turn into? (Kinetic energy of the moving car, plus some sound energy.)

5. What form is the energy in when it stops? (Heat energy. Ultimately, friction between the moving parts turns the kinetic energy into heat energy.)

Summing Up

This suite of activities on energy changes is largely qualitative, but it can be adapted to make it more quantitative as well. Doing this science lab with toys also encourages students to think *outside the walls;* to think of science as something that applies to the world beyond the classroom.

For More Information

CMMAP, the Center for Multi-Scale Modeling of Atmospheric Processes: http://cmmap.colostate.edu

Little Shop of Physics: http://littleshop.physics.colostate.edu

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