

Can energy be created or destroyed?

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



Overview

Energy is the single most important science concept your students will understand. Understanding conservation of energy is vital as students study the earth's energy budget and make informed decisions for the future.

Theory

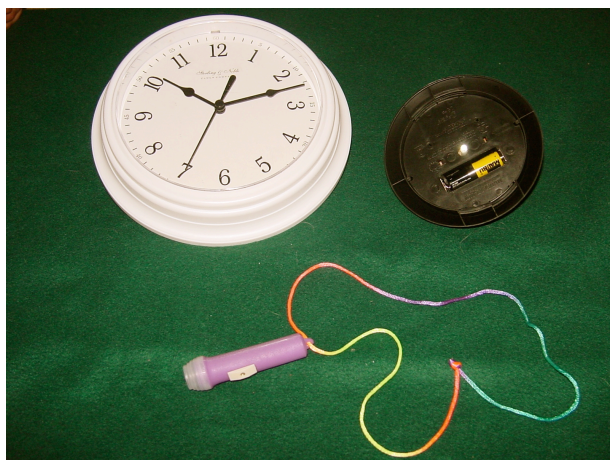
Conservation of energy is another concept that is difficult to explain but easy to grasp through experimentation. We say that *energy is conserved*: you can convert energy from one form to another, but it cannot be created or destroyed. In this set of activities, students can make quantitative comparisons which work quite well. They can explore the rate at which energy is used: a one-minute charge of the battery via solar cell will run a flashlight for several seconds but will run a clock for quite a bit longer.

Doing the Experiment: Part 1: First Steps

This activity requires sunlight to charge the battery using the solar cells. You can use the sun coming in a window, or have the students take their solar cells outside for charging. We prefer the latter. When students take their solar cells outside for charging and then bring them in, it helps them see that they are bringing the energy of the sun indoors!

Now close the curtains in your classroom and turn out the lights. The lights in the solar cell night light units will come on! If the lights don't come on, it may be because there is still light hitting the top of the unit. Cover this with

your finger, and the white light will come on. Have students see how long the lights will stay lit. Have them discuss: where did the energy come from to make the units light?



The battery from the solar night light can run other things as well.

Necessary materials:

- 1 solar cell night light device, with battery
- time-keeping device (clock or stop watch)
- 1 one-battery flashlight
- 1 one-battery clock
- 1 one-battery toy car

The solar cells are part of solar garden lights available at hardware and variety stores. The battery, in the top of the unit, is a NiCd battery that can be charged and discharged repeatedly. It's a standard AA battery that can run many different things.

When you put the battery in a toy or a clock or a light, you see how long the stored energy will last.

Part II: Concepts

As preparation, you will need to be sure that the batteries from the solar cell night light devices are totally discharged. A good way to do this is to put the batteries in the flashlights and let them run down. You can also let the night lights run overnight. Now, proceed as follows:

- Have the students put the batteries in the solar cell units and put the cell in bright sunlight for 2 minutes then bring the solar cell unit indoors and remove the battery. This is easily done if you turn the units over so that the battery is visible.
- Have the students put the battery from the solar cell unit in the flashlight. Have them turn the flashlight on

and measure how long the energy in the battery can run the flashlight. (This is a good time to have the students think about their experimental methods. As time goes on, the flashlight gets dimmer and dimmer. How do you determine the point at which the flashlight goes out? The main thing is to have a measurement that can be made consistently!)

- Next, have students discuss why the flashlight goes out. They will likely mention energy, that the battery has run out of energy. This is correct, and it leads to consideration of the next segment of the activity, in which students will take quantitative data.

Part III: Data

This section of the activity is a chance for your students to collect data and note a trend. The data isn't perfect, but the trends are clear. This is how real science is often done, with imperfect data from which general correlations are discovered. Have the students proceed as follows:

- Set the solar cell in the sun for 1 minute to charge the battery.
- Measure the time the battery can run the flashlight.
- Set the solar cell in the sun for 2 minutes to charge the battery.
- Measure the time the battery can run the flashlight.
- Set the solar cell in the sun for increasing amounts of time: 3 minutes, 4 minutes...
- In each case, after charging, measure the time that the battery can run the flashlight.
- Finally, have students make a graph or chart of their data, to show the trend. Have them think about what deductions they can make from their data. It will be quite clear that the longer the solar cell charges the battery, the longer the battery can run the flashlight. But given uncertainties in the process, the data won't necessarily show that charging the battery for twice as long will allow it to run the flashlight for twice as much time. (A few things that make a difference: the flashlight draws more energy from the battery at the very start, and then tapers off. Also: the more charge in the battery, the faster the draw. So the time that the battery can run the bulb won't be exactly proportional to the energy in the battery. The battery may have a bit of a "rebound" effect as well, as many batteries do. If you take the flashlight and let it run the battery down and then turn the flashlight off and turn it on again after a short wait, you may find that the flashlight lights again! This rebound effect will complicate the data.)
- Have the students give an overall conclusion for this experiment. What does the data show? Have them phrase their conclusion in terms of *energy* and *energy conservation*.

Part IV: Differences

The final part of the experiment is designed to show that different devices use energy at different rates. When you charge the battery up with the solar cell for one minute, this puts a certain amount of energy in the battery. If this energy is drawn out slowly, it can last for a long time; if it is drawn out quickly, it won't last very long.

Have your students proceed as follows:

- Set the solar cell in the sun for 1 minute to charge the battery.
- With this much of a charge in the battery, see how long the battery will power the flashlight.
- After the battery is discharged, use the solar cell to recharge it for one minute; this should put the same amount of energy in the battery as before.
- Now, see how long this amount of energy will allow the battery to power the clock. You will likely find that the time is much greater; the clock uses energy at a much slower rate.
- Next, have your students see how long a one-minute solar charge will allow the battery to power the toy car. (A question: which is the best measure of how much energy is in the battery: the time that the car will run, or the distance it will travel?) You might have your students think about this.)
- Finally, have your students discuss what they have observed. Have them phrase their observations in terms of *energy* and *energy conservation*.

Summing Up

This is a wonderful activity for putting a quantitative face on the idea of energy conservation and energy changes.

For More Information

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

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