Running on Sunshine

The activity presented here is one of 60 learning cards that make up SAE's *A World in Motion* program that teaches basic mobility physics concepts to fourth, fifth, and sixth graders. The objective of this sample activity is to illustrate how energy from the sun can be harnessed and converted to motion. The point being that this limitless natural resource is an alternative energy source that has no adverse effect on the environment.

Summary of Activity

This activity has two parts. Part one - Explore-shows that the sun can produce electricity. A solar cell is connected to a galvanometer (professional or homemade) to show that sunlight (solar energy) has been converted to electricity. In Part two-investigate-students construct a simple electric motor and observe the conversion of electricity into motion.

Activity Content

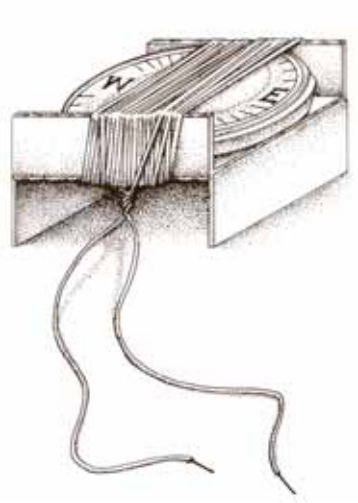
This sample activity is intended for sixth graders. It is the third card in a three-card unit of *A World in Motion.*

Although this sample activity is intended to be part of the three card series, it is sufficiently self-contained to stand alone. NOTE: In the activity cad: that precedes this activity in the *A World in Motion* program; students make a model galvanometer, which is used in this activity. If you have access to a professional galvanometer, you may wish to use it for this activity. You may prefer to build, or have students build the model galvanometer. Following are directions intended for student use.

Building a Model Galvanometer

Materials

- compass
- cardboard
- bell wire
- pushpin



1- Cut the cardboard into two pieces the same width as the compass, but 2 cm longer than the length of the compass. Fold up opposite sides of the pieces. Glue the pieces back-to-back as shown to make a platform.

2. Put the compass on the Platform so that north (N) and south (S) are against the folded sides. Trim the folds the same height as the compass.

3. Wrap bell wire 30 times around the compass as shown, leaving about 25 cm free on each end. Twist the free ends together at the platform so the wire does not unwind. Use a dull knife to scrape about 2 cm of insulation off the ends of the wire.

Preparation

1 - Read all material. Decide if you will use a professional galvanometer or if you will make or direct students in making a model galvanometer.

2. Decide if you will present the activity as a demonstration or will direct students in carrying it out.

3. Gather all materials. (Activity materials are listed on card; galvanometer materials are listed at left.) If students will do the activity, plan on having them work in small groups (about four students). If you plan on giving students copies of the activity, be sure to make sufficient copies before the class meets.

Activity Presentation Suggestions

1. Start with a brief discussion of energy. Include the following points: Energy is the ability to do work. Solar energy is just one of the many forms of energy. Other forms include chemical, heat, electrical, nuclear, potential, and kinetic energy. The law of conservation of energy indicates that energy can be transformed but cannot be created or destroyed. A system gains energy only if energy is lost elsewhere. Most energy comes from the sun and is stored in such sources as oil, coal, and wood, which release the energy when burned.

2. Ask students what solar energy is. Ask if solar energy can be changed into electric energy. Ask how they could prove this is so. Tell students that a galvanometer can be used to detect electric current. Explain what a galvanometer is. Include these points:
A galvanometer is an instrument that detects small amounts of electricity. Electricity is caused by the movement of energy-charged particles called electrons. When currents of electrons pass from an object through the wires of a galvanometer, the galvanometer needle moves. The needle moves because the electric field cuts across the magnetic field of the compass, generating a force that moves the needle.
Demonstrate how attaching a galvanometer to a battery makes the needle move. Ask how the galvanometer could be used to prove *that solar energy can be changed into electrical energy.

3. If students are to make a model galvanometer, have them do so now

4. If you are demonstrating the activity, present side one-**Explore**. If students are participating, pass out copies of the activity or lead students through the Explore steps.

5. Briefly explain how solar cells work. Include the following points: Photovoltaic (solar) cells turn the sun's energy directly into electricity via the photovoltaic effect sunlight hits a layer of electron-releasing metal placed against another metal layer that collects and transfers the electrons to outgoing wires as an electric current. (Take care to keep the explanation at students' comprehension level.)

6. Tell students that changing solar energy to electric current is the first step in using solar energy to fuel motion. Explain that they (you) will use a flashlight battery (size D) to create a motor to change electric current into motion (A battery is used because or the prohibitive cost of solar cells powerful enough to make the motor function.)

7. If you are demonstrating present side two-**Investigate**. If students are participating, pass out copies of the activity or lead students through the investigate steps.

Follow-up Discussion

The follow-up discussion should center on the link between this activity and the environment. Explain that one reason scientists and engineers investigate alternative forms of energy, such as solar energy, is to reduce the use of pollution-causing and limited fossil fuel energy sources. You may wish to discuss other alterative energy sources, such as wind and water.

How to Take Part in *A World in Motion* Program

A World in Motion is a fully integrated print and video program that emphasizes hands-on discovery of science principles in a cooperative learning setting. The program is distributed free to schools. The sponsors of *A World in Motion* are the members of SAE, an organization of 60,000 engineers dedicated to advancing the art and science of mobility engineering on land, sea, air, and space. SAE is dedicated to the furthering of science education. !n addition to sponsoring the development of *A World in Motion* materials, SAE volunteers throughout the country are ready to participate in classroom visits to assist with this program. If you as an engineer or an educator would like to be part *of A World in Motion*, write to the Education Program Developer at: SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096

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START HERE

Materials needed:

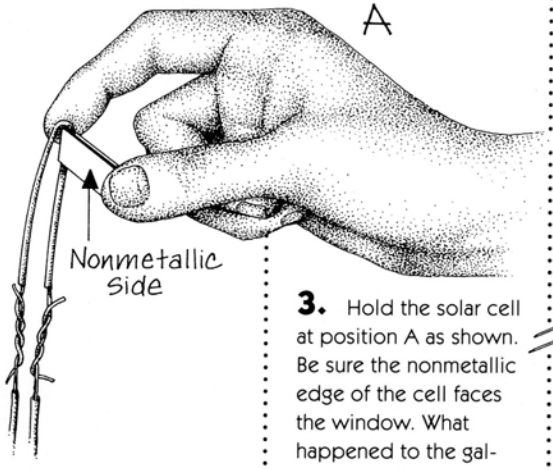
- model galvanometer
- small solar cell with leads
- zinc and copper strips, each 5 cm long
- D battery
- 3 pencils
- bar magnet
- bell wire, 45 cm
- polystyrene cup
- masking tape
- rubber band
- dull knife
- scissors

EXPLORE

If you have not made a model galvanometer, see instructions and Discover the Science on Card 2 of this unit. Do not attach the copper and zinc strips to the galvanometer. **Handle the solar cell very gently!**

1. Work in sunlight. Use a dull knife to remove 1 centimeter (cm) of insulation from the ends of the solar cell wires. Carefully connect these wires to the galvanometer wires by twisting the wires together. Bend down the ends of the solar cell wires.

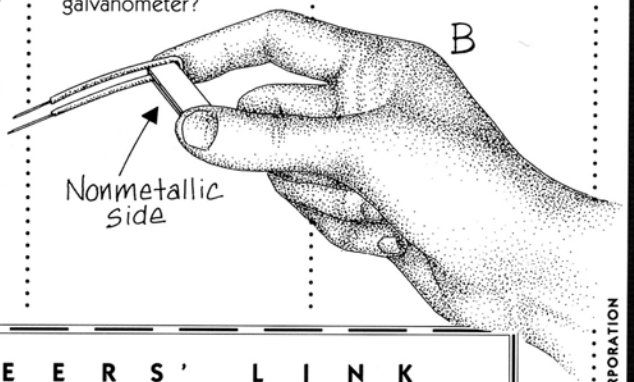
2. Have a teammate hold the galvanometer steady so the needle points north (N).



3. Hold the solar cell at position A as shown. Be sure the nonmetallic edge of the cell faces the window. What happened to the galvanometer?

4. Repeat Step 3, holding the solar cell flat at position B as shown. Sunlight should shine directly on the nonmetallic side. What happened to the galvanometer?

5. Repeat Step 4 with the metallic side up. Did the galvanometer move a little or a lot?



DISCOVER THE SCIENCE

Light and heat from the sun produce **solar energy**. Solar cells collect the sun's energy and change it to electricity. When light strikes the metal inside a solar cell, tiny particles called **electrons** flow in a current from the metal into the cell's wires. Flowing electrons create the electricity. When did the solar cell pass on the most electricity to the galvanometer? Why?

ENGINEERS' LINK

Most of the world's energy comes from coal, oil, and water. Recently, other energy sources, such as the sun, are being used. Engineers study ways to change energy into motion. They have designed satellites and cars that are powered by solar energy. You can investigate changing energy too.

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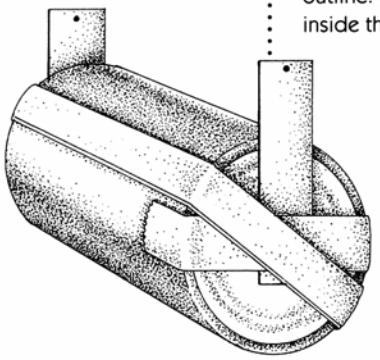
INVESTIGATE

How can electrical energy be changed into kinetic, or moving, energy?

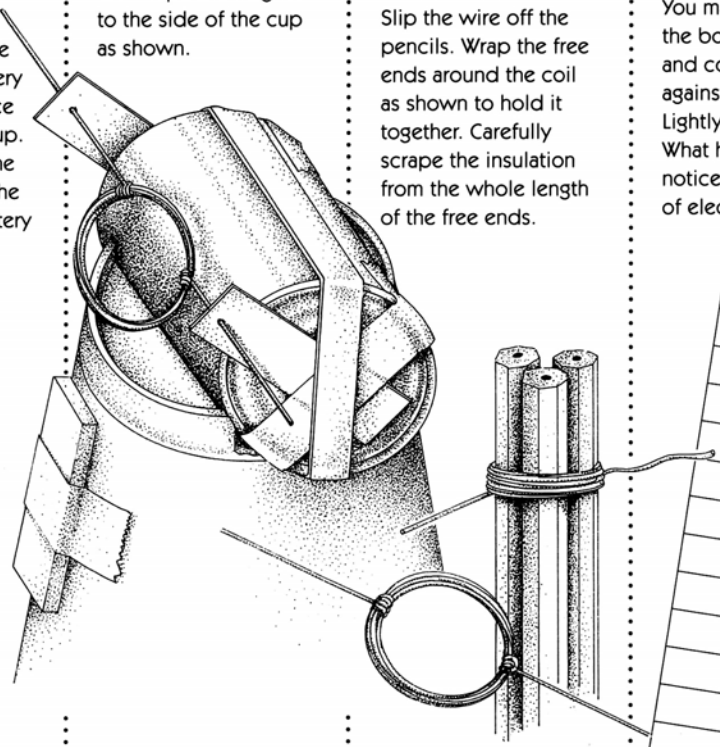
To answer this question, you must find a source of electrical energy and build a device that changes that energy into motion. A model motor is a good device. Follow the directions to build a model motor.

1. Tape the zinc and copper strips to the ends of the battery so the holes in the strips stick up about 3 cm as shown. Make sure the strips touch the battery ends in the center. Wrap a rubber band tightly around the ends of the battery to hold the strips in place.



2. Set the cup upside down on the table. Rest the battery on the cup and trace its outline on the cup. Make a cradle for the battery by cutting the outline. Set the battery inside the cradle.

3. Tape the magnet to the side of the cup as shown.



4. Hold three pencils together in a bundle. Wrap the wire around the pencils six times. Leave 5 cm of wire free at both ends. Slip the wire off the pencils. Wrap the free ends around the coil as shown to hold it together. Carefully scrape the insulation from the whole length of the free ends.

5. Slide the stripped ends of the coil into the holes of the zinc and copper strips so the wires stick straight out. Turn the battery so the coil hangs almost above the magnet as shown. What happens? **Note:** You may need to press the bottom of the zinc and copper strips against the battery. Lightly spin the coil. What happens? Do you notice any other signs of electricity?

What did you find out? Was electrical energy changed to motion? How do you know? If you used a solar cell to run the motor, what other element would you need to have?

Investigate Further: Does the amount of wire in the coil affect the way the motor runs? How could you find out? Try it! What did you find out?