ACTIVITY 20

Solar Cells

BROWARD COUNTY ELEMENTARY SCIENCE BENCHMARK PLAN

Grade 5—Quarter 2
Activity 20

SC.B.1.2.1
The student knows how to trace the flow of energy in a system (e.g., as in an ecosystem).

SC.B.1.2.2
The student recognizes various forms of energy (e.g., heat, light, and electricity).

SC.B.1.2.3
The student knows that most things that emit light also emit heat.

SC.B.1.2.4
The student knows the many ways in which energy can be transformed from one type to another.

SC.B.2.2.2
The student recognizes the costs and risks to society and the environment posed by the use of nonrenewable energy.

SC.B.2.2.3
The student knows that the limited supply of usable energy sources (e.g., fuels such as coal or oil) places great significance on the development of renewable energy sources.

SC.H.1.2.2
The student knows that a successful method to explore the natural world is to observe and record, and then analyze and communicate the results.

SC.H.1.2.3
The student knows that to work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions.

SC.H.1.2.4
The student knows that to compare and contrast observations and results is an essential skill in science.

SC.H.1.2.5
The student knows that a model of something is different from the real thing, but can be used to learn something about the real thing.

SC.H.2.2.1
The student knows that natural events are often predictable and logical.

ACTIVITY ASSESSMENT OPPORTUNITIES

The following suggestions are intended to help identify major concepts covered in the activity that may need extra reinforcement. The goal is to provide opportunities to assess student progress without creating the need for a separate, formal assessment session (or activity) for each of the 39 hands-on activities at your grade.

1. Remind the students of the kinds of energy conversions they observed in earlier activities this quarter (light energy transferred to plants was converted into chemical energy for growth; light energy transferred to water heated the water in solar collectors). Ask the students what energy conversion they think took place with the solar cells they saw in operation. (Energy from the sun was used to make electrical energy, which in turn was converted to mechanical energy by the motor.) Ask the students what might have happened over the past month if the school building used only solar energy to generate electricity. (On sunny days there might be enough energy. If there were a lot of cloudy days, then there might not be enough energy to meet the school's needs.)

2. Use the Activity Sheet(s) to assess student understanding of the major concepts in the activity.

In addition to the above assessment suggestions, the questions in bold and tasks that students perform throughout the activity provide opportunities to identify areas that may require additional review before proceeding further with the activity.

ACTIVITY 20

Solar Cells

OBJECTIVES

In this activity, students use a solar cell to capture and convert solar energy to electrical energy.

The students

- discuss solar cells and electric current
- observe that a partially obscured solar cell produces less electrical energy than does a fully exposed solar cell

SCHEDULE

About 50 minutes

VOCABULARY

electrical energy
mechanical energy
nonrenewable resource
renewable resource
solar cell

MATERIALS

For each student

1	Activity Sheet 20
1 pr	safety goggles*

For the class

1	electric motor
1	solar cell
2	wire leads, with clips
	tape, transparent*

*provided by the teacher

PREPARATION

1. Make a copy of Activity Sheet 20 for each student.
2. Connect the solar cell to the motor as follows: Attach the clip at one end of each wire lead to the metal connectors on the solar cell's wire. Attach the clip at the other end of each wire lead to the connectors on the motor. Place the solar cell near a light source on a centrally located demonstration table. Check to see that the shaft of the motor turns.
3. To make the turning motion of the shaft more visible to students during your demonstration, wrap a piece of tape around the shaft and press the two ends together to make a sort of flag (see Figure 20-1).

BACKGROUND INFORMATION

A ***solar cell*** is a device that converts solar energy to ***electrical energy.*** When light strikes a solar cell, it gives off a flow of electrons to a layer of adjoining metal. The flow of electrons is called *electric current.*

In this activity, students discover that a solar cell can be used to convert solar energy to electrical energy. They also discover that a partially obscured solar cell absorbs less solar energy than does a fully exposed cell.

▼ Activity Sheet 20

Solar Cells

1. **a.** Predict what will happen if half the solar cell is covered.
   Answers will vary.

   b. Predict what will happen if the entire solar cell is covered.
   Answers will vary.

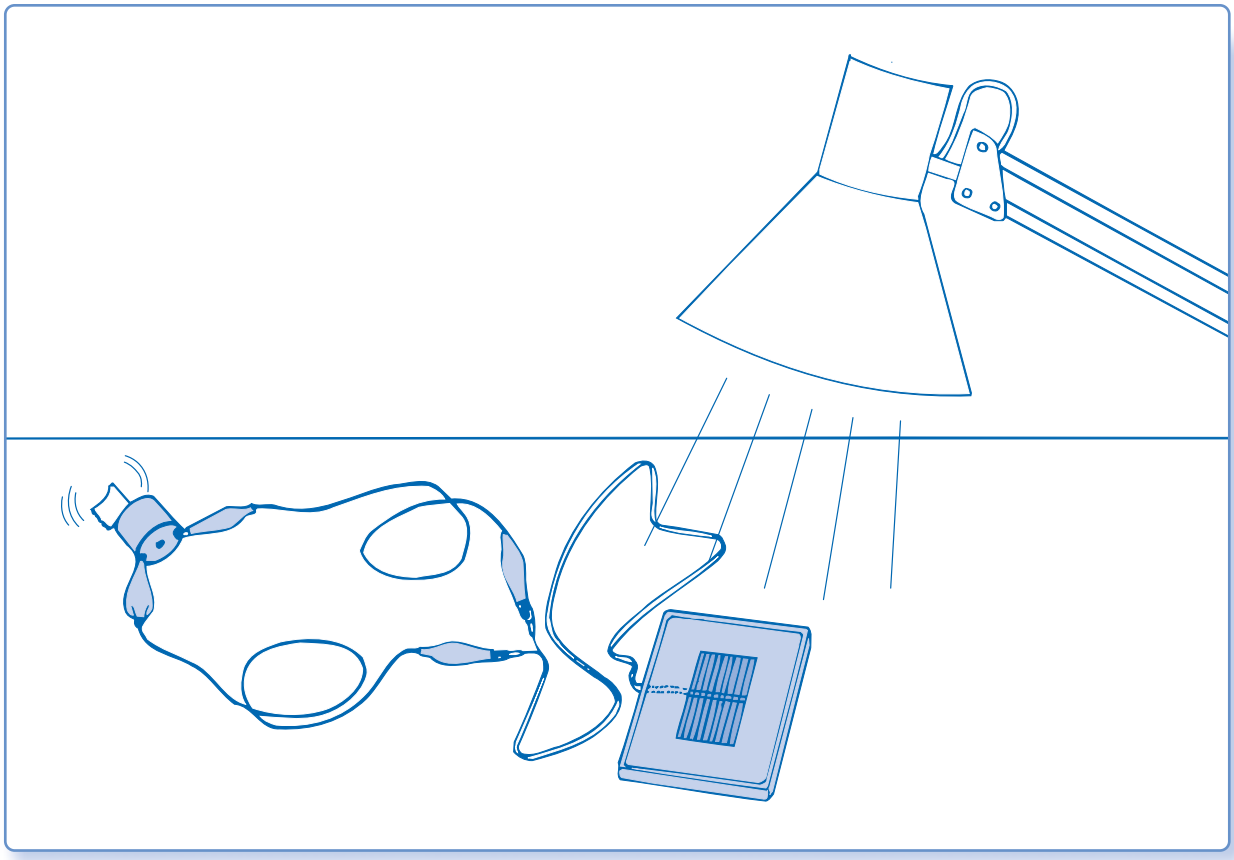
   c. Predict what will happen if the lamp is turned off.
   Answers will vary.

2. Observe as your teacher demonstrates what happens when the amount of light that reaches the solar cell decreases. Based on your observations, what can you conclude about how solar cells work?
   Solar cells need light or solar energy to work.

3. Describe the energy transformations that took place during the demonstration.
   Solar energy changed to electric energy then to mechanical energy.

4. Why is solar energy a good alternative to using fossil fuels?
   Solar energy does not pollute the environment and it is renewable.

5. How could you design an experiment to test how solar energy can be used to heat water in homes?
   Answers will vary. Accept all reasonable designs.



▲ ***Figure 20-1.*** *A solar cell in operation.*

Guiding the Activity

		Additional Information
1	Write the terms **solar cell** and **electrical energy** on the board. Ask volunteers to name some devices that run on the electrical energy produced by a solar cell. Explain that solar cells are devices used to convert solar energy to electrical energy. Solar cells are made of materials that, when struck by light, release their electrons to a layer of adjoining metal. This produces a voltage, which causes an electric current. The electric current (flow of electrons) flows through wires and provides energy to operate electric motors and lights, for example. In motors, the electric energy is transformed into **mechanical energy,** or the energy of motion.	*Some students may be familiar with solar cells that power calculators and other equipment.*
2	Show the solar cell and motor to students. Demonstrate how the motor turns when the solar cell is exposed to sunlight or artificial light.	*Artificial light from a desk lamp will be sufficient to operate the motor. If using artificial light, the solar cell should be held no more than 1 ft from the lamp. The motor is designed to turn slowly so that students can perceive differences in the speed of the motor as the amount of light hitting the solar cell increases or decreases. If your situation permits, take students outdoors and demonstrate the operation of the solar cell and motor using direct sunlight.*
3	Distribute a copy of **Activity Sheet 20** to each student. Ask, **What do you think the motor will do if half of the solar cell were covered?** Have students write their predictions on the activity sheet.	*Suggestions will vary. Some students may say that the motor will not turn at all, while others may think that there will be no difference in the speed of the motor. Still other students may correctly predict that the motor will turn more slowly.*
4	Demonstrate what happens to the motor when the amount of light reaching the solar cell decreases. Cover half of the cell and have students observe the motor as it slows down. Cover the entire cell and have them observe the motor stop. Repeat, this time leaving the solar cell exposed and turning the lamp on and off.	

Guiding the Activity

	Additional Information
5 Have students trace the transformation of energy in this experiment. Students should write their answers in their activity sheet.	*Solar energy transformed to electrical energy then mechanical energy.*
6 Write the terms **renewable resource** and **nonrenewable resource** on the board. Explain that solar energy is a type of renewable energy. Renewable energy sources can be replaced in a short amount of time. In contrast, nonrenewable energy sources may take millions of years to replace. They include fossil fuels such as coal, oil, and natural gas. Point out that using fossil fuels tends to be more damaging to the environment than using renewable sources.	*Other examples of renewable energy sources include wind, water, geothermal, and biomass energy.*
7 Discuss the advantages and disadvantages of different energy sources. Ask, **Why would it be better to use solar energy instead of fossil fuels to provide electricity?** Have students write their answer on the activity sheet.	*Solar energy is renewable and less polluting than fossil fuels.*
8 Explain that there are drawbacks to using any energy source. As students have learned, fossil fuels are nonrenewable and polluting. Ask students to review what they learned about solar energy in this activity, and then brainstorm why solar energy is not used more widely on a large scale.	*Based on the activity, students should realize that solar energy would not work well in areas that do not receive a lot of sunlight. Some students may also realize that the cost of solar technology is another factor that limits its use.*
9 Tell students that more and more people are using solar energy on a small scale to heat water or provide electricity to their homes. Ask them to design an experiment to test how solar energy can be used to heat water. What materials would they use? How would they set-up their experiment? Students should write their answer on the activity sheet.	*Students could put water in solar trays, place the trays in sunlight, and record the temperature change of the water at regular intervals.*

Reinforcement

Attach the solar cell to a simple galvanometer made by winding about 15 turns of insulated wire around a small compass. Let groups take turns using the device to detect small amounts of electric current produced by the solar cell under different lighting conditions, such as in a light from a flashlight, a fluorescent bulb, and incandescent bulbs of low wattages.

Science Journals

Have students place their completed activity sheets in their science journals.

Cleanup

Return the solar cell, motor, and wire leads with clips to the kit.

Connections

Science Challenge

Borrow a Crookes radiometer from a physical science teacher, and set it in sunlight so students can observe its operation. Ask students to suggest explanations for the vanes' rotation. (The black surfaces absorb more solar energy and become warmer than the white or polished surfaces. The warmer air above the black surfaces moves more quickly, and the air molecules rebound against the sides of the vanes, causing them to turn.)

Science and Language Arts

As a follow-up to the second Science, Technology, and Society activity below, tell students to imagine that they are passengers on a "solar sailboat" traveling to Venus or Mars. Have them write short stories describing the voyage and their observations from the time of leaving Earth to their approach to or arrival on the other planet.

Science and Math

Let students investigate the relationship between the number of turns of the motor and the distance of the solar cell from a light source (up to three feet is a good range). Also have them investigate the relationship between the number of turns and the amount of the solar cell that is covered: 0%, 25%, 50%, 75%, and 100%. For both investigations, students can construct a line graph of the results, with the vertical axis labeled *Number of Turns* and the horizontal axis labeled either *Distance from Light Source* or *Amount Covered*.

Science and Social Studies

Tell students that the word *power* means the amount of work that can be done in a given period of time. Explain that electrical power is measured in units called *watts,* named for the Scottish engineer James Watt. Ask students to research Watt's discoveries and inventions.

Science, Technology, and Society

Encourage interested students to research the construction of solar, or photovoltaic, cells. A typical photovoltaic cell consists of sandwiched layers of materials that function as semiconductors—substances that conduct electricity less readily than metals. When sunlight strikes the outer layer, it causes an electric current to flow to the next layer. As current flows through all the layers, the voltage increases. Ask students to investigate practical applications of photovoltaic cells.

Suggest that students investigate the phenomenon known as "solar wind," which is created not by moving air but by high-energy atomic particles streaming away from the Sun. Encourage interested students to research and report on the potential use of solar sails to "catch" solar wind for traveling in space. Point out that the strength of the solar wind decreases with distance from the Sun, so solar sails would be usable only for travel between the planets that are closer to the Sun.