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Teacher Notes

Solar Cell Introduction

The focus of the activity should be on observation of the phenomenon rather than on an explanation of the cause of the relationship. The voltmeter enables students to investigate quantitatively a phenomenon that would otherwise be only based on a qualitative observation.

It is not appropriate to expect the younger students to understand the intricacies of how electric current operates in a solar cell. Primarily they are making observations of electrical phenomenon. Devices using solar power, such as calculators, have become familiar components in children's lives. The focus of this activity is to use a quantitative measure, made available with the multimeter, to explore an area of electricity that would be inaccessible otherwise.

In addition, students will gain experience with inquiry skills, including:

1. identifying variables that can affect the outcome of an experiment;

2. gaining skills and confidence in using scientific measurement tool, the multimeter, as well as the spreadsheet and graphing capacity of a computer to represent and analyze data.

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Discussion Guide

Initiate a discussion in the class by asking each group: You've had a lot of experiences in class connecting electrical cells in circuits. What changes happened in your circuits when the circuits were turned on? Have the students make a list in their groups that they can share with the class.

After a few minutes, have the groups share the results of their discussions. They will probably come up with a list that includes light and heat (light bulbs) and motion (motors).

Ask the students if electricity, heat, light, and motion have anything in common? Children may know that they are all forms of energy. If not, it might be an occasion to tell them that scientists consider them all forms of energy.

If this activity follows the decaying battery experiment, ask if any change occurred in the batteries. If not, ask if they have had experiences with battery powered electrical devices that have been left on for an extended period. Ask the students to discuss possible explanations for why battery powered electrical devices seems to run out of power, while those connected to electrical power in the home or school will run continuously.

Ask if they know of any other sources of light, electrical, and heat energy besides batteries or electric power in their homes. Ask if they think it would be possible to capture the energy of the sun and use it to power an electrical device? Discuss their ideas.

Introduce the solar cell. Explain that it is an invention used to change the light energy from the sun into electrical energy.

Distribute the solar cells for students to examine. If they have had prior experience with measuring voltage in Decaying Batteries, challenge the students to measure how much electrical power the cell generate. Tell the students that in order to measure the electricity produced by the solar cell it needs to be connected to an electrical device. The solar cells are low voltage producers so they will not produce enough current to light the bulbs they have used in their circuits. Instead they will use a 2-ohm resistor to serve the function of placing a load on the electric current. Have a number of flashlights available for students to investigate how turning on or off a flashlight aimed at the solar cell affects the voltage. Have students share results. Most likely their results will vary. Ask them to write down what might account for the differences and discuss their theories.

Ask the students if they think there might be changes in voltage if they used the solar cells outside? Discuss their ideas about what might account for these differences. After the discussion one theory might be that the amount of sunlight powering the cell varies depending on the amount of sunlight. Others might argue that the temperature outside would be a factor. If they do not raise the issue of the effect of cloud cover, prompt the discussion by posing the question.

Ask students to each read "Thinking About the Question" and then allow them to discuss in their groups how they could design an experiment to determine if their theories are true. Discuss the proposals as a class and come to agreement on how to conduct a fair test.

Encourage the students to observe and record the changes in weather for several days prior to using the solar cell. They will no doubt observe changes in both cloud cover and temperature.

Ask the students to write down their predictions about how these different conditions might affect their measure of the voltage produces by their solar cells.

The students should conduct their investigations on two different days, but at the same time of day. See "Investigation I" for suggestions about how to guide the set up of their investigations. The best day to conduct this investigation would be a partly cloudy day with fast moving clouds. This will enable variation in voltage readings from the solar cell over the observation period.

Encourage the students to look at and describe details and patterns in their data first. Then they should look for relationships between variation in cloud cover and voltage.

Some children may think that the temperature is a variable. This may persist even after experimentation. If this occurs you may want to explore this further. In fact, changes in air temperature are an indirect result of changes in the intensity of incoming solar radiation.

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Additional Teacher Background

The atmosphere affects the amount of sunlight that reaches the earth. Sunlight enters our atmosphere with a lot of energy, about 1,000 watts to every square meter. By the time it gets to you, it is greatly reduced. The atmosphere absorbs some of this energy. If the sun is not directly overhead, striking the ground at a slant reduces the energy further. This is a result of the light being dispersed across a greater surface area and by going through more air, resulting in less energy per unit of area.

Students may question why solar cells are not more widely used. It is true that the energy of the sun can be turned into electrical energy using a solar cell, but solar cells do not work when the sun is not shining! By logging local weather conditions, the students can develop a sense of how useful solar cells would be in their area.

There are a number of measures related to electricity. Batteries typically have a rating in **volts**. **Voltage** is a measure of the "push" or pressure on an electric current. In order for an electric current to move there must be a conductor, a material through which electric current can move. One property of materials is the extent to which they permit the free flow of electrons. This characteristic is called **resistance**. It is measured in **ohms**. The amount of pressure (volts) and the resistance of a material (ohms) affect the rate of the **current** (the rate at which electrons move across a circuit) which is measured in **amps**.

In order to test the amount of electricity released, the solar cell needs to be connected to a device that offers resistance to the flow of electrons. Often in the classroom small light bulbs offer resistance within a simple circuit. You will insert a 2-ohm resistor into the circuit with the solar cell and multimeter to create a "load" in the circuit. A "load" offers resistance to the circuit.

Students often link solar cells with NASA. Spacecraft are big users of solar cells, since there is no atmosphere to block solar rays in space. For this reason, space exploration vehicles are big users of solar cells. All the equipment aboard spacecraft must be powered and solar cells are used to recharge the batteries aboard the vehicle.

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Solar Cell Suggested Timeline

The amount of time you spend on introductory discussions, data collection, and analysis, will determine your overall timeline. The following represents a possible timeline.

- One class period - Introductory Discussion
- One class period - Investigation I: First Day of Solar Readings
- One class period - Investigation II: Second Day of Solar Readings
- One class period - Analysis

Additional days can be used for further investigations.

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