

Activity 1: What does a Solar Panel Do?

Time Required: 45 minutes

Materials List

Group Size: 2 students per group

Each group needs:

- Solar Panel (from Solar Car kit)
- Digital Multimeter
- Motor (from Solar Car kit)
- 2 wires with Alligator Clips
- 2 D cell batteries

To Share with Class:

- Electrical tape
- Scissors

Youth Worksheets

What Does a Solar Panel Do? Worksheet

Learning Objectives

After this activity, students should be able to:

- Explain that a solar panel converts light energy into electricity.
- Be able to explain that a solar panel is like a battery when sunlight hits it because it can directly power electrical devices.
- Explain that the voltage of solar panels connected in series is the sum of the individual panel voltages.

Introduction:

During the next few sessions, we will be learning about generating electricity using the sun, and in the process, we will be building a solar car. Today, we will be exploring solar panels to prepare us for building the solar car. Have any of you ever seen a solar panel before? Where have you seen a solar panel? What are some things you have seen powered by solar panels? [Allow the students to think about this for a bit and brainstorm some answers. If you have a board, write down the students' responses. These may include calculators, solar powered lights (lights that line your drive-way or walk-way), traffic signs with lights powered by solar panels, construction equipment powered by solar panels.]

A solar cell converts sunlight into electricity. In the cell, energy from sunlight is transferred to electricity (moving electrons). Not all of the energy of the sunlight is converted to electricity. Some of the sunlight is reflected and some is turned into heat. The solar panels that you are using in these activities produce about 4 watts of power in full sunlight. As a comparison typical incandescent light bulbs you might see in your house require approximately 60 watts of power.

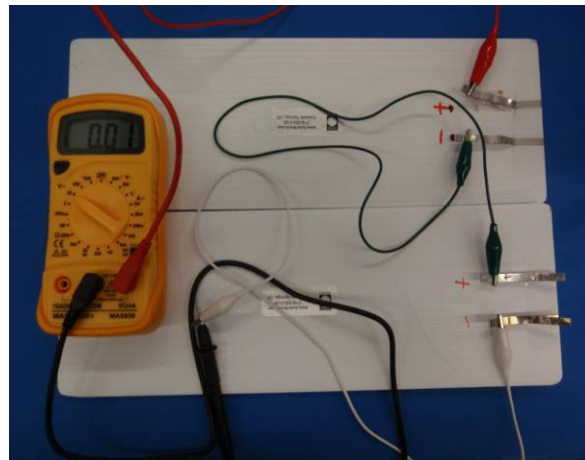
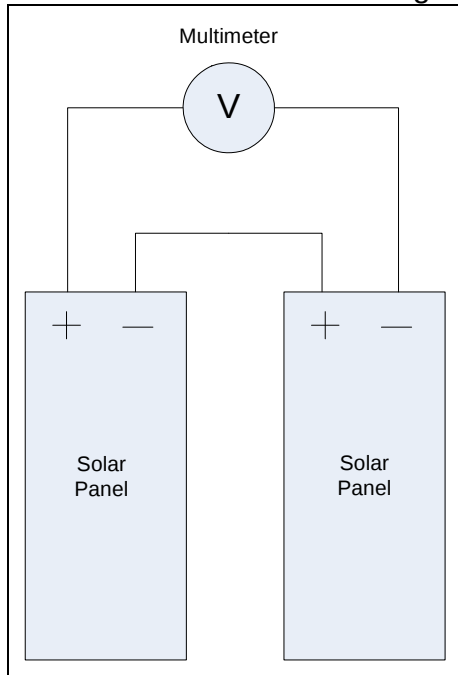
Vocabulary

Word	Definition
Voltage	Electrical energy that causes current to flow.
Current	Flow of electricity
Solar Cell	Converts sunlight into electrical energy
Conductor	A material through which electricity flows easily. Metal is a good conductor.

Procedure**During the Activity:**

- 1) Split the students into pairs.
- 2) Provide each group with an activity sheet and this activity's materials.
- 3) Ask the students first to examine their solar panel:
 - a. Warn the students that the solar panel is fragile and can easily be cracked or broken so care must be taken not to drop, bend, or twist the panel. The solar panel can still be used if there are cracks, but its efficiency is reduced. Have the students examine their panel for cracks and record any cracks they see on their activity sheet. If the panel is broken, care must be taken to properly discard the pieces (the pieces will be sharp like pieces of glass).
 - b. Ask students to verify that their panel is clean (dirt on the panel will block sun absorption and reduce efficiency). If the panel needs to be cleaned, the student should use a soft rag and rub gently.
 - c. Warn the students to not remove, pull, or twist the conductor tabs (the two silver tabs on the solar panel).
- 4) Ask the students to adjust the dial on the multimeters to measure voltage and then to hook up the leads on the digital multimeter as shown in their worksheets to the solar panel and measure the voltage when the solar panel is placed in the dark (in a desk for example), is exposed to bright lights inside, and is exposed to sunlight. Students will likely understand that without any light energy, the panel will not create any voltage.
- 5) While measuring voltage, if the positive lead of the multimeter (red) is connected to the positive connector tab on the panel, the reading will be positive. If the leads are reversed, the reading will be negative. Use this information to mark the connector tabs on the solar panel as positive and negative using a pen or marker. This is important when connecting multiple panels together. Since the panels are reused each year, they may already be marked. In this case, ask the students to use the multimeter to verify the markings.
- 6) Ask the students what they expect will happen if two solar panels are connected together. Then have two groups join together so that there are two panels per four students. Have the students think about how they can connect the two panels together to increase the voltage. To do this, they will discover that they must connect the panels as shown below. You can tell them that this is called a series connection by electrical engineers.

Series Connection: To connect the panels in series the students should use one alligator clip to connect the positive connector tab on one of the solar panels to the negative connector tab on the other solar panel. The multimeter leads should then be connected to each of the free connector tabs on the two panels. The students will find that when the two solar panels are connected in series the voltage produced is double the voltage produced when only one solar panel is used. This is the configuration the students will find increases the voltage.



- 7) In pairs once again, ask the students to measure the voltage across the battery. Ask the students to connect their motor to a battery and see that the motor runs. You may find the electrical tape useful in connecting the motor wires to the battery. Try connecting the batteries in series using electrical tape and running the motor. Measure the voltage across both batteries. How does the voltage from the batteries compare to the voltage from the solar panel? [Answer: The solar panel produces a little over 3 volts while the batteries produce a little over 1.5 volts each if they are new. In series, the voltage of the two batteries is added together to equal approximately 3 volts.]
- 8) Then ask the students to disconnect their motor from the battery and then connect the motor to the solar panel. Make sure the students understand that the solar panel works like a battery and provides current to the motor.
- 9) If they would like to, the students can get into groups of four again and try connecting the motor to two solar panels in series to find out what happens differently than one solar panel.

Processing and Activity Closure:

Discussion questions for students:

1. What did you find out when measuring the voltage produced by the panels in different lighting conditions?

2. What conclusions can you draw from this information?
3. How did the number of solar panels connected in series affect voltage?

Possible answers to questions:

1. When more light shines on the panels, the panels produce more voltage.
2. The motor will run more easily when more light shines on the panels because when the panels produce more voltage, they can provide more electrical energy to the motor.
3. When the solar panels are connected in series, the voltage of the two panels is added together.

Additional Instructor Resources:

If you're interested in learning more about how solar panels work, you can find out online at HowStuffWorks.com.

<http://science.howstuffworks.com/solar-cell.htm>

Embedded Assessment

Please collect and copy pages 9-11 from the student worksheets. The following questions are included in the student activity worksheet; please collect and copy the students' answers to these questions.

- What factors affect the voltage produced by the solar panel(s)?

Some examples include the light source (sunlight, light bulb), the type of connection (series, parallel), and the area of the solar panel that is exposed to light.

- Discuss applications that can use solar panels as an alternate energy source.

Some examples include a solar car (similar to what will be built in the next activity), solar lights (lights that line your drive-way or walk-way), solar traffic signs (signs that caution you to drive slower in a school zone).

- Explain what a solar panel does. [Answer: A solar panel converts light into electricity.]

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Exploration Activity – What Does a Solar Panel Do? Worksheet

Name: _____

Date: _____

Materials List

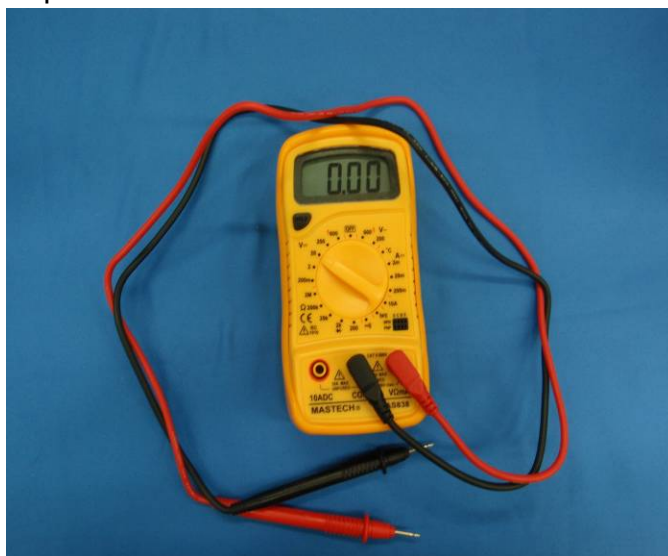
- Solar Panel (from Solar Car kit)
- Digital Multimeter
- Motor (from Solar Car kit)
- 2 wires with Alligator Clips
- 2 D cell batteries
- Electrical tape and Scissors to share with the class

Rules

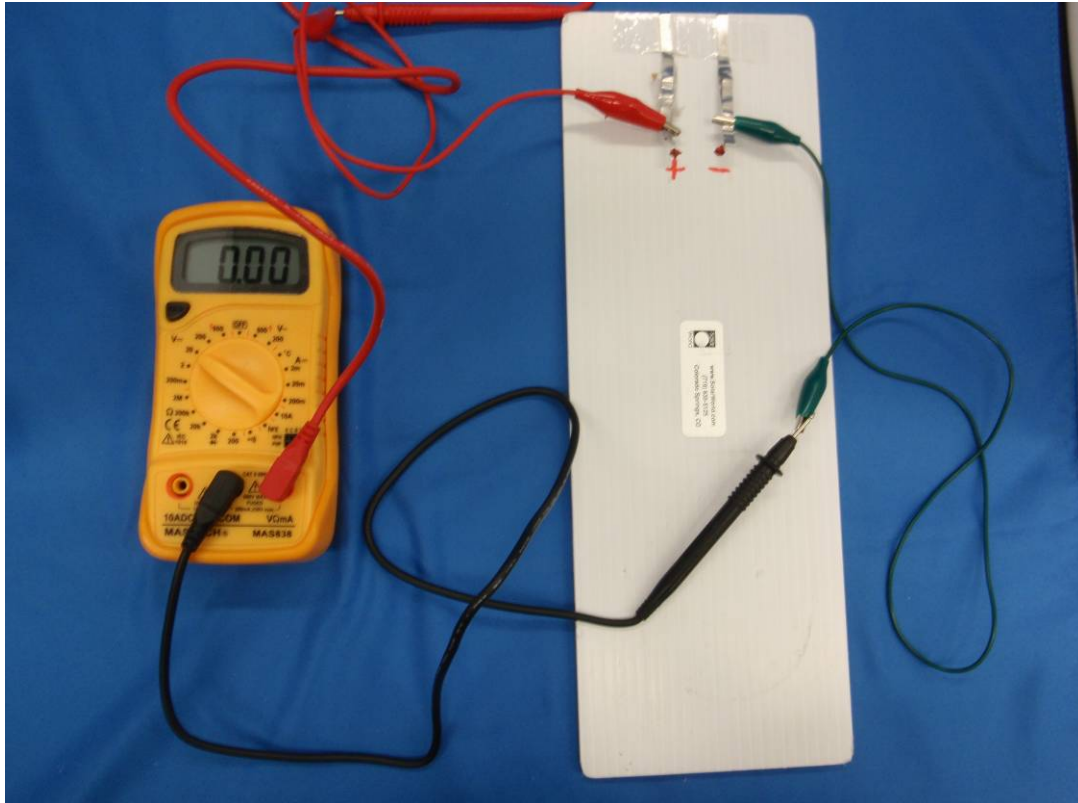
- Do not lose any of the parts. These parts will be used by future classes.
- Do not bend, drop, or damage your solar panel. Cracks and damage to the solar panel will reduce the efficiency of your panel. Your solar car will not be able to go as fast when you are racing it if the solar panel is damaged.
- Do not remove or damage the two silver conductor pins attached to your solar panel.

Procedure

- 1) A voltmeter measures voltage. The red probe is positive (+) and the black probe is negative (-). Set the dial on the front of the multimeter to 20 V DC (DC means constant, 20 V is the max voltage you can measure). You do this by rotating the dial until the indicator points to 20 V DC as shown in the picture. In this position, it will measure up to 20 volts.



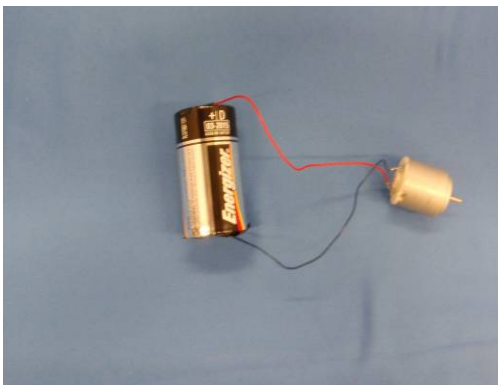
- 2) **Measure the voltage** across your solar panel by connecting the red probe (+) to one of the wire tabs on the back of the panel and the black probe (-) to the other. You can use the wires with alligator clips to make the connection between the probes and the tabs. If the readout of the multimeter is negative, switch the probes. Once the readout is positive, this means that the red probe is connected to the positive terminal and the black probe is connected to the negative terminal. Use a pen or marker to write + and - next to the two tabs on the solar panel as shown.



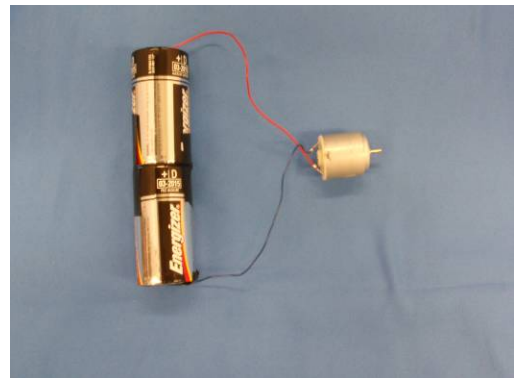
- 3) Measure the voltage across the solar panel under three different lighting conditions: when your panel is covered and no light reaches it, when it is exposed to bright lights inside, and when it is exposed to sunlight. Record your measurements in the table below.

- 4) Join together with another group so that you have two solar panels. Try to connect the two panels together in such a way that you increase the voltage measured by the multimeter compared to using only a single panel. The type of connection you will find is called connecting the panels in series. Draw how your solar panels are connected below. Record your voltage measurements in the table below.

- 5) Measure the voltage across a battery. Connect your motor to a battery and see that the motor runs. You may find the electrical tape useful in holding the motor wires to the battery. Try connecting the batteries in the same way as you did the solar panels, in series, and running the motor. Measure the voltage across both batteries. How does the voltage across one battery compare to the voltage across the solar panel? Two batteries?

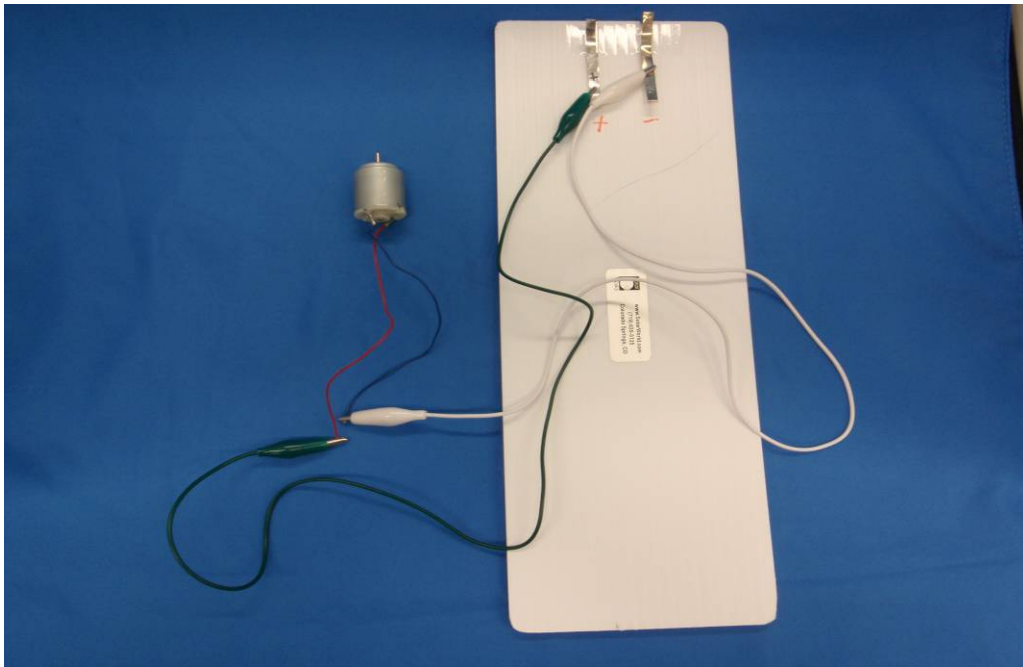


Motor connected to battery



Motor connected to 2 batteries in series

- 6) Disconnect your motor from the battery and then connect the motor to the solar panel as shown below. Here are a few things to think about, but you do not have to write answers to these questions:
- Does the solar panel work like the batteries?
 - How many batteries are needed in series to equal the voltage across the solar panel?
 - Under what light conditions?



- 7) Why do you think batteries would be connected in series in an electronic device?

	Voltage
Single Solar Panel in Dark	
Single Solar Panel Inside	
Single Solar Panel outside exposed to Sunlight	
Two Solar Panels Connected in Series	

Exploration Questions:

What factors affected the voltage output from your solar panel?

List applications where solar energy can be used as an alternative energy source?

Explain what a solar panel does.