

Maximizing Solar Energy

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Lesson Overview

Students will experiment with mini solar panels and multimeters to identify the precise tilt, orientation, and location to maximize solar power production.

Lesson Outline

TOTAL TIME: 45 min



Time



Topic

15 min	Activity: Engage & Explore – Introduction to the Solar Panel and Multimeter
5 min	Discussion: Explain – Solar Production Variables
20 min	Activity: Elaborate – Maximizing Solar Power Production
5 min	Discussion: Evaluate – Placing a solar system

Lesson Objectives

Students will be able to...

- Identify 3 factors that impact how much electricity a solar panel makes: tilt, direction, and shading.
- Measure solar electricity generation using the solar panel and multimeter.
- Determine the optimal placement of a solar panel based on the 3 factors.
- Discover that solar panels convert solar energy into electrical energy.


Preparation

To prepare for this lesson, practice setting up and using the solar panel and multimeter before introducing them to students. It is also recommended that you have a simple diagram of the outside of your classroom or school set area. This will help with the debrief when students discuss the best place to put a solar panel. To help students with cardinal directions, you may want to put up directional signs for North, South, East, and West. The compass app on smart phones is a good resource to identify these directions. If you would like to save time in class, you may also want to set up the multimeters per the instructions on the slides rather than having students do this.

Materials

- 1 Volt Solar panels (1 per group, recommended group size: 2-4 students)
 - Purchase from [SunWind](#) or [Amazon](#)
- Multimeters (1 per group)
 - Purchase from [Amazon](#)
- Signs that indicate the cardinal directions (optional)
- Handouts
 - [Maximizing Solar Power](#) per student)
- Electrical leads (1 per group)
- Compass (1 per group) or directional signs for North, South, East, and West
- Protractor (1 per group)

Activity: Engage & Explore - Introduction to the Solar Panel and Multimeter

Follow along with the [Maximizing Solar Energy slides](#) as you lead this lesson. The  **symbol indicates a corresponding slide.**

Maximizing Solar Energy

- Tell students: Today we will be learning how to set up solar panels to maximize the amount of solar energy they capture. The more solar energy is captured, the more

electrical energy can be generated. This will help us understand how to maximize the sun's energy so we can heat water efficiently without using fossil fuels.

Multimeter Setup - Measuring Voltage

- Voltage is one way that we can measure electricity.
- We recommend measuring with voltage. The slide describes the ideal set up for measuring electrical production from the solar panel.
- You can explain to students that the DCV (direct current voltage) setting measures electrical voltage. The solar panel is a 1 volt panel so power production is maximized when the meter reads 1.
- Electrical voltage is directly proportional to current, so as the voltage increases so does the current that the panel produces.
- When you are setting up the multimeter make sure that the meter is off until all of your setup is complete. Only have students turn on the meters when it is time to measure.

Multimeter Setup - Measuring Current

- If you are interested in exposing the students to more electrical measurements, you may choose to have students measure their panel productivity using current in addition to voltage. The handout doesn't contain space to include current measurements, so students should extend out the voltage table into the margin to record data. Students might have questions about the difference between voltage and currents.
- When you are setting up the multimeter make sure that the meter is off until all of your setup is complete. Only have students turn on the meters when it is time to measure.

Introduction to the Solar Panel and Multimeter

In this activity, students will freely explore the solar panels and multimeters to familiarize themselves with the tools and decide what factors change the amount of voltage/current the panel generates.

- Break students into small groups depending on the number of multimeters and solar panels you have. Ideally students are working in groups of 2-4.
- In groups have students explore the panels and multimeters and think about answering the question:

- How does a solar panel work?
- How the multimeters are measuring the amount of electricity that the solar panel is producing.
- You may choose to have the students set up the multimeters themselves according to the instructions on the slides. You may also choose to set up multimeters for the students and allow them to change the settings as they explore. Students might have questions about the different features and settings. You can use this question to make a **career connection** and explain that a multimeter is a tool used by professionals such as electricians, electrical engineers, and solar installers. There are many different ways to measure electricity, and the different settings allow people to take these measurements so they can better accomplish their task.
- After a few minutes of exploration, call the students back to discuss the questions.
 - How does a solar panel work?
 - i. The solar panels use photovoltaic cells to turn energy from the sun, in the form of photons, to electrical energy.
 - What is the multimeter measuring?
 - i. Explain how the multimeters are measuring the amount of electricity that the solar panel is producing in the form of voltage or current depending on the multimeter set up.
 - ii. The meter is simply measuring how much energy the panel is converting from the sun into electricity.

Solar Scenarios

Now, instruct students to go through the following scenarios while observing the electrical generation using the multimeter. The goal is to help students identify variables that impact solar power generation.

- The panel faces towards the sun
- The panel faces away from the sun
- The panel is covered
- The panel is flat on the ground
- The panel is straight up on the ground
- The panel is tilted

Discussion: Explain- Solar Production Variables

Solar Production Variables

Have students reflect on when they observed their panels making the most electricity and when they made the least. Ask students:

- When did your panel have the highest voltage or current?
- What variables changed how much electricity was created?

Solar System Site Choice

There are several key considerations when designing a solar system.

- **Orientation (Direction):** South is the optimal orientation for solar panels, but you can still produce plenty of power from a panel facing west or east
- **Tilt (Angle):** A solar panel should be angled so that it faces the sun. The optimal tilt is equal to the location's latitude, but the range between 15 degrees less than your latitude in the summer and 15 degrees more in the winter is sufficient.
- **Shading:** Full or partial shading of the panels restricts the production of electricity. Even a small amount of shading can create a disproportionate reduction in electricity
 - When choosing how to orient the solar panel, the panel should be perpendicular to the sun's rays as often as possible. Remember, any shadows cast on the panel will result in a decrease in production.

Activity: Elaborate- Maximizing Solar Power

Maximizing Solar Power

Students will take measurements using the multimeter to determine the optimal direction, tilt, and shading of a solar panel in the garden.

- Divide the participating students into groups of 2 - 4 depending on the number of multimeters and panels you have. There should be one set of materials per group.
- Distribute the [Maximizing Solar Power](#) handout, one per group and review with the students the procedure for completing. Remind them to pick one spot outside and

stay in it to take their measurements. When they pick that spot, make sure it is not shaded.

- After review release the students to follow along with the handout and complete the activity

Discussion: Evaluate- Placing a Solar System

Placing a Solar System

- After each group has completed the handout, gather the students to review results. If you have time, diagram their results on the school map.
 - Ask each group:
 - Which tilt created the most electricity?
 - Which direction created the most electricity?
 - How did shading affect the solar panel? Remember that shade moves throughout the day!
- As a class, identify which location, tilt, and direction is best to put a solar panel. If groups had varied outcomes, brainstorm reasons and/or potential experimental errors.
- You may need to have a solar panel and multimeter ready to clarify any misconceptions.

