



Unit: Understanding Science and Engineering Through Solar Power

Lesson 3 Solar Powered Calculator

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DESCRIPTION: The teacher will show an example of a solar powered device using a solar powered calculator.

GRADE LEVEL(S): 2, 3, 4, 5

SUBJECT AREA(S): Science inquiry, engineering design, solar power, energy, electricity

ACTIVITY LENGTH: 30 minutes

LEARNING GOAL(S): Students will be able to explain that some devices use light energy and transform into electrical energy, which powers different devices such as lights.

STANDARDS MET:

Common Core:

- W.2.8. Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1)
- SL.2.2 Recount or describe key ideas or details from a text read aloud or information presented orally or through other media
- W.3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories
- W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
- W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

Next Generation Science Standards:

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat and electric currents.

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Student Background:

- Students should be familiar with the basic idea that there are things in our world that run on electricity and that this electricity comes from somewhere.
- It's helpful full if students have already completed the following activities as a part of a larger solar pumping unit:
 - **Understanding Science and Engineering Through Solar Power: Lesson 1 Setting Expectations for Science and Engineering Projects**
 - **Understanding Science and Engineering Through Solar Power: Lesson 2 Probes of Prior Knowledge**

Educator Background:

- **Solar cells or modules** are thin modules of **silicon** that covert sunlight or **light energy** into **electrical energy** using the **photovoltaic effect**.
- A **circuit** is a circular path by which electricity flows from a power source (solar module in this case) to a device that does work (water pump in this case) and then back to the power source. Several power sources can be linked together in a circuit series to produce more energy.
- **Scientific inquiry** is the “diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work.” (*National Science Education Standards*, p. 23). Scientific inquiry requires students to form testable questions about the natural world that they have observed. After developing a hypothesis (or educated guess) related to their question, students design and conduct experiments to test whether or not their hypothesis is correct. Conducting an experiment includes gathering data and recording observations. Often time scientists display their data using graphs, which is good practice for students. Students then analyze the data gathered during the experiments and draw conclusions about whether or not their hypothesis was correct.
- **Engineering design** is a process by which students identify or are given a problem to solve. The problem must have given constraints (time, materials, money etc.). Students then design a solution to the problem, create a prototype, and test their design. Data from testing the prototype is collected and the design is evaluated. The prototype is then modified based on the results from the first test and then tested and evaluated again. Finally both designs are evaluated against the criteria of the problem to determine effectiveness. The process can continue iteratively until the design criteria are met.

Other Materials List:

- Class set of “Solar Student Worksheet, Part 3: How Does the Calculator Get Electricity”
- One digital calculator

Vocabulary:

- Solar module, photovoltaic effect, silicon, electricity, light energy, electrical energy

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Lesson Details:

1. Show students a solar powered calculator using a document camera and projector. Ask students if they know what they are looking at. Then ask student if they know what makes it work. In particular, where does calculator gets its energy from. In other words, ask students what power source turns the calculator on. Have students answer question 1 on the worksheet. Guide discussion to lead students to identify that the small solar module on the front makes it work.
 - a. If students suggest batteries, show them that there is nowhere to put batteries in the calculator.
 - b. If students suggest it was plugged in, show them that it is not plugged in.
 - c. If students are struggling to identify what makes the calculator work, ask them to observe what happens when you cover the small solar module up with a finger or piece of paper. Demonstrate this a few times.
2. Once students have identified that the small **solar module** (they might not call it this at first and that is okay) gives the calculator energy to run, ask students why they think the calculator turns off when the module (or “black part” if that is the name they gave it) is covered?
 - a. Have students share their thinking with a partner. Students partner off as Partner 1 and Partner 2. Have Partner 1 share his/her answer with Partner 2. Have partners switch roles.
 - b. Ask students to share what their partner thought and what their rationale was, thus requiring partners to have listened well to their partner the first time.
 - c. Lead a class discussion to uncover students thinking, arriving at the idea that the light is somehow making the calculator work and turn on.
 - d. Once students have realized that the “black part” or solar module uses light to make electricity, explain to students that the **solar module** in the calculator is taking **light energy** from the sun or from a light bulb and changing it to **electrical energy**. We call this the **photovoltaic effect** (this is a term more suited for 4th and 5th grade).
 - e. Be sure to provide time for students to ask questions either with their partners, by writing down their questions on paper, or by simply raising hands. This can either be followed by a class discussion or by simply listing and posting all the questions somewhere in the classroom (e.g., question board).
 - f. Review content objective as a class.