Power Up: Introduction of power with Photovoltaic Cells

Grade 6th

POWER

OBJECTIVE:

The objective of this section is to give students an understanding of power. Student at the end of this lesson should understand current, voltage, and what it means when Power is calculated with the power equation. Students learn how to calculate power (P = V*I) by using mini solar panels.

Instruction:

Here we will be connecting solar panels in two different ways, series and parallel; the concept can be explained simply by drawing two parallel lines (parallel) and a single line (series). It is more important to explain how the two panels need to be connected to be in series and parallel; diagrams are provided below.

Background/Introduction: (15 minutes)

Measuring electricity: We can measure electricity in a number of different ways, but a few measurements are particularly important.

Voltage: is an electrical force that makes electricity move through a wire. Voltage is measured in volts. The bigger the voltage the more current will tend to flow. The analog in water flow is the height of the water in two reservoirs connected by a pipe. Water will flow from the higher reservoir to the lower reservoir, just as electricity flows from high voltage to low voltage.

High voltages are often desirable, since the energy losses on transmission lines are reduced. However, high voltages are also dangerous to humans. This is why transmission lines have voltages of several kilo-volts, home electricity systems have 110 V, and our solar panels only have about 1 volt. When you connect solar panels together, to reduce energy losses in the wires, one would usually choose to connect several together in series until one reaches a higher voltage such as 480 V. In the short wires used in the lesson plan, these losses are so small that no distinction between series or parallel power measurements will be apparent. Nevertheless, the dependence of energy losses on voltage can serve to motivate the lesson plan.

Current: Voltage does not, itself, go anywhere or does it "flow through" things. What moves through the wire in a circuit is electrical current: a steady flow of electrons, measured in amperes (or amps, A). The analog in water flow is the flow rate of water.

Power: Together, voltage and current give you electrical power. The bigger the voltage and the bigger the current, the more electrically power you have. Power is measured in watts.

Power = Current (Amps) *Voltage (V)

Reference: http://www.explainthatstuff.com/electricity.html

Explanation of experiment:

Here we will be connecting solar panels in two different ways, series and parallel; the concept can be explained simply by drawing two parallel lines (parallel) and a single line (series). It is important to explain how the two panels need to be connected to be in series and parallel (refer to figures 1 and 2).

Preparation: (5 minutes)
Each group should have

- two solar panels
- one voltmeter, and
- 60W INCANDESCENT desk lamp or outside sunlight.
- Calculator

Students should be in groups of 2-4 people.

Procedure: (20 minutes)

1. Divided the class into groups. Each UCSD student will supervise 2-3 groups.
2. If it is cloudy set up gooseneck desk lamps per group. If it is not cloudy have the groups follow their UCSD teacher to a designated outside spot.
3. Students will connect cells in series, (Fig. 1) and take voltage measurements with both cells exposed to light, with one cell covered, and with both cells covered. Then they will calculate power created using the current given and P=IV.
4. When students return back to the classroom each group will have about 10 -15 mins to answer the analysis questions. Then UCSD student will go through each of the answers asking volunteers to share their answer.
5. This concludes the lesson. If time permits ask students to answer questions from the additional section and you can go over a few questions or ask the teacher to provide them the answers later.

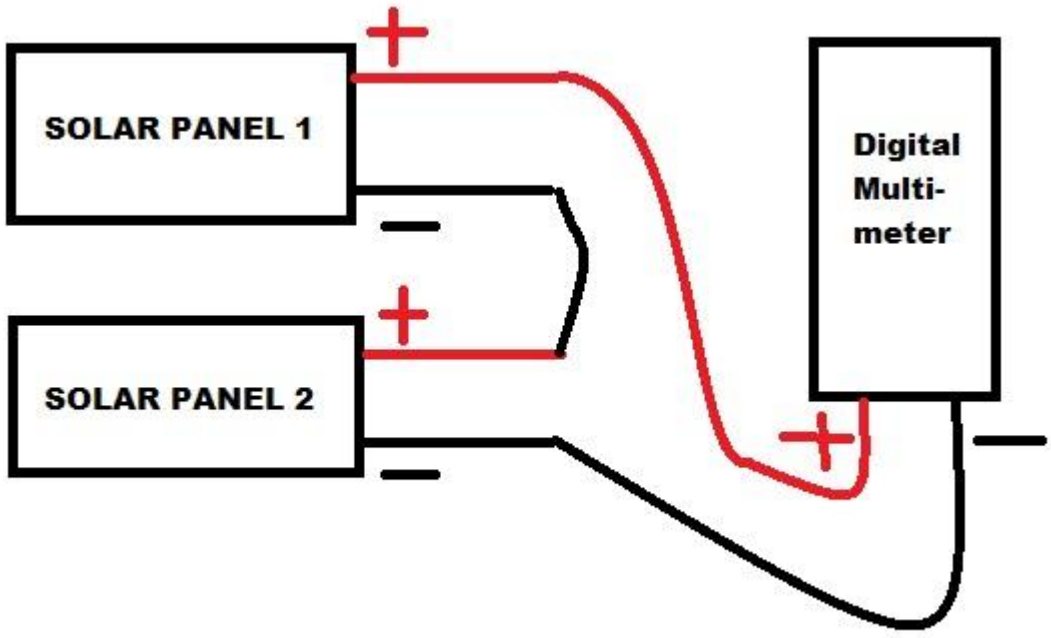

Figure 1: PV cells in series

6. They will repeat instruction 3 above with the cells in parallel. (Fig. 2)

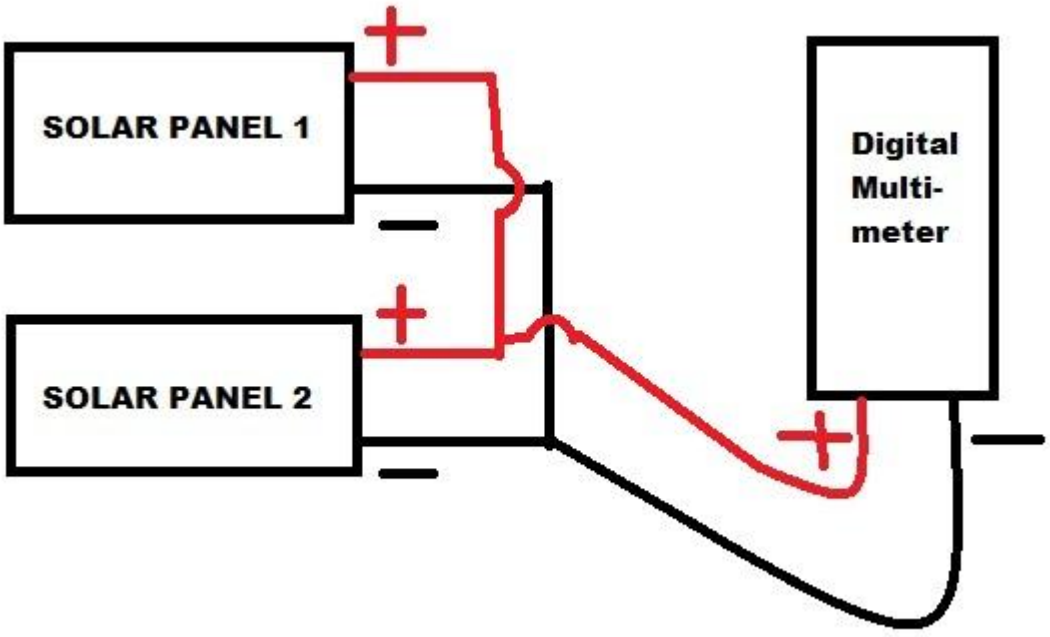

Figure 2: PV cells in parallel

7. At this point, the students should be prepared to answer analysis questions. (15 – 20 mins)

Applicability to the California Standard Curriculum

Grade Six

Focus on Earth Sciences

Heat (Thermal Energy)

1. Heat moves in a predictable flow from warmer to cooler objects until all the objects are at the same temperature. As a basis for understanding this concept:

a. Students know heat energy is also transferred between objects by radiation (radiation can travel through space)

Energy in the Earth System

2. Many phenomena on Earth's surface are affected by the transfer of energy through radiation and convection currents

a. Students know the sun is the major source of energy for phenomena on Earth's surface; it powers winds, ocean currents, and the water cycle

b. Students know solar energy reaches Earth through radiation, mostly in the form of visible light.

Resources

3. Sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation

a. Students know the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process.

b. Students know different natural energy and material resources and know how to classify them as renewable or nonrenewable

Investigation and Experimentation
4. Scientific Process is made by asking meaningful questions and conducting careful investigations. As a basic for understanding this concept and addressing the content in the other three strands, student should develop their own questions and perform investigations
a. Develop a hypothesis
b. Select and use appropriate tools and technology to perform tests, collect data, and display data
c. Construct appropriate graphs from data and develop qualitative statements about the relationship between variables
d. Communicate the steps and results from an investigation in written reports and oral presentations
e. Recognize whether evidence is consistent with a proposed explanation

Grade Seven
Focus on Life Sciences
Investigation and Experimentation
1. Scientific Process is made by asking meaningful questions and conducting careful investigations. As a basic for understanding this concept and addressing the content in the other three strands, student should develop their own questions and perform investigations
a. Select and use appropriate tools and technology to perform tests, collect data (Vernier), and display data
b. Use a variety of print and electric resources (World Wide Web) to collect information and evidence as part of a research project
c. Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from scientific evidence
d. Construct scale models, maps, and appropriately labeled diagrams to communicate scientific knowledge
e. Communicate the steps and results from an investigation in written reports and oral presentations

Grade Eight
Investigation and Experimentation
1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.
a. Plan and conduct a scientific investigation to test a hypothesis.
b. Evaluate the accuracy and reproducibility of data.
c. Distinguish between variable and controlled parameters in a test.
d. Recognize the slope of the linear graph as the constant in the relationship y = kx and apply this principle in interpreting graphs constructed from data.
http://www.cde.ca.gov/ci/cr/cf/documents/scienceframework.pdf

Answers

Analysis questions:

1. In your own words describe current.

   Refer to the definitions on lesson plan

2. In your own words describe voltage.

   Refer to the definitions on the lesson plan

3. What is the equation for power?

   P=V*I

4. What can you say about the voltage when the PV cells are connected in series with no shade? What about when one cell is covered?

5. What can you say about the voltage when the PV cells are connected in parallel with no shade? What about when one cell is covered?

6. What is the power output of the PV cells connected in parallel and no shade?

7. What is the power output of the PV cells connected in series and no shade?

Additional questions:

1. A 12-volt car battery will generally produce more current than a 1.5-volt flashlight battery. TRUE OR FALSE?

2. The word photovoltaic comes from words meaning:

a. wind energy
b. brightness
c. light and electricity
d. picture which moves

3. Developing solar energy is important because it:
   a. the electricity it produces does not cause pollution
   b. can be utilized in most regions of the U.S.
   c. reduces our dependency on imported energy
   d. all of the above
4. When planning your future home you will:
   a. never consider photovoltaic systems
   b. research the cost of a PV system as a supplement to the grid
   c. work with local builders to find out if PV will be practical
   d. b and c

5. The voltmeter reads:
   a. Volts
   b. Amps
   c. Ohms
   d. none of the answers

6. What do you think some benefits of using solar power are?

   Renewable.
   No pollution.
   Reduces the dependency of coal.