



Macro-Scale Solar

AUTHOR: Clayton Hudiburg

DESCRIPTION: This lesson begins with basic chemistry with regards to atomic structure. The lesson then moves to understanding the special properties of silicon as a photoelectric semiconductor. Building on this, the basic structure of photovoltaic solar cells is described in detail.

GRADE LEVEL(S): 9, 10, 11, 12

SUBJECT AREA(S): Electricity, renewable energy

ACTIVITY LENGTH: 3 hours

LEARNING GOAL(S):

- Students will be able to describe the basic structure of a photovoltaic solar module implementing the ideas of series and parallel wiring.
- Students will be able to describe the basic structure of a photovoltaic solar array implementing the ideas of series and parallel wiring.
- Students will be able to describe the function and necessity of an inverter when using photovoltaic arrays.

STANDARDS MET:

Common Core:

- WHST.11-12.8. Gather relevant information from multiple authoritative print and digital sources.
- WHST.9-12.7. Conduct short as well as more sustained research projects to answer a question or solve a problem.
- RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

Next Generation Science Standards:

- PS1.A. Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons and surrounded by electrons. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms
- PS2.B. Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter as well as the contact forces between material objects.

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- PS3.B. Energy cannot be created or destroyed, but it can be transported from one place to another or transferred between systems.
 - PS4.B. Photoelectric materials emit electrons when they absorb light of a high enough frequency.
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Student Background:

At this point, my students will already have had exposure to units like kilo, Mega, Giga etc. If this is not the case for your students you may want to quickly review what these prefixes mean.

Educator Background:

- If you are not particularly confident teaching the structure and “how it all works” aspects of photovoltaic technology, you can probably learn to do so with a few hours of searching on the Internet.
- If you are unfamiliar with Cornell Notes feel free to have students take notes using whatever format you generally prescribe.
- Practice using the photovoltaic modules and multimeter under different conditions to anticipate student areas of confusion or difficulty.

Science Kit Materials List:

- (2) Individual Solar Module—1.5 Volt, 500 mA
- Multimeter

Other Materials List:

- Student Worksheets #2 and #3 (one per student)
- “Macro-Scale Photovoltaic Technology” PowerPoint presentation
- “Configuration Images for Multimeter” student handout
- Alligator leads
- Computer access for PowerPoint and YouTube videos

Vocabulary:

- Solar Cell
- Solar Panel
- Solar Array
- Series Wiring
- Parallel Wiring
- Voltage (volts)
- Current (amperes)
- Power (watts)

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- Inverter
 - DC Power
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Lesson Details:

Day 1:

Opening (15-20 minutes)

Hand out Student Worksheet #2. The list of key vocabulary at the top of the student sheet should probably be addressed prior to beginning the power point presentation. Feel free to employ your own personal methods for introducing new vocabulary.

Before showing PowerPoint, have the students read the prompt and guiding questions as a focus for their note taking.

Body (30 minutes)

Have the Macro-Scale Photovoltaic Technology PowerPoint presentation loaded and ready to show the students. This lesson begins on slide #5. The slides are simply an outline and need to be supplemented with further explanation as you go. The YouTube clips are helpful, but optional. Stop the PowerPoint on slide #11.

Closing (5-10 minutes)

Have one set of the photovoltaic modules and multimeter ready to quickly review the key concepts regarding series and parallel wiring and to demonstrate how to use the modules. The students will be experimenting with the modules on day 2.

Day 2:

Opening (10-15 minutes)

Allow 5-7 minutes for students to review their notes from yesterday. Hand out Student Worksheet #3, which contains directions for how to use the PV modules and multimeters to experiment with the effects of various lighting conditions, series and parallel wiring.

Body (30+ minutes)

Have students collect their materials and follow the directions from student sheet #3.

Conclusion (10-15 minutes)

When students are done collecting data, have a class discussion about their findings.

Day 3:

Go through the last few slides of the Macro-Scale Photovoltaic Technology PowerPoint presentation and allow the students ample time to do the collaboration and summary. This may take more or less time than indicated on the slides depending on the level of your students.

Assessment:

I suggest establishing a scoring rubric or itemized scoring guidelines for the student summaries. At this point I would structure the evaluation as formative rather than summative.

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