



Solar Radiant Heating and Angle of Incidence

NS 696 V: Weather and Climate for Educators

State Science Standards:

Standard 1

Students apply the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.

Standard 2

Physical Science: Students know and understand common properties, forms, and changes in matter and energy. (*Focus: Physics and Chemistry*)

Special Materials:

Class set of solar powered outdoor lighting tops. Each top has an LED, solar cell and rechargeable AA battery. The lab requires 2 tops for each group. The average group size is 3 students per group, thus 20 solar tops are required for a class of 30 students. Lighting sets can be purchased from Home Depot or Harbor Freight and come in sets of 4 to 8 units per box at reasonable costs.

Background information assumed:

It is assumed that students have a general sense that heating from the sun is different at various places on our planet. Students have a general knowledge of solar power, electrical currents, and LED lights.

Objective:

The students will investigate the relationship between the angle of the sun and how that affects the transfer of solar radiant energy to electrical energy. The students will record and interpret their results and will determine if there is a relationship between the angle of the sun and solar powered energy.

Theory: The sun's energy can be harnessed with using a solar cell made of special material such as silicon. The sun energy is transferred from visible light to electricity by knocking an electron loose from the solar cell material (Einstein named this phenomena as the "photoelectric effect"). This loose electron flows with other loose electrons like a river and we can use this flow to power things like calculators and even cars!

We must also consider how much of the sun's energy is available to produce electricity. Solar radiant energy reaches the earth's upper atmosphere in all forms of the electromagnetic spectrum. Most of the energy is in the wavelength of visible light which can easily pass through our atmosphere. Some wavelengths are largely absorbed by the atmosphere. Much of the UV light is thankfully absorbed by the ozone layer in the stratosphere. Once the solar energy reaches the earth other factors affect the intensity of that energy. Some materials absorb sun energy and some reflect it. White reflects light energy away and thus white material heats less. Dark material absorbs light and therefore the material heats up quickly. You have experienced this when you wear a dark shirt on a hot day. Finally, the angle that sun light hits the earth (angle of insolation) influences the intensity of the sun light. The angle of the sun light causes the seasons.

Lesson:

Engage: Pass out the defraction glasses and have the students the look at white light prism in the room. As the students look at the prism of light, discuss the concept of the electromagnetic spectrum.

Explore: Use the following lab.

Note: This lab is written in a style that is in standard use with Loveland High freshman. The I.V. will be the angle of the sun. The levels of I.V. are solar cell directly pointed at sun and solar cell at an angle to the sun. The D.V. will be the time it takes for the light to go out after exposure to the sun. An example of a constant might be having the same amount of sun exposure for each cell (not having one cell in the shadow of a tree). Please feel free to provide feedback on how to improve this lab. I am trying to think of a way to measure the LED intensity as the light goes out so the students can quantify and then graph the dimming effect minute by minute and see if it decreases in a linear or exponential way.

Lab: (Below)

Explain: Students will share their time results with the rest of the class on the board. Discuss their findings and their answers to the Lab questions.

Extend: Students use the internet to learn how solar cells are manufactured.

Evaluate: Teacher evaluates during the discussion portion of the lab if the activity created interest and understanding about solar energy or in energy transfer.

Lesson generated by Ben Brown, Loveland High School

Name _____

Period _____

Lab: Investigating the angle of the sun on the amount of energy a solar cell can produce.

Background information: The sun’s energy can be harnessed by using a solar cell made of special material such as silicon. The sun energy is transferred from visible light to electricity by knocking an electron loose in the solar cell material (Einstein named this phenomena as the “Photoelectric effect”). This loose electron flows with other loose electrons like a river. We can use this flow to power things like calculators and even cars!

We must then consider how much of the sun’s energy is available. Solar radiant energy reaches the earth’s upper atmosphere in all forms of the electromagnetic spectrum. Most of the energy is in the wavelength of visible light which can easily pass through our atmosphere. Some wavelengths are largely absorbed by the atmosphere. Much of the UV light is thankfully absorbed by the ozone layer in the stratosphere. Once the solar energy reaches the earth other factors affect the intensity of that energy. Some materials absorb sun energy and some reflect it. White reflects light energy and thus white material heats less. Dark material absorbs light and therefore the material heats up quickly. Finally, the angle that sun light hits the earth (angle of insolation) also influences the intensity of the sun light.

In this experiment you will investigate the angle of sun light on the ability of a solar cell to produce electricity.

Hypothesis:

Independent variable		
Levels of I.V.		
Number of Trials		

Dependent variable:

Constants:

Conclusion:

Questions:

1. Why do think the angle of the sun affects the intensity of the sun light.
2. Give one example of how the angle of the sun light influences your life on planet earth.
3. If you were to build a house, how might you want to align your roof if you were planning to use solar power?
4. List at least two other ways that the sun light intensity might be limited on the earth.
5. What might happen if one solar cell was white and one was black?
6. What other experiment might we be able to do with these solar cells?