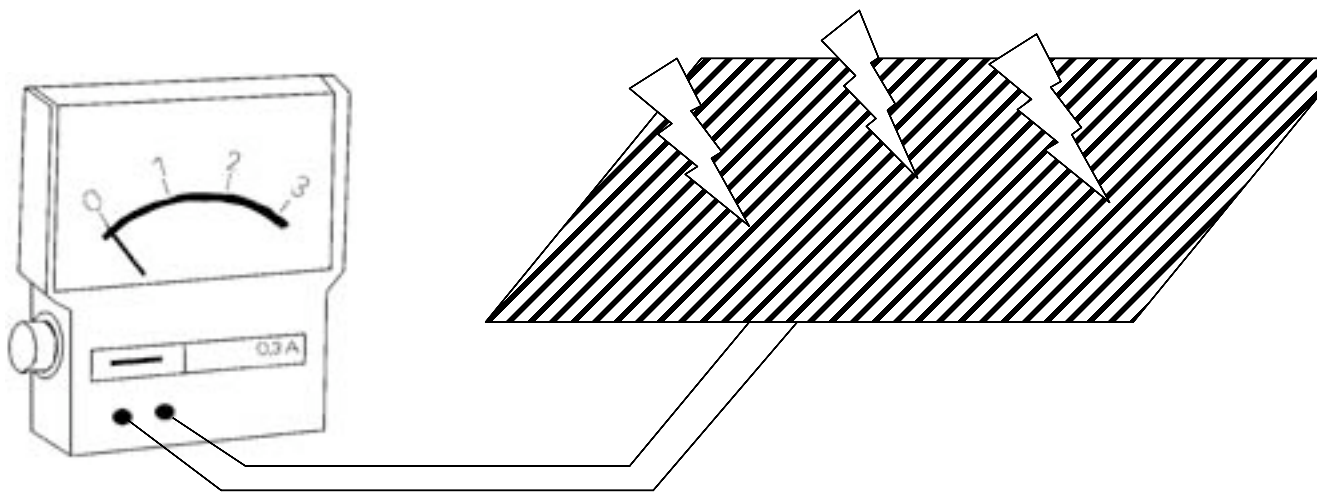
Solar Cell Experiments

By Jerry Loomer

A solar cell (photovoltaic cell) is a solid-state electronic device that takes in light energy and converts it directly into electrical energy. This is sort of like a light bulb that is acting in reverse.

The typical blue/silver solar cell has a base of the element silicon. The silicon is doctored so that some loosely held electrons in the silicon could be bounced into the electrical circuit. These moving electrons, also known as electrical current, can power electronic devices, especially devices that have low power requirements. Low power devices would be things like calculators, radios, LED lights, electronic switches, monitoring equipment, rechargers for batteries, and such.



Solar cells have made space habitation and space research possible. The International Space Station gets its electrical power from massive arrays of solar cells. Similarly, the earlier Space Lab and Mir Space Stations also used solar power. The Space Shuttle does not use solar cells, but uses fuel cells, which produces drinking water as a by-product. Most satellites orbiting the earth use solar cells for power. Planetary probes go away from the earth and sun and the light intensity diminishes, so they do not rely on solar power but use other power sources.

Solar Cell Experiments

Purpose:
The purposes of these experiments are to examine the relationships between lights and the electrical output of solar cells.

Procedure:
Attach the leads from the solar cell to the leads from the Multimeter by using the alligator clip leads. Position the solar cell so that it is facing the sun or another bright light source. Read the voltage produced by setting the Multimeter to the DCV (Direct Current Voltage) scale appropriate for the size of the measured voltage. Read the milliamps of current produced by setting the Multimeter to the DCA (Direct Current Amperage) and set the dial for the appropriate current measuring scale.

Depending on what you are testing, vary only that one item and check the voltage or amperage to see if there is a relationship between your variable and the output of the solar cell.

Question 1: Does the distance between the bright light source and the solar cell affect the voltage?
Measure the voltage (DCV) as you change the distance between the light and the solar cell. If possible, measure the distance from the center of the bulb to the face of the solar cell. [One would expect to find an inverse squared relationship meaning that as the separation doubles, the output drops to one-fourth. The light from an overhead projector may not follow this relationship as it is focused through lenses.]

Light source →				
Solar Cell →				
Separation (cm)	1.0	2.0	3.0	4.0
Voltage (V)				

Question 2: Does the distance between the bright light source and the solar cell affect the current?
Measure the current (DCA) as you change the distance between the light and the solar cell. If possible, measure the distance from the center of the bulb to the face of the solar cell. [One would expect to find an inverse squared relationship meaning that as the separation doubles, the output drops to one-fourth. The light from an overhead projector may not follow this relationship as it is focused through lenses.]

Light source →				
Solar Cell →				
Separation (cm)	1.0	2.0	3.0	4.0
Current (mA)				

Question 3: Does the angle between the bright light source and the solar cell affect the voltage?
Measure the voltage (DCV) as you change the angle between the light and the solar cell. The ninety degree angle is with the light hitting directly onto the face of the solar cell (with the flat part of the protractor on the surface of the solar cell and the protractor perpendicular to the surface of the solar cell, place a pencil at the 90^{o} place and turn the solar cell until the shadow of the pencil is at the center of the flat portion of the protractor). For other angular measures, place the pencil at the test angle and rotate the solar cell until the shadow of the pencil is on the center of the protractor.

Light source →						
Solar Cell →						
Angle (^{o})	90	75	60	45	30	15	0
Voltage (V)							

Question 4: Does the angle between the bright light source and the solar cell affect the current?
Measure the current (DCA) as you change the angle between the light and the solar cell. The measure of the angle is described in Question #3.

Light source →							
Solar Cell →							
Angle (^{o})	90	75	60	45	30	15	0
Current (mA)							

Question 5: Does the color of the light affect the voltage and current of the solar cell?
Measure the voltage (DCV) as you change the color of the light that reaches the solar cell. Place layers of colored cellophane over the solar cell. To make the color more intense, use more than one layer of cellophane, but be sure to use the same number of layers for all tests. Separately, measure the current output (DCA) of the solar cells.

Light source →				
Solar Cell →				
Color →				
Voltage (V)				
Current (mA)				

Question 6: Does the intensity of the light affect the voltage and current of the solar cell?
Measure the voltage (DCV) as you change the amount of light that reaches the solar cell. Take a piece of cardboard (or other material that blocks all of the light) and use it to cover about ¼ of the surface of the solar cell. Record the voltage and current generated. Now move the card so it covers ½ of the solar cell and ¾ of the solar cell. Did the voltage and current change as

Light source →				
Solar Cell →				
Coverage →	0% coverd	¼ covered	½ covered	¾ covered
Voltage (V)				
Current (mA)				

Question 7: Does the location where the light hits the solar cell affect the voltage and current of the solar cell?
Measure the voltage (DCV) as you change the location of the spot where the light reaches the solar cell. Take a piece of cardboard or other material that does not permit light to pass through it and cut a hole in it. The hole can be square, circular, or irregular; it does't matter. What matters is that all measurements be taken with the same hole admitting light to the solar cell. Move the spot to a corner, sides, middle of the solar cell and take voltage and current measurements.

Light source →				
Solar Cell →				
Location of light spot →	Center	Side where lines end	Side with long lines	Corner of solar cell
Voltage (V)				
Current (mA)				

If you use a long, skinny hole, then you can run it parallel to the long lines on the solar cell surface to see if that changes anything. Then move the long skinny hole perpendicular to the lines to see if that changes anything.

Other Questions:
How are the voltage and current affected by:
- **Temperature of the solar cell**
- **Layers of glass covering solar cell**
- **Reflected light versus direct light**
- **Thickness of water above solar cell**