



Semiconductors



Goals

- ✓ Use a solar panel to generate electricity from light
- ✓ Understand how semiconductors in the solar panel change light to electricity



Background

Metalloids are strange elements. They exhibit characteristics of both metals and nonmetals, defying categorization in either category. Silicon and germanium, the metalloids in Group 14, have become some of the most important elements to our modern world: they're the most commonly used semiconductors.

A semiconductor is a material that conducts electricity weakly due to high resistance. However, unlike metals, their resistance decreases when heated. From the first experiments with semiconductors in the 1830s by Michael Faraday, it was obvious that they behaved differently. They quickly became vital materials for radios and telephones. Since the late 20th century, they've enabled the mass production of computers and solar panels.

In a solar panel, silicon semiconductors use the photovoltaic effect to convert sunlight to electricity. Photons of light strike valence electrons in the semiconductor, causing them to travel through the material and generating an electric current that can be collected and used as a power source for all kinds of applications, from satellites and spaceships to pocket calculators.

During this activity, we will use the semiconductors in a solar panel to generate an electric current and use that current to power a small motor and determine how the semiconductors work.



Procedure

1. Use your solar cell to power the small motor that controls the fan. You'll need to connect the solar cell to the fan using wires to carry the electricity. Why do you think you need two wires?
2. When you've connected the solar cell to the motor, you may have to give the fan a little push to get it started. The solar cell will work best in direct sunlight. What happens to the fan if you try the solar cell with other light sources?
3. You can use the electricity from the solar panel to generate hydrogen gas using the electrolyzer. The electrolyzer is the square with "H₂" and "O₂" printed on either side. What do you think will happen if you connect it to a source of electricity like the solar cell?
4. Your electrolyzer is also a hydrogen fuel cell that can generate electricity from hydrogen and oxygen. It has two small tubes attached to it. Is there anywhere else on the fuel cell that you could attach the longer tubes?
5. Look at the remaining pieces of your kit. If the fuel cell splits water into hydrogen and oxygen gases, what could you use to trap the gases so they don't float away?



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6. Connect the tubes of your fuel cell so that you can trap the gases. To generate hydrogen, you'll need to supply an electric current. You can do this with the battery pack or the solar cell. Try both. Which is better at producing hydrogen? How do you know?
7. When you've produced hydrogen, you can use the fuel cell to power the motor just like you did with the solar cell. Plug the motor into the fuel cell and it should start turning. Note in your observations if you see any difference in how the motor works with the fuel cell instead of the solar cell.



Observations



Experimentation

1. With the motor attached, try tilting the solar panel so that it changes the angle of the light that hits it. Can you tilt it far enough that the motor stops running? Does it matter which direction you tilt the panel? Using a protractor, measure the biggest angle at which you can still run the motor.
2. You can use colored plastic gels, or different lightbulbs, to change the color of light hitting the solar panel. Do certain colors work better than others? Try using the solar panel to run the electrolyzer while the panel is hit with different wavelengths of light and record your observations below:



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Light Color:	Time to fill H ₂ :	Observations:

3. Attach the solar panel to the motor and use a piece of paper or other method to shade parts of the panel. Using a ruler, measure the farthest distance in from the edge of the solar panel that you can move the covering before the motor stops running.

Side:	Distance:	Observations:



Measurement

For this section, you will need a multimeter or the Horizon Renewable Energy Monitor. For an introduction to using a multimeter, [click here](#).

1. With the solar panel connected to the motor, measure the current in Amps and the voltage in Volts while tilting the panel to get the highest values. Record your measurements below:

Current: _____ A

Voltage: _____ V



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2. Measure the current in Amps and the voltage in Volts while shading the solar panel. What is the lowest current and voltage that will still run the motor?

Current: _____ A

Voltage: _____ V

3. Use different colors of light with your solar panel as before. Measure the current in Amps and the voltage in Volts while running the motor. What color gave the highest values? Record your answers below:

Color: _____

Current: _____ A

Voltage: _____ V



Analysis

1. Make a scientific claim about silicon semiconductors based on what you observed while running the solar panel.

2. What evidence do you have to back up your scientific claim?



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3. What reasoning did you use to support your claim?

4. Design an experiment that could test the effects of temperature extremes on the silicon in the solar cell. Describe your experiment below:



Conclusions

1. Based on your observations, do you think a solar panel would be useful for generating electric energy from any type of light? Explain your reasoning.

2. What would you say is the most important factor in determining how much electric energy a solar panel produces?

3. Based on your observations, what color of light is absorbed most easily by the solar panel?