Light

Next Generation Science Standards

NGSS Science and Engineering Practices:

- ☐ Asking questions and defining problems
- ☐ Developing and using models
- ☑ Planning and carrying out investigations
- ☑ Analyzing and interpreting data
- ☑ Using mathematics and computational thinking
- ☑ Constructing explanations and designing solutions
- ☑ Engaging in argument from evidence
- ☑ Obtaining, evaluating, and communicating information

NGSS Cross-cutting Concepts:

- ☐ Patterns
- ☑ Cause and effect
- ☐ Scale, proportion, and quantity
- ☐ Systems and system models
- ☑ Energy and matter
- ☐ Structure and function
- ☐ Stability and change

NGSS Disciplinary Core Ideas:

☑ PS3.D: Energy in Chemical Processes and Everyday Life

Initial Prep Time

Approx. 5 min. per apparatus

Lesson Time

1 – 2 class periods, depending on experiments completed

Assembly Requirements

- None

Materials (for each lab group):

- Horizon Electric Mobility Experiment Set
- Stopwatch
- Colored construction paper
- Various colored light filters
- Heat lamp and/or UV lamp (optional)
- Horizon Renewable Energy Monitor or multimeter (optional)

Light

Lab Setup

- Your students will need the car frame, red and black wires, the solar panel, and the solar panel support to assemble the solar car.
- Lab includes small parts that can go missing easily. Set up a resource area for each lab table or for the entire class to minimize lost pieces.
- A heat lamp or UV lamp may be used during experiment #2, if available.
- If you don't have access to a multimeter or Horizon Renewable Energy Monitor, omit the Measurements section of this activity.

Safety

- Students should use protective gloves if changing recently-used bulbs as certain types can become quite hot.

Notes on the Solar Panel:

- Direct sunlight, or a strong electric light, is necessary for operation. Overcast and indirect sunlight may not provide sufficient energy. Be sure any artificial light source is close to the solar panel.

Common Problems

- Check your electrical connections if the car fails to operate properly.

Light

Goals

- Use a solar panel to generate electricity from light
- Run a motor with the electricity generated
- Use the speed of the motor to measure light energy

Background

Light is a strange phenomenon. You've probably been using two highly sensitive light detectors since the day you were born, and they're helping you to read these words right now. But what we see as light is just part of a diverse type of energy that exists all over the universe and has many uses here on our own planet as well.

Light is just a small part of something known as the electromagnetic spectrum, a form of energy that travels through space as waves. You can see only part of that spectrum with your eyes, which your brain interprets as colors. Difference in wavelength (the distance between the peaks of the waves) result in different colors. The colors you can see range from red at the long end of the spectrum to violet at the short end.

But there are many more "colors" beyond those that you can't see, although you may have heard of their names. We call the colors with wavelengths too short to see "ultraviolet" and those with wavelengths too long to see "infrared." Other types of electromagnetic waves, like X-rays and gamma rays, have even shorter wavelengths than ultraviolet. Radio waves and microwaves have even longer wavelengths than infrared.

Solar power is a way of generating electricity that uses the energy contained in these waves to create an electric current. During this activity, you'll use a solar panel to generate an electric current and describe how it works.

Procedure

1. Look at the top of the car frame to see where you should attach the solar panel support. Make sure the solar panel support fits securely onto the top of the frame.
2. Place the solar panel on top of the support.
3. Connect the wires from the motor to the red and black plugs nearest to them on the front of the frame.
4. Use the other red and black wires to connect the solar panel to the other plugs on the front of the frame.
5. Make sure the car is in direct sunlight, and it should start to run.
6. Use the stopwatch to time how long it takes your car to complete the track.

Light

Observations

Experimentation

1. 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 car while the panel is hit with different wavelengths of light and record your observations below:

Light Color:	Time to fill H2:	Observations:

2. The solar panel is dark in color. Does the color of its surroundings affect how well it collects light for generating electricity? Try using the panel to run the car while the panel is in front of different colored backgrounds and record your observations below:

Light Color:	Time to fill H2:	Observations:

Light

3. Raise the front wheels off the ground and use a piece of paper or other method to shade parts of the panel and observe the effects. How much of the solar panel can you cover before the motor stops running? Does it matter which side of the solar panel is shaded?

Students should note that, depending on which side you shade, it doesn't take much at all to stop the motor. This is the result of how the individual photovoltaic cells in the solar cell are wired together.

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. Raise the front wheels off the ground. Measure the current in Amps and the voltage in Volts while shading the solar panel to find the minimum values for each that will still run the motor. Record your answers below:

(Answers will vary, but check that they are within reason, i.e. not >1A.)

Current: _____ A

Voltage: _____ V

2. Voltage is equal to the current multiplied by the resistance (V = IR), so according to your data what is the resistance of the motor?

Resistance: _____ Ω

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

Light

Analysis

1. Make a scientific claim about what you observed while running the solar car.

Claim should reference the limits of the solar cell's capabilities, in terms of wavelengths of light, amount of light, or absorption of its surrounding.
Example: "The solar panel works best with visible wavelengths of light."

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

Evidence should cite data in Observations and/or Experimentation sections.
Example: "The car completed the track in 15 seconds when the solar panel was under visible light. Infrared took 26 seconds and ultraviolet took 24 seconds."

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

Reasoning can draw from Background section and/or other materials used in class.
Example: "The solar panel must have been producing less current if it took longer for the car to run the same distance."

4. Design an experiment that could test the relationship between the energy of light and its wavelength.

There are many possible answers, but there should be a mention of a way to measure both the wavelength and energy of the light, and clear control and experimental groups in the experiment.

Light

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.

"Yes" or "no" are both acceptable answers, so long as students are able to point to specific data from their experiments to back up their assertion.

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

Student answers should reference data collected in all experiments.

3. Based on your observations, what color of light emits the most energy?

Answers will depend on the variety of colors used.

4. Based on your observations, what color of background absorbs the most energy?

Answers will depend on the variety of colors used.