QuickView

Students experiment to determine how the light source affects the operation of the solar vehicle.

Standards Addressed

NSTA 5-8
Students develop the abilities necessary to do scientific inquiry.

- Students identify questions that can be answered through scientific investigations.
- Students design and conduct scientific investigations.
- Students use appropriate tools and techniques to gather, analyze, and interpret data.
- Students think critically and logically to make the relationships between evidence and explanations.
- Students communicate scientific procedures and explanations.
- Students use mathematics in all aspects of scientific inquiry.

Students develop an understanding of transfer of energy.

- Students understand energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical; energy is transferred in many ways.

Students develop an understanding of the nature of science.

- Students understand it is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists; evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations; although scientists may disagree about explanations of phenomena, about interpretations of data, or about the value of rival theories, they do agree that questioning, response to criticism, and open communication are integral to the process of science; as scientific knowledge evolves, major disagreements are eventually resolved through such interactions between scientists.

NCTM 6-8
Students use mathematical models to represent and understand quantitative relationships.

- Students model and solve contextualized problems using various representations, such as graphs, tables, and equations.

Students understand measurable attributes of objects and the units, systems, and processes of measurement.

- Students understand both metric and customary systems of measurement.

Students apply appropriate techniques, tools, and formulas to determine measurements.

- Students select and apply techniques and tools to accurately find length, area, volume, and angle measures to appropriate levels or precision.
- Students solve simple problems involving rates and derived measurements for such attributes as velocity and density.*

  *This standard may be addressed by requiring students to record the velocity on the worksheet for this activity.

Students formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

- Students formulate questions, design studies, and collect data about a characteristic shared by two populations or different characteristics within one population.

Students solve problems that arise in mathematics and in other contexts.

Students recognize and apply mathematics in contexts outside of mathematics.

ITEEA 6-9
Students develop an understanding of engineering design.

- Students learn that modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

Time Required

90-135 minutes (will vary with class size)

Content Areas

Primary: Science
Secondary: Math, technology, language arts

Vocabulary

- artificial
- conclusion
- control
- data
- hypothesis
- lumen
- natural

Materials

- Completed solar vehicle
- Artificial light source – lamp (100-watt incandescent)
- Light meter
- Stopwatch
- Pencil
- Tape measure
- Masking tape
- "Natural vs. Artificial Experiment" worksheet
- "Scientific Method" resource page
- "Speed and Velocity" resource page

Note: Students may require additional materials depending on their experimental procedure. Additional stopwatches, light meters, and light sources may be needed.

Procedure

Note: You may choose to have students work in pairs or small groups on this activity.

1 After completing the solar vehicle, consider what options are available for powering the vehicle. Obviously, the natural light source for the vehicle would be the Sun's rays. Can you think of other natural light sources? List any that you come up with on the "Natural vs. Artificial Experiment" worksheet. There are many artificial light sources. List some examples of artificial light sources on your worksheet as well.

This could work well as a group discussion to introduce this lab activity. Have students list some examples of artificial light sources – candles, flashlights, heat lamps, desk lamps, strobe lights, and so forth. Students may give the Moon as an example of another natural light source; however, you should take the opportunity to point out that the Moon appears to glow because of the Sun's rays bouncing off its surface. You might even want to use the phases of the Moon as proof that the Moon is not producing its own light. Stars, like the Sun, are burning, and this is the source of the light they give off. Fire could also be listed as a natural light source. You may want to have a class discussion about whether a candle is a natural light source – the fire burning on top of the candle could be seen as a natural light source; however, the candle itself is manufactured.

2 Test your vehicle using the Sun's rays and an artificial light source. Make sure the vehicle moves using either light source. Use the light meter to determine the strength of each light source. It is not necessary to record distance or time traveled. Only do one or two test runs.

3 Propose a hypothesis stating how you think the light source affects the function of the vehicle. Record your hypothesis on your worksheet.

You may want to explain to students that a hypothesis is not just a guess; it is based on prior knowledge. This is why students were instructed to test their vehicles briefly before proposing a hypothesis.

4 Come up with a method for testing your hypothesis. You may want to work with a partner or small group, or you may want to formulate a testing process on your own. Review the "Scientific Method" resource page for help in developing an experimental process. Make note of your procedure on a scrap piece of paper. Before recording the procedure on the worksheet, talk through the procedure with your instructor.

You may want to give students a mini-lesson on using the light meter before they begin this activity. Students can use a flashlight or other mobile light source for testing. The classroom's overhead lights cannot be used, since fluorescent lights do not have sufficient

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energy to activate the solar panel. They should record the lumens for the light source.

Evaluate the students' testing procedures. Point out to students that they should account for all the variables in the experiment. Depending on the skill level of students, you may need to give them examples of ways to test their hypotheses. Students may have a difficult time controlling variables in the experiment. A simple procedure for testing the affect of the light source on the vehicle would be to test a vehicle with no light source – zero lumens – for a set amount of time and record the vehicle's distance traveled. Test the same vehicle using the Sun as a light source (record the lumen strength) for the same amount of time and record the distance traveled. Finally, test the vehicle using an artificial light source with the same lumen strength as you recorded for the Sun and for the same amount of time and record the distance traveled. The important thing is to point out to students that they should be creating controlled, reproducible experiments.

5 Record your procedure in the space provided on your worksheet. If necessary, you may use a second sheet of paper.

6 Identify the materials you will need to complete the testing procedure. List these items in the appropriate section of your worksheet.

You may choose to have students submit their materials lists to you the class period before they perform the testing. This will give you the chance to gather any items that may not be readily available.

7 Locate the necessary materials.

8 Perform the experimental procedure.

9 Record the experimental data on your worksheet.

10 Using the data, record any conclusion that you can make from the experiment. Will you accept or reject your hypothesis? Complete the conclusion section of the worksheet.

You may want to discuss with students the fact that scientific testing results in conclusions supported by data.

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Natural vs. Artificial Experiment

List examples of each type of light source.

Natural

Artificial

Record the following information:

Hypothesis

Experimental procedure

Materials

Data

Type of Light Source	Lumens	Distance Traveled or Velocity

Natural vs. Artificial Experiment continued

Conclusion(s)

Evaluate your experiment using the following criteria:

Could another student reproduce this experiment without my help? Why or why not?

Does the data seem reasonable? Why or why not?

Explain how the data supports your conclusion.

Explain why you have either accepted or rejected your hypothesis.