ABSTRACT

Solar-powered cars, assembled by students, transform the school sidewalks into a mini racetrack. As cars zoom past a photogate attached to a laptop computer, the computer calculates the time that each car travels between specified points. Students can then calculate the speed of the car. Students add more solar cell batteries to the car wired in a series circuit, and measure speed. *Solar Race Cars* helps students answer the following questions about solar energy: Will the speed of the car increase proportionally with additional batteries? What happens when the cells are wired in parallel circuitry? Will season affect race car speed?

TIES TO CURRICULUM

Solar Race Cars introduces force, motion, and mechanical energy, and teaches students that motion is a change in position over time and can be represented graphically. *Solar Race Cars* promotes learning about and measuring motion. This lesson addresses several mathematical components of science, including the application of addition, subtraction, multiplication, division, and application of the concepts, data analysis, patterns and relationships among functions, and graphing. Also, in keeping with the *National Science Education Standards*, students use technological tools to organize information into useful graphical forms to recognize and evaluate patterns in the data.

LEARNING OBJECTIVES

The students will

- wire solar batteries using series and parallel circuitry to determine if the speed of the cars increases proportionally with the number of batteries;
- understand relationships between time traveled, distance, and speed;
- calculate the speed of the car while varying distance and time;
- graph data results; and
- determine how increased mass of cars and batteries influences speed.

NUMBER OF LAPTOPS AND GROUP SIZE

At least one laptop is needed for this lab, although one laptop per group of four students is ideal.

TIME REQUIREMENT

Conduct *Solar Race Cars* over a whole year. Besides a one-time introduction, this activity uses about two hours during three different seasons for car preparation, data collection, and data analysis.

Task	Time	Location
Introduction	45 minutes	Classroom
Car preparation	45 minutes	Classroom
Data collection	45 minutes	Outside
Data analysis	45 minutes	Classroom/homework

LESSON DESCRIPTION

MATERIALS

- Laptop computers
- Logger Pro software
- Universal Lab Interface (ULI) with 9V power supply and serial interface cable
- Solar car kits (see References)
- Photogate or motion detector
- Meter stick
- Index card or thick paper
- A balance and set of masses

Solar Race Cars can be used to study motion, electronics, and solar energy. Students learn how speed is influenced by the time and distance the solar vehicle travels. What great ideas students have if they are challenged to make, tinker, and experiment with machines of their own design!

Teacher Preparation

Assemble a solar car and conduct test runs to make sure the batteries and photogates work, and to anticipate questions.

Introduction

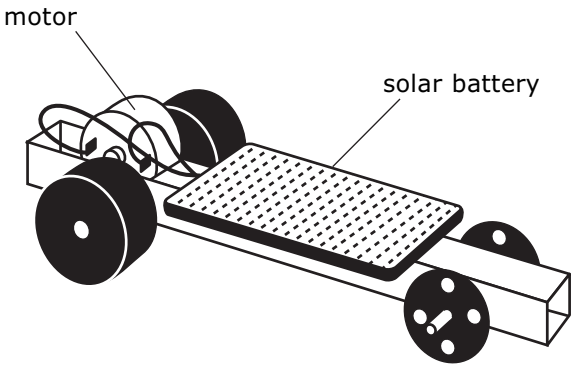
Have students use multi-media sources to research solar energy topics. Students can research the following questions: How are solar batteries made? When is the collection of solar energy most efficient? What are the means of storing solar energy? Have students share what they have learned about solar energy in a discussion and write a one-page report using the computer's word-processor.

Introduce students to calculating distance, speed, and time:

Distance = Speed x Time Speed = Distance/Time

Assign sample problems so students can learn this type of problem solving.

Figure 1: The solar race car and battery



Car Preparation

Unveil a model solar car, pre-assembled. Divide students into groups of four to form a pit crew like in a real auto race. Each crew should assemble its car, and then calculate the mass of the car and a solar battery (see Figure 1). Before any time trials take place, students should estimate the speed of the car.

Data Collection

The Logger Pro software on the laptop computer records the time it takes for each car to pass a photogate. The motion detection device, or photogate, straddles the pathway of the raceway like a tunnel (see Figure 2).

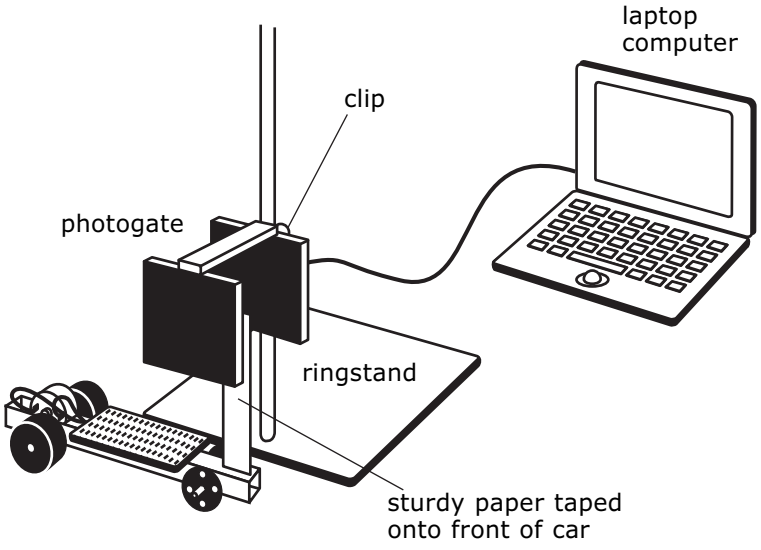
The photogate emits ultrasonic pulses, and the car breaks the pulse as it passes through as the photogate. The computer detects the amount of time that the pulse was interrupted. Crews measure the distance that the car traveled. Once crews have a measurement for distance and time, they can calculate speed.

Crews wire another solar battery using series circuitry (see Figure 3), and calculate the mass and speed of the car for each battery that is added. They graph each

SUGGESTIONS

- The school's computer technician should install the software before the lab.
- Set up and test the photogate and computer before the experiment.
- Conduct *Solar Race Cars* on sunny days. Overcast or cloudy weather makes it difficult to compare seasonal performance of the solar cars.

Figure 2: The photogate and the raceway



trial as batteries are added. Crews will also draw a correlation between the additional mass that the car must carry (by the addition of batteries) and the speed of the car. Repeat these steps using three batteries.

Crews will then wire the batteries using parallel circuitry (see Figure 3). Crews estimate the speed of the cars using one battery, and then after adding additional batteries. Crews should graph their results up to three batteries. At the end of the exercise, each student writes a formal lab report discussing the findings.

Conduct this experiment three times during the year, if possible: once in the fall, once in winter, and again during late spring. After the final trial, students can determine whether the angle of the sun's rays makes a difference in the speed of the car.

ASSESSMENT

Base student assessment upon participation in a discussion of solar energy, the short report about solar energy, calculations for finding distance, speed, and time, homework assignments that reinforce the calculation of motion, and the formal lab report.

REFERENCES

Books

National Research Council. *National Science Education Standards*. Washington DC: National Academy Press, 1996.

Web sites

Department of Energy's ESTEEM Program. Solar energy: http://www.sandia.gov/ESTEEM/Sun.html

Pitsco. Science equipment, including solar powered cars: http://www.pitsco.com/

Sunwind. Solar energy education and kits:http://www.web.net/~sunwind/

Figure 3: Wiring the car using series and parallel circuitry