Solar Schools
for British Columbia

A collection of lessons to assist teachers and students with their exploration of solar energy

SolarBC
Join the Solar Revolution

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Solar car races

Build and retrofit for speed

What will happen

In teams, students construct and race miniature solar cars to help them discover how speed changes with the angle of the solar cell. They also design and build add-on features to concentrate the light source to increase the amount of solar energy going to the motor.

Students will

- Recognize that power can be produced using an alternative other than fossil or nuclear fuels;
- Understand that the angle at which a solar cell is positioned in relation to the sun affects its power output;
- Experiment with solar energy generation;
- Experiment to understand how to generate solar energy;
- Describe the characteristics that affect solar energy.

Total Time 3 hours	Establish what students know	Activity - Part A	Activity - Part B	Debrief what students learned
	10 minutes	45 minutes	Building the cars 45 minutes Racing the cars 45 minutes	15 minutes

What you need to know

- This activity focuses on solar photovoltaic (solar PV) technology. Solar PV is a method of generating electrical power by converting solar radiation into direct current electricity. With the solar cars, the solar panel is the power source for the car. Sunlight strikes the solar cells and the light is converted to electricity on an atomic level.
- The amount of current produced by a photovoltaic cell is proportional to the amount of the light hitting the cell. Thus, increasing light intensity or increasing the size of the cell itself will increase the power output of the cell.
- The angle of the solar panel to the sun also makes a difference. Think of a shadow cast by a panel when it is rotated to different angles. The larger the shadow the more light the panel is catching.

What might surprise you

The world's largest solar PV power plant is in Portugal. The 11MW plant has 52,000 photovoltaic modules that produce 20,000 MWh of power every year. That's enough to supply 8,000 homes and reduce greenhouse gas emissions by 30,000 tonnes per year! Source: Green Learning

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In Advance

Prepare a set of solar cells to the degree suitable for your students according to the instructions provided by the supplier.

What you need

- Voltage and/or current meter
- Sunlight
- Lamps
- One solar car kit for each pair or group- ensure your solar car kit comes with a motor. Solar car kits can be obtained through most science supply companies.
- Stop watch

Main Activity

Part A

Experiment with a Solar Panel

Hook the leads of the solar panel up to a volt meter. Conduct the following tests to get a feel for how sensitive the solar panel is to different light conditions:

1. Vary the light level on the solar panel. How does the meter reading change between indoor light, incandescent light bulbs, fluorescent lights, direct sunlight, shade, etc.
2. Vary the angle of the panel to the sun. Watch how the volt meter reading changes in relation to the size of the panel's shadow.
3. Investigate the effects of shadows on part or all of the panels. What happens if you shadow one cell? What happens if you shadow all the cells?
4. Investigate how much of a difference temperature makes. Take a cool panel and quickly place it in the sun. Let the panel warm up in the sun and see if you can detect a difference on the volt meter.
5. Have students record the results for each test and compare the relative efficiency of each type of available light.

Part B

Built for Speed

1. In teams, students build solar cars according to the instructions provided with the solar kits. Students should choose a name for their team.
2. Remind students that they want the solar panel to collect as much light as possible, and to convert it as efficiently as possible. An important part of the car construction is to figure out where to position the panel on the car. The top side is probably best, and nothing should cast a shadow across it.
3 Set-up the solar car race course either as a whole group or in small groups.
4. Have the student teams conduct a series of races against each other. After each race, have them record which team won and what they think gave that team's car an advantage.

5. Invite the teams to alter their solar cell positioning to seek maximum energy, and thus speed, production. Does one car consistently win? Why or why not?

Debrief what students learned

As a class, discuss their observations using questions like:

- What is the relationship between the speed of the solar cars and the cell's angle to the light source?
- What was the optimum angle for the cell to be set at? What if the races were held at a different time of day or at a different time of year?
- What would you need to do to keep the solar cell producing the same amount of power throughout the race?
- How did or would cloud cover impact the races?
- How did the materials and resources to optimize racing speed?
- Which 'customizing' features produced the best results?
- How would you set up a solar car race course differently?

Assessment

- Can students explain how the optimum angle for a solar cell is determined? Can they accurately describe how the amount of solar energy is impacted by the concentration of light? How well did students adjust their solar cars to improve racing speed?
- Challenge students to identify how they would measure the energy produced by a solar cell for different:
  a. angles of the sun
  b. distances from the light source
  c. concentrations of light

Extensions

Invite students to alter their cars to improve the racing speed. They may wish to try a different material for the car's body, adding more panels, etc.

Check out

Calculator

Photovoltaic (PV) cells convert sunlight directly into electricity. They are a convenient source of power for certain hobby projects. Effective use of PV cells requires proper matching of cells to the electrical load. Here is a calculator that will help you estimate the electrical current and voltage that can be supplied by various PV cell configurations. http://chuck-wright.com/calculators/pv-hobbyist.html

Lessons

- 15 Solar Kit Lessons designed for use with mini-solar electric panels (1 volt, 400 milliamps). Lessons 3 and 4 also require raw solar cell chips. Each lesson calls for varying materials. Most need one or two mini-solar electric panels with attached alligator clips, though lesson 13 needs sixteen of them. You will have to solder on your own alligator clips or other type of connector. http://www.powernaturally.org/Programs/SchoolPowerNaturally/InTheClassroom/kitlessons.asp?i=9

- Four solar experiments using ammeter or voltmeters to measure the impacts of light intensity, sun's angle, concentration of light, and cells in series and in parallel circuits. (p. 26-31) http://www.mge.com/images/PDF/Brochures/SolarPower/SolarCurriculum_Part1.pdf

Case Studies

- Solar Taxis travelled 53,451 km around the world in 534 days.
- The Queens' University Solar Car team set the **Guinness world land distance record for solar vehicles**. Using only 1,000 watts of power, they drove 7044 km (4377 miles), at an average speed of 80 km/h (50 mph). **Radiance** took second place at both **Sunrayce '99** and the **1999 World Solar Challenge** in Australia.
- **Junior Solar Sprint** is a fun hands-on educational program for 6th, 7th and 8th grade students in the U.S.A. Students are supplied with solar cells, motors, and detailed suggestions; and mentored to build and race working model solar cars. Excellent middle school mechanics instructions wrapped around designing and building a solar car. Free downloads in pdf format and animated computer programs http://www.nrel.gov/education