SECTION A

There is growing demand for electricity due to the increasing use of technology throughout the globe. The burning of fossil fuels is the most common way that electricity is generated.

Unfortunately, fossil fuels are non-renewable and cause pollution when they are used to generate electricity. For these reasons, in addition to potential money savings, people are looking to other sources to produce energy.

Using solar panels to generate electricity from the sun is becoming increasingly common. Solar panels can be used at many scales to generate power. A single, small panel can be used to charge electronic devices such as your cell phone. Large numbers of panels can function together to generate electricity for an entire neighbourhood.

The amount of electricity that can be generated by a solar panel is affected by many variables. In this experiment, you will explore how the amount of current and voltage produced by a solar panel is affected by the distance to a lamp. You will then test your equipment in direct sunlight and calculate the efficiency of the photovoltaic cell when converting the energy from the sun into electrical energy.

SECTION B

Experiment
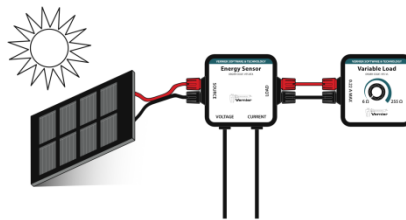
Aim

To understand how solar panels can be used to generate electricity.

- Predict variables that affect how much electricity is generated by a solar panel.
- Determine the efficiency of a solar panel.

Materials

- Computer with Logger Pro
- 2 wire leads with clips
- Vernier computer interface
- Protractor
- Light bulb
- Vernier Energy Sensor
- Light bulb socket or lamp
- Vernier Variable Load
- Sunshine
- KidWind 2 V solar panel

Procedure

Exploring solar panel efficiency
In this part of the experiment, you will use the Voltage and Current connectors, along with a Light Sensor, to determine the efficiency of the photovoltaic cell

1. Set Light Sensor to the 0–150,000 lux range and connect it to the interface.
   Start Logger Pro.
2. Zero the sensors.
   a. Disconnect the solar panel.
   b. Disconnect one of the wire leads that connect the Variable Load to the Energy Sensor. Use it to connect the Energy Sensor Source terminals to each other in order to create a short circuit.
   c. Cover the Light Sensor so no light is reaching the sensor.
   d. Choose Zero from the Experiment menu. All sensors are selected. Select ⬛ OK ⬛. The readings should be close to zero.

   Note: The resistance value is not meaningful when the current and voltage values are near zero.
   Connect the solar panel to the Energy Sensor Source terminals and connect the Variable Load to the Energy Sensor.
3. Verify the current and voltage values and adjust the load.
   a. Position the solar panel so it is facing toward the sun.
   b. Note whether the voltage values are positive, negative, or zero.
   c. If the values are positive, the setup is correct. If the values are negative or zero, switch the wires connected to the Source terminals so they are connected to the opposite terminals.
   d. Adjust the load by turning the knob on the Variable Load until the resistance is approximately equal to 70Ω resistance.
4. Tilt the solar panel so it is facing toward the sun. Hold the Light Sensor at the same angle.
5. Click ▶ Collect to start data collection
6. Determine the mean power and light levels.
   a. When data collection is complete, choose Go To Next from the Page menu. Graphs of power vs. time and illumination vs. time are displayed.
   b. Click the power vs. time graph to select it. Choose Statistics from the Analyze menu. Record the mean power value in the data table.
   c. Click the illumination vs. time graph to select it. Choose Statistics from the Analyze menu. Record the mean value in the data table.
7. Repeat Steps 5–6. Keep the tilt of the solar panel and Light Sensor the same in both runs.

Data table

Exploring solar panel efficiency		
Run	**Power (mW)**	**Illumination (lux)**
1		
2		
Average power		W
Number of cells on panel		
Area of each cell		cm^2
Total area of solar cells		m^2
Power per square meter		W/m^2
Power from the sun		W/m^2
Panel efficiency		%

Questions

Exploring solar panel efficiency

1. Calculate the average power and illumination values for the two runs and record them in the data table.
   Record the average power (in watts) in lower part of the table.

1.

2. Examine the solar panel and record the number of cells on the panel.

_____

_____

3. Determine the area of one cell in cm2. Remember, the area of a rectangle is length x width and the area of a triangle is ½ base x height. Draw a diagram of one cell and label any measurements that will help when calculating the area.

_____

_____

4. Calculate the total area of the cells in m2 using the equation

$$\frac{\textbf{Number of cells on panel} \times \textbf{Area of one cell}}{\textbf{10000cm}^2\textbf{/m}^2}$$

_____

_____

5. Determine the power per square meter output of the solar panel by dividing the power output by the total area of the cell.

_____

_____

6. Determine the power per square meter output of the sun by dividing the average illumination value by 75 since 1 W/m2 = 75 lux.

_____

_____

7. Calculate the efficiency of the PV cell using the equation.

$$\frac{\textbf{Power per square meter of PV cell}}{\textbf{Power per square meter of sun}} \times \textbf{100\%}$$

_____

_____

8. How does the efficiency of your PV cell compare to your predicted efficiency?

_____

_____

9. What factors may contribute to the lack of efficiency of the PV cell?

_____

_____