Sunshine Timer with Data Logger Option

Suggested Level: Grades 3 through 6. Can be adapted for Grades 7 and 8

LEARNING OUTCOME

Students collect data on cloud cover using a simple instrument and display data through graphs, tables, and charts. Students then interpret the data for patterns of cloud cover that affect solar-powered energy production and predict energy production under given cloud conditions.

LESSON OVERVIEW

Students use a simple and easy-to-understand homemade technological device, the sunshine timer, to monitor cloud cover over an extended study period. They learn to observe conditions in the sky, such as location of the sun and types of clouds present. This study provides daily and weekly opportunities for students to collect and display data; use graphs, tables, and charts to interpret data; make predictions; and relate patterns of cloud cover to their effect on solar energy production.

MATERIALS

- Student handouts
- 1 V, 400 mA mini-solar panel
- Analog DC-powered clock (must run on one AA battery)
- Maximum temperature thermometer or local weather station data
- Highlighter (optional)
- Vernier LabQuest
- Vernier Light Sensor

SAFETY

Tell students not to look directly at the sun. Permanent eye damage can result.

TEACHING THE LESSON

This lesson could easily be adapted to encompass fractions and percentages, and data could readily be transferred to spreadsheets.

Preparation - Set up the sunshine timer: Remove the AA battery from the DC-powered clock. Use alligator clips to connect the mini–solar panel's red lead to the clock's positive (+) battery terminal and black lead to the negative (-). The clock will run when the mini–solar panel is aimed at the sun unless a cloud obscures the sun. Set the clock to noon at the start of a data collection period. The clock will advance as long as clouds do not cover the sun. In this way, the clock will record the number of hours of unobscured sunlight. Students can subtract the number of hours the clock advances from the number of hours of data collection to get the number of hours of cloud cover.

The clock can be powered by a mini–solar panel that is aimed within 45 degrees of facing the sun directly. From August through April, the sun is within 45 degrees east of south to 45 degrees west of south for a three-hour period centered on noon. From May through July, you will need to shorten the daily data collection period to two hours because the sun will be at too great an angle from due south during the three-hour period centered on noon. Alternatively, you can extend the daily data collection period by adjusting the direction of the sunshine timer to track the sun.

Data Logger/Analyzer Option:

Use the Vernier LabQuest, in combination with the light sensor, to record the luminance for the three-hour period. The light sensor should be pointing in the same direction as the mini solar panel and will record the data and graph the variance in the luminance.

Integrating the Light Sensor:

1. Obtain a Vernier LabQuest and a Light Sensor for each group.
2. Connect the light sensor to the Vernier LabQuest.
3. Flip the light sensor range switch so that it will record in the 0-150,000 lux range for measurements of sunlight, or use the UVB sensor.
4. Using the pen, click the rate button to the right of the screen.
5. Adjust the length to one hour or however many hours/minutes you desire.
6. Choose the amount of samples per interval of time desired.
7. Adjust the rate of samples per hour or samples per minute. 12 samples per hour is recommended or one measurement every 5 minutes.
8. Click the OK button.
9. Make sure the mode reads time-based and click the start button on the bottom left of the screen to begin recording.
10. The sensor should record and graph the luminance vs. time.

Opening Discussion: Begin by discussing how solar electric systems depend on radiation from the sun to produce power. Demonstrate a mini–solar panel powering a small motor. Explain that solar electricity is a growing energy source throughout New York State. Use information from the Background Information section at the end of this lesson to introduce the idea of peak electrical demand and the fact that the highest demand for electricity occurs during hot summer days when there are large amounts of sunshine.

Ask students what might hinder our use of sunshine for electricity. What might New York State decision makers want scientists to study to determine if solar electric panels are a good way to supply electricity in the middle of the day?

Tell the students that they will conduct a long-term study of middle-of-the-day cloud cover. Demonstrate how the sunshine timer works and give students an opportunity to handle the timer and become familiar with it.

Help students determine where in the school or in the classroom they can place the cloud meter. It must receive sunlight for one to three hours around noontime unobscured by the shadows of trees, buildings, or other objects. It must face due south and tilt up at an angle to face the sun at around noon. It must be protected from the weather.

Collection of Data from Measured Period: Distribute the student handouts and explain the daily cloud logs. Have students record the length of the data collection period for each day and convert the time to minutes. At set intervals during the daily data collection period, have students check off the box that best fits the current cloud conditions. Have students use the "Weather Notes" section to record daily peak temperature. They could also use it for additional work involving cloud identification or to record experiences for other weather observation opportunities that you may want them to have.

Prediction: At or before the end of the data collection period, but before students check the sunshine timer, have them make a prediction on how many minutes of sunshine will have been recorded.

Collection of Measured Sunlight Data: Have students record the length of sunshine for each day and convert it to minutes.

Data Collection: For the Vernier LabQuest 2 Option, have the students also record the average luminance for each day and convert it from lux to watt/square meter. For example, if we want to convert the luminance from lux to w/m^2, we must divide the lux value by 343 lumens/watt (an average conversion value representing 380-770 nm) to obtain the equivalent irradiance value w/m^2.

Calculated Data: Have students subtract the number of minutes of sunshine from the number of minutes for the data collection period to get the number of minutes of cloud cover. Students who would benefit from additional work with fractions or percentages might use these numbers for daily practice and to form additional weekly graphs.

Graphing: Distribute and explain Graphs 1–3. Help students label the x- and y-axes. In the title of Graph 2, students must fill in the number of minutes of the daily data collection. Have students fill in these graphs on a regular basis—for instance, daily or once a week.

- *Graph 1:* This graph is actually five bar graphs on top of one another. Students should use a different color for each weather condition. For each day, have students record the number of times each weather condition is observed.
- *Graph 2:* Have students graph their predictions with a pencil dot and the measured value as a bar colored with a highlighter.
- *Graph 3:* Have students graph the peak daily temperature as a line graph.

Review Questions: Go over appropriate review questions daily, weekly, or at the end of the data collection period.

- Have your predictions on the amount of sunshine improved over time? Have students discuss why.
- What types of clouds or cloud cover seem to affect solar energy production the most? What types affect it the least?
- Visit nearby Internet sites that have solar data and cloud cover available and compare this to your results.
- How could solar electric power help provide electricity for the high midday demand of high- temperature days?

ACCEPTABLE STUDENT RESPONSES

The results will vary depending on the kind and extent of cloud cover during the data collection period.

BACKGROUND INFORMATION

Daily peak needs for electrical power in New York State's large metropolitan areas are closely coincident with available sunlight. New York's highest power demands occur during summer heat waves, when there are large amounts of sunshine.

Studies conducted by the University at Albany Atmospheric Sciences Research Center show that for the mid-Atlantic region (including downstate New York), sunlight is available when it is needed to offset peak power 60% to 70% of the time. This is comparable to much of Arizona, Florida, and California—the "traditional" solar areas.

The result is that, together with very small amounts of backup power (such as batteries) and/or programs to reduce peak demand for electricity, solar electric panels could provide a 100% guaranteed peak power source for New York's metropolitan areas.

(STUDENT HANDOUT FOLLOWS)

Name ________________________________ Date ____________

Sunshine Timer - Daily Cloud Log

Data collection period: Hours ____________ Minutes ____________

Converted to minutes ____________

Cloud Conditions

	Starting Observation	At the end of the 1st hour	At the end of the 2nd hour	At the end of the 3rd hour
Clear blue sky				
Heavy clouds passing by				
Thin clouds passing by				
Heavily overcast sky				
Light hazy sky				

Weather Notes

Daily peak temperature ___________

Prediction

Over the data collection period, I predict that we received ____________ minutes of sunshine.

Measured Data

Length of time of sunshine: Hours ____________ Minutes ____________

Converted to minutes ____________

Calculated Data

Number of minutes of the data collection period ______________ min.

Minus number of minutes of sunshine ______________ min.

Number of minutes of cloud cover ______________ min.

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Name ______________________________ Date ____________

Graph 1 - Cloud cover conditions over the sun

Days & Weeks								
Clear blue sky								
Heavy clouds passing by								
Thin clouds passing by								
Heavily overcast sky								
Light hazy sky								

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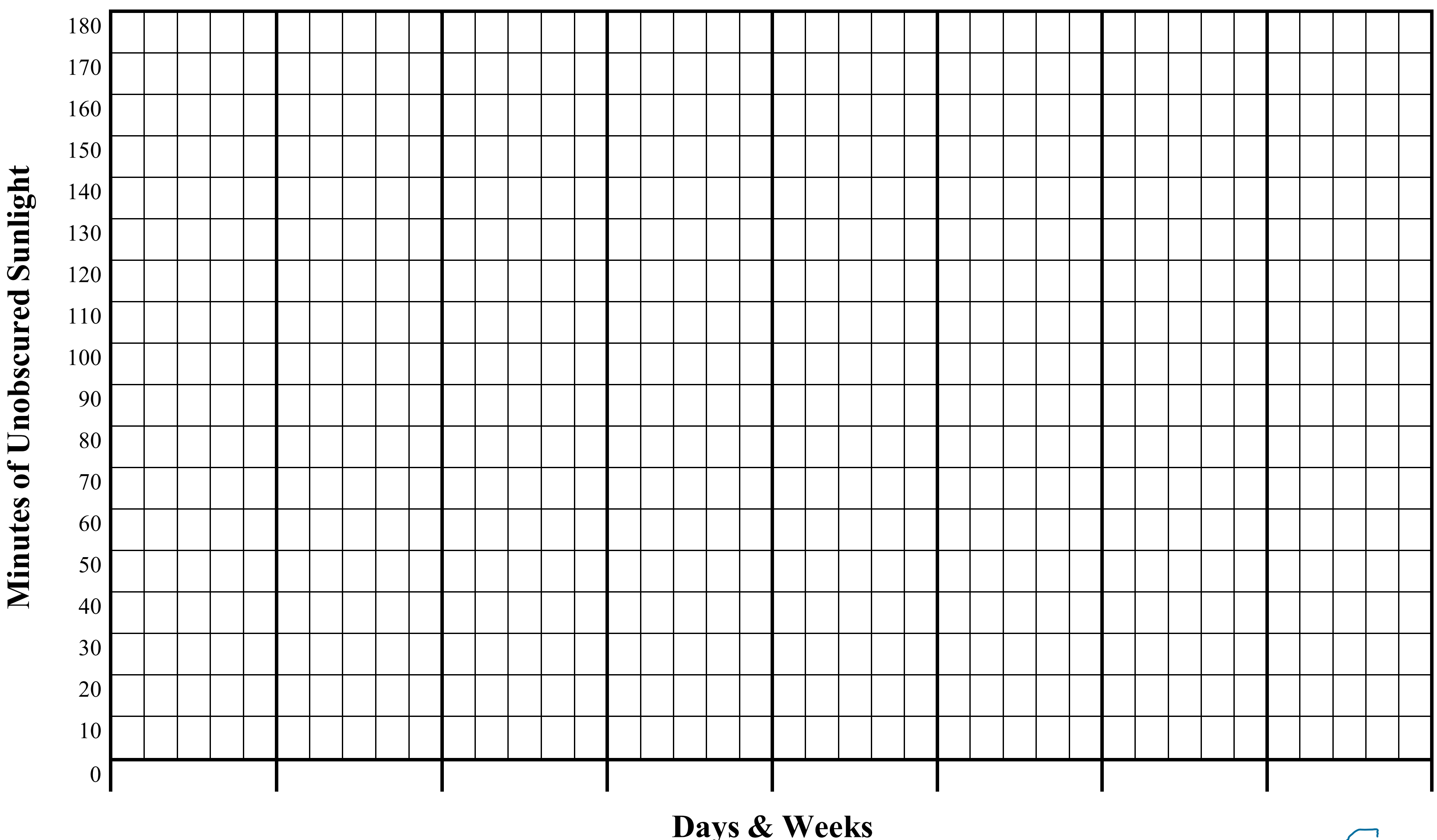
Graph 2 - Minutes of sunshine per ________-minute period



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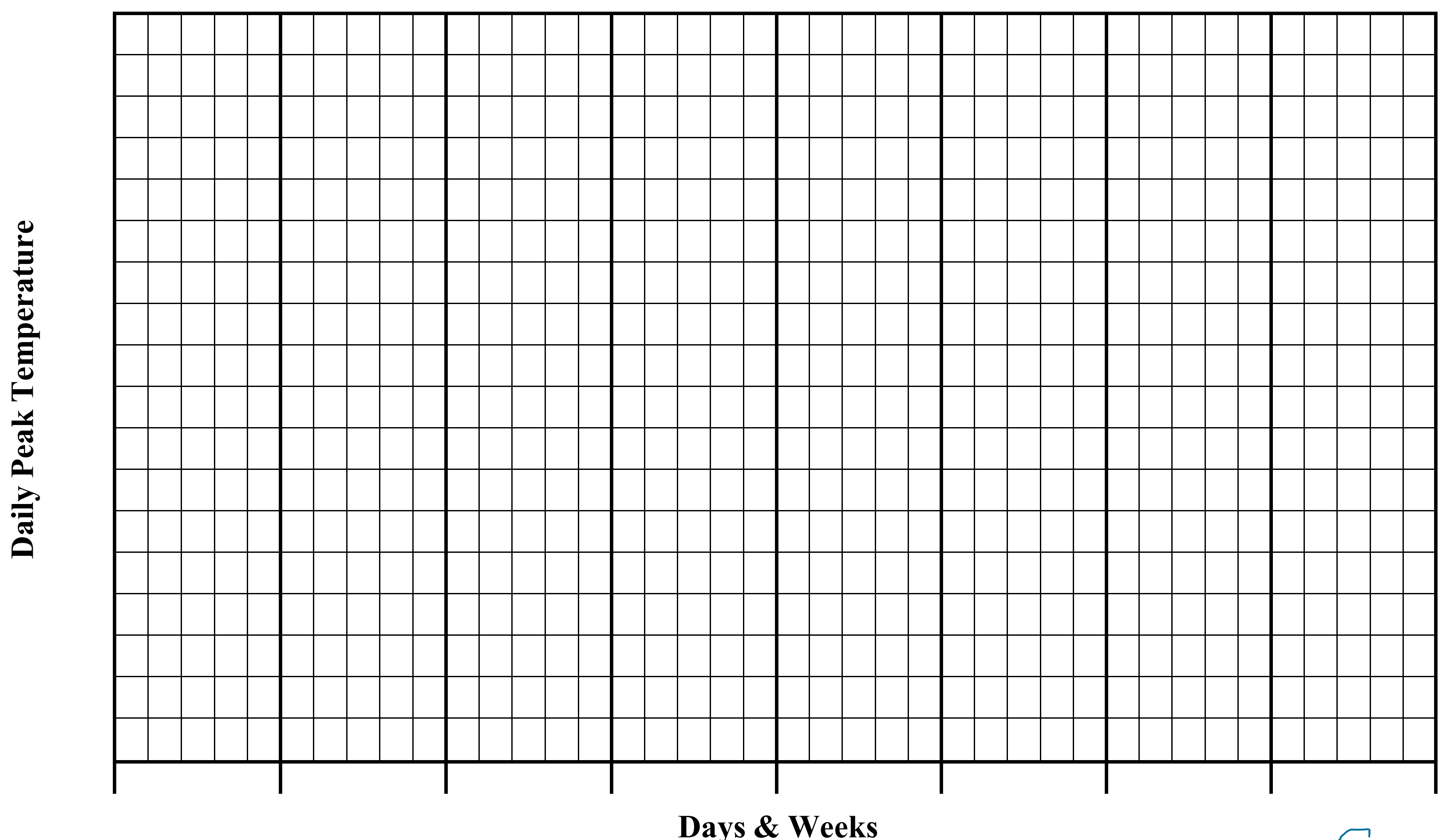
Name ____________________ Date __________

Graph 3 - Daily peak temperature



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