ACTIVITY 17

Solar Energy and Exposure Time

BROWARD COUNTY ELEMENTARY SCIENCE BENCHMARK PLAN

Grade 5—Quarter 2
Activity 17

SC.B.1.2.2
The student recognizes various forms of energy (e.g., heat, light, and electricity).

SC.B.1.2.3
The student knows that most things that emit light also emit heat.

SC.B.1.2.5
The student knows that various forms of energy (e.g., mechanical, chemical, electrical, magnetic, nuclear, and radiant) can be measured in ways that make it possible to determine the amount of energy that is transformed.

SC.B.1.2.6
The student knows ways that heat can move from one object to another.

SC.H.1.2.1
The student knows that it is important to keep accurate records and descriptions to provide information and clues on causes of discrepancies in repeated experiments.

SC.H.1.2.2
The student knows that a successful method to explore the natural world is to observe and record, and then analyze and communicate the results.

SC.H.1.2.3
The student knows that to work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions.

SC.H.1.2.4
The student knows that to compare and contrast observations and results is an essential skill in science.

SC.H.1.2.5
The student knows that a model of something is different from the real thing, but can be used to learn something about the real thing.

SC.H.2.2.1
The student knows that natural events are often predictable and logical.

SC.H.3.2.2
The student knows that data are collected and interpreted in order to explain an event or concept.

ACTIVITY ASSESSMENT OPPORTUNITIES

The following suggestions are intended to help identify major concepts covered in the activity that may need extra reinforcement. The goal is to provide opportunities to assess student progress without creating the need for a separate, formal assessment session (or activity) for each of the 39 hands-on activities at your grade.

1. Ask students to look at the activity sheet and describe what the graph shows in the form of a sentence. (The more time that passes, the higher the temperature of the water rises.) Ask them which type of relationship the graph shows, direct or inverse. Remind them that an inverse relationship means that as one factor (variable) increases, the other decreases. In a direct relationship, both factors (variables) increase or decrease at the same time. (The relationship in this activity is direct.)

2. Use the Activity Sheet(s) to assess student understanding of the major concepts in the activity.

In addition to the above assessment suggestions, the questions in bold and tasks that students perform throughout the activity provide opportunities to identify areas that may require additional review before proceeding further with the activity.

ACTIVITY 17

Solar Energy and Exposure Time

OBJECTIVES

Students investigate the relationship between the length of time a solar collector is exposed to sunlight and the amount of solar energy the collector absorbs.

The students

- measure the change in water temperature in a solar collector over the course of 45 minutes
- conclude that the longer the collector is exposed to the sun, the more solar energy the water will absorb
- graph their results

SCHEDULE

About 1 hour

MATERIALS

For each student

1	Activity Sheet 17
1 pr	safety goggles*

For each team of four

1	solar tray, black
1	solar tray cover
1	thermometer, Celsius
1	tumbler, large

For the class

1	container, 6-L
1	VCR*
1	video, *Solar Energy*
6 L	water, tap*
	DSR *Earth, Moon, and Sun*

*provided by the teacher

PREPARATION

1. Make a copy of Activity Sheet 17 for each student.
2. Select an area outdoors where 8 solar collectors can be left undisturbed for 45 minutes in direct sunlight.
3. At least two hours before the start of the activity, place the 6-L container of tap water in the shade near where the students will conduct their experiments.
4. Each team of four will need one black solar tray, one solar tray cover, one tumbler, and a thermometer.

BACKGROUND INFORMATION

In this activity, students will observe how exposure time affects the temperature of the water in their solar collectors. They will discover that, up to a point, the total amount of energy absorbed by the water in the trays increases the longer the trays are exposed to the sun.

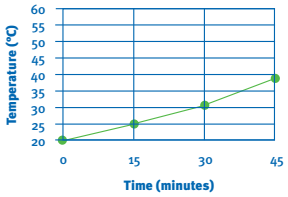
Part Two of the *Solar Energy* video is titled "Transferring Solar Energy." Show Part Two after students have finished taking measurements.

▼ **Activity Sheet 17**

Solar Energy and Exposure Time

Exposure Time (minutes)	Temperature (°C)
0 (setup)	20°C
15	25°C
30	31°C
45	38°C

1. Measure the temperature of the water during the setup (at 0 minutes) and record it in the table above.
2. I predict that over the next 45 minutes, the temperature of the water will _____
3. Measure the water temperature at each 15-minute interval and record it in the table above.
4. Make a line graph to show the change in water temperature over the course of 45 minutes.



5. What is the relationship between exposure time and amount of solar energy absorbed?
The longer the water is exposed to the sun, the more solar energy it absorbs, up to a point.

Guiding the Activity

1 Refresh the students' memories by asking, **What happens to the temperature of the water in a solar tray that is left in the sun for 45 minutes?**

Ask, **What do you think would happen to the water temperature if that same tray were left in direct sunlight for an additional 45 minutes?**

2 As appropriate, read or review page 6 from the Delta Science Reader *Earth, Moon, and Sun*.

Distribute a copy of **Activity Sheet 17** to each student. Divide the class into teams of four and distribute one black solar tray, one solar tray cover, one tumbler, and a thermometer to each team. Then, lead them to the experiment site.

Additional Information

Students will recall from previous activities that the temperature of the water rises.

Students will probably reason that the temperature of the water would continue to rise the longer the tray is in the sun, but they may not know why.

Guiding the Activity

	Additional Information
3 Have each team pour water from the containers into a tumbler, filling it to the bottom of the frosted rim. Tell the teams to measure the temperature of the water and then pour the water into a tray. They should tilt the tray so that the water is evenly distributed among the troughs. Remind them to record the temperature of the water (at 0 minutes) on their activity sheets. When the students have finished, lead them back to the classroom. Remind them to bring their tumblers, thermometers, activity sheets, and the 6-L container with them.	*Make sure the students position their trays so that they face the sun.*
4 Once back in the classroom, tell the students that they will take turns measuring the temperature of the water in their team's tray every 15 minutes for the next 45 minutes. Remind students of the discussion earlier in the activity about what they think would happen to the water temperature in a tray, the longer the tray is left in the sun. Tell them to record their predictions on Activity Sheet 17.	
5 Fifteen minutes after the experiments have been set up, have two members from each team bring a tumbler, thermometer, activity sheet, and pencil outdoors and pour the contents of their team's tray into a tumbler (see Figure 17-1), measure the water temperature, and record it on the activity sheet. After the temperature has been measured, have the students pour the water back into their solar trays and position the trays as before. Have the students gather their materials and return to the classroom to report the temperature of the water to their teammates. Remind all students to record on their activity sheets the temperature of the water at this time interval.	*Suggest that while taking their measurements, students are careful not to block the sunlight hitting their tray or the trays of other teams.* *Tell students to be careful not to spill any water during the transfer from tray to tumbler and back to tray again, as a change in water volume will skew their results.*

Guiding the Activity

Additional Information

▲ ***Figure 17-1.*** *Measuring the temperature of the water.*

6 Repeat this procedure two more times until the temperature of the water in each tray has been measured a total of four times (including during the initial setup). After the last measurement has been taken (at 45 minutes), team members should dump out the water and bring all of the materials back to the classroom.

7 Once back in the classroom, have students complete the chart on Activity Sheet 17. Then ask, **How did your results compare with your predictions? How did your results compare with the results of the other teams?**

Students should realize that the longer the trays sat in the sun, the warmer the water in the trays became.

Have the students graph their data on the activity sheet. Chart team results on the board and discuss possible explanations for any data that are not consistent with those results.

At this point students may be under the impression that the water temperature will rise indefinitely if the tray is kept in direct sunlight. Explain that eventually the water temperature will plateau—reach its maximum temperature and not rise any further, no matter how much longer the tray sits in the Sun.

Reinforcement

Ask students if they have ever gotten a sunburn. Encourage them to explain the relationship between the length of time they were exposed to the sun and the amount of energy their skin absorbed.

Cleanup

Return the 6-L container, solar trays, covers, tumblers, and thermometers to the kit.

Connections

Science Extension

Provide each group of students with a variety of fresh fruit suitable for sun-drying, such as apples, peaches, and apricots. Have students wash the fruit thoroughly. Apples should be peeled and cored; peaches and apricots should be pitted but not peeled. Tell students to slice the fruit into long, thin pieces and then pat them dry with paper towels. Have students arrange the slices on a flat pan so they do not touch each other and cover the pan with cheesecloth tucked underneath the pan and taped. (Cheesecloth will protect the fruit from birds and insects but still allow air to circulate.) Have students put the pan in direct sunlight for at least eight hours each day. Depending on the climate and daily weather in your area, the fruit may dry thoroughly in a day or two or may take a week or longer. *Note:* You may want to combine this activity with the first Science Extension in Activity 15 (making solar tea) so that students can make a "solar snack."

Science and Health

Encourage students to research and report on the relationship between exposure to ultraviolet rays in sunlight (or from a sun lamp) and an increased risk of developing skin cancer. Ask the class to develop a set of guidelines for decreasing that risk, including using a sunscreen whenever they are outdoors, not just while sunbathing. Explain that sunscreens are rated with a number called the *sun protection factor,* or SPF. The higher the SPF number, the greater the protection. Ask students to examine sunscreen labels and find the SPF numbers. What was the lowest SPF they found? the highest?

Science and Math

Ask students why a line graph, not a bar graph, is appropriate for plotting the data recorded in this activity sheet investigation. If necessary, guide students by having them compare the variables in this investigation with those in the previous activity sheet investigations. Students should realize that a line graph is appropriate here because the temperature change is continuous, even though they read and recorded the temperature only at 15-minute intervals.

Science and Social Studies

You could do the following activity as a lead-in or follow-up to the Science Extension above. Ask students to investigate the historical use of sun-drying to preserve foods. What types of foods were (or still are) sun-dried by different cultures? What techniques did they use to insure that the foods would be thoroughly dried and safe to eat? How were the dried foods stored so they would not spoil?

Science, Technology, and Society

Encourage students to research and report on the development and use of sundials to tell time. Also suggest that they work in small groups to make a simple sundial, as follows. Secure a pencil upright in an empty thread spool glued in the center of a sheet of stiff, light-colored poster board. Put this sundial base in a location where it will get sun throughout the entire day. Use a compass to align the base north-south, and mark *S* on its south-facing short edge. At the next full hour on a clock, mark the pencil's shadow on the paper and label the line with the hour. Continue doing this every hour throughout the day. Once all possible hours are marked, the sundial can be used to tell time in any sunlit location so long as it is correctly aligned north-south.