ACTIVITY 16

Solar Energy and Water Volume

BROWARD COUNTY ELEMENTARY SCIENCE BENCHMARK PLAN

Grade 5—Quarter 2
Activity 16

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

SC.B.1.2.4
The student knows the many ways in which energy can be transformed from one type to another.

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 if they think this activity was a fair test of only one factor. (Yes, we changed only one factor, the amount of water in the two trays.) Have the students look at their bar graph and put it into sentence form. (Solar energy heats a smaller volume of water to a higher temperature than it heats a larger volume of water in the same amount of time.)

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 16

Solar Energy and Water Volume

OBJECTIVES

Students investigate how the same amount of solar energy affects different volumes of water.

The students

- measure the change in temperature of different volumes of water exposed to the Sun for the same length of time
- conclude that the smaller the volume of water, the more quickly it heats up
- graph their results

SCHEDULE

About 1 hour

MATERIALS

For each student

1	Activity Sheet 16
1 pr	safety goggles*

For each team of four

2	solar tray covers
2	solar trays, black
2	thermometers, Celsius
2	tumblers, large

For the class

2	containers, 6-L
1 roll	tape, masking
12 L	water, tap*
	DSR *Earth, Moon, and Sun*

*provided by the teacher

PREPARATION

1. Make a copy of Activity Sheet 16 for each student.
2. Select an area outdoors where 16 solar collectors can be left undisturbed for 40 minutes in direct sunlight.
3. At least two hours before the start of the activity, fill the 6-L containers with tap water and place them in the shade near where the students will conduct their experiments.
4. Each team of four will need two black solar trays, two solar tray covers, two pieces of masking tape, two thermometers, and two large tumblers.

BACKGROUND INFORMATION

If you've ever been to the beach on a hot summer day and waded in the shallow pools of water that collect on shore at low tide, you will have noticed how much warmer the temperature in these tidal pools is compared to the ocean. This is because a smaller volume of water heats up faster than a larger volume of water when exposed to the same amount of solar energy for the same length of time.

In this activity, the students set out four solar collectors, each containing a different volume of water, and measure the change in water temperature in each tray after 40 minutes in the Sun.

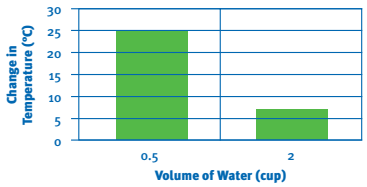
▼ **Activity Sheet 16**

Solar Energy and Water Volume

Starting Time _____			Ending Time _____	
Tray No.	Volume of Water (cup)	Starting Temperature (°C)	Final Temperature (°C)	Change in Temperature (°C)
1	0.5	20°C	45°C	+ 25°C
2	2.0	20°C	27°C	+ 7°C

1. Record the starting temperature of the water and the starting time.
2. I predict that the water temperature in the solar trays will be highest in tray _____ because

3. After 40 minutes, record the final temperatures of the water and the ending time. Calculate and record the change in temperature for each tray.
4. Make a bar graph to show the change in temperature in each solar tray.



5. The water in tray 1 got the warmest. Explain why.
Tray 1 contained the smallest volume of water. The same amount of solar energy will heat a smaller volume of water faster than it will heat a larger volume of water.

Guiding the Activity

1 Encourage discussion by asking, **How do you think the amount of water in a solar collector affects the temperature of the water?**

Explain that in this activity, students will fill each of two solar trays with a different amount of water. They will then measure the temperature of the water in each tray after 40 minutes outdoors in the sun.

2 Distribute a copy of **Activity Sheet 16** to each student. Divide the class into teams of four and distribute two black solar trays, two solar tray covers, two thermometers, and two tumblers to each team.

Tell the students to gather their materials, including Activity Sheet 16 and a pencil, and lead them to the site.

Additional Information

Students may suggest that the more water in the collector, the longer it will take to warm up.

Guiding the Activity

Using a thermometer, have one member from each team measure the starting temperature of the water in the 6-L containers, and have all team members record this temperature on Activity Sheet 16.

Tell the teams to use masking tape and a pencil to label their trays and tumblers 1 and 2. The tape should be placed on the edge of each tray and tumbler.

Then have each team add the following amounts of water to their trays: tray 1, 0.5 cup; tray 2, 2 cups (Figure 16-1). Tell them to record the starting time on their activity sheets.

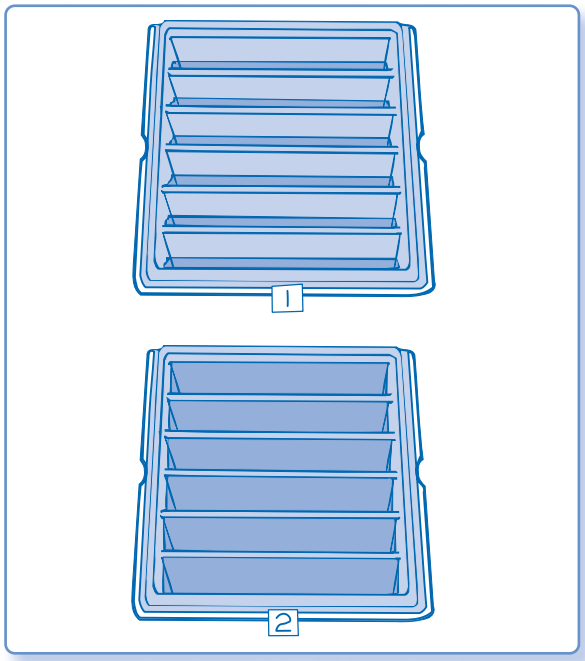
Instruct them to distribute the water evenly among the troughs in each tray. If necessary, remind them to position the trays so that the angled side of the troughs is facing the sun.

Tell the students that they will return to the site in about 40 minutes to measure the temperature of the water in each tray. Return to the classroom. Have the students bring their tumblers, thermometers, activity sheets, and the two 6-L containers with them.

Additional Information

Note that because the temperature is taken before the water has been poured into trays, the starting temperatures entered in the chart on Activity Sheet 16 will be the same for both trays.

Tell students that one large tumbler holds 9 ounces of water—a little more than a cup.



▲ ***Figure 16-1.*** *Two labeled solar collectors, each containing a different volume of water.*

3 Once back in the classroom, ask, **What can you say about the starting temperatures of the water in the two trays?**

Students should state that the starting temperatures are the same because the water temperature was taken while the water was still in the 6-L containers.

Invite students to predict what will happen to the water temperature in each tray. Tell them to record their predictions on Activity Sheet 16.

Then ask, **Do you think the temperature of the water in the trays will be the same after 40 minutes in the sun? If not, in which tray do you think the water will be warmest? coolest? Why?**

Accept all answers.

Guiding the Activity

Additional Information

4 Return to the site about 40 minutes after setting up the experiments. Have the students bring their tumblers, thermometers, and activity sheets with them. Tell the teams to pour the contents of each tray into tumblers with corresponding numbers and measure the temperature of the water in each tumbler.

Remind teams that tray 2 contains more than one tumblerful of water. Tell them that they need only pour enough water from this tray to fill one tumbler. The excess water can be dumped out.

Have the students record on their activity sheets the final temperature of the water in each tumbler and the time at which they were taken (ending time).

When students are finished, tell them to dump out the water, collect all the materials, and return to the classroom.

5 Once back in the classroom, ask, **In which tray did the water temperature increase the most after 40 minutes in the sun?**

Students should have found that the water temperature increased the most in the tray containing the smallest volume of water (tray 1, 0.5 cup of water).

Ask, **Why do you think that the water temperature in tray 1 increased the most?**

Some students may suggest that more energy was transferred to tray 1. This is not true.

Explain that the same amount of solar energy was transferred to each tray. The reason that tray 1 got the warmest is because a given amount of solar energy will heat a smaller amount of water faster than it will heat a larger amount of water.

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

Tell students to complete the activity sheet by making a bar graph of their results and answering the question at the bottom of the page.

Reinforcement

Tell students to imagine two equal-size swimming pools side by side, one completely full of water and the other half full. Ask students, **At noon on a sunny day, which pool do you think contains the warmer water?** Students should respond that the pool containing the smaller volume of water will be warmer than the pool containing the larger volume of water.

Cleanup

Tell students to remove the tape from the trays and tumblers and return the 6-L containers, solar trays, covers, tumblers, and thermometers to the kit.

Connections

Science Challenge

Explain that just as the covers held solar energy in the water trays (and, in the second Science Extension below, the plastic wrap held energy in the shoe box), carbon dioxide in Earth's atmosphere holds heat close to Earth's surface and keeps the heat from escaping into space. This condition is called the *greenhouse effect*. Encourage students to research the greenhouse effect, particularly the factors that increase the effect (primarily, the burning of fossil fuels by automobiles, power plants, and factories) and the possible results if the effect were to worsen over time. Ask volunteers to add a representation of the greenhouse effect to the bulletin board display or mural created in the Science Challenge for Activity 15.

Science Extension

To ensure that students understand the direct relationship between the volume of water and the temperature increase, have them repeat the activity sheet investigation to find out how long it takes each volume of water to reach the same temperature. Tell them to measure and record the temperature of the water in tray 1 after 30 minutes of exposure. Then, at regular intervals—preferably every 15 minutes but at least every 30 minutes—they should measure the temperature of the water in the other tray. When tray 2 reaches roughly the same temperature as tray 1 reached in 30 minutes, discontinue temperature readings for that tray. Make sure students record the elapsed times and temperature readings for tray 2. Then have students use these data to construct a line graph with the horizontal axis labeled *Elapsed Time,* the vertical axis labeled *Temperature,* and each tray's data plotted in a different color.

Encourage students to investigate the Sun's warming effect on various types of solid materials as well as on water. Working in small groups, students should paint the inside of a shoe box with black paint or line it with black paper. Have them put into the box four identical small glass jars (such as baby food jars), each filled to the same level with a different material—water, soil, sand, and pebbles or gravel. Tell students to insert a thermometer into the material in each jar, then cover the box with a sheet of plastic wrap and set the box where it will receive direct sunlight for at least two hours (preferably three or four hours, if possible). Have students read and record the temperature of the material in each jar every 30 minutes. At the end of the time period, have students remove the box from the sunlight, let it stand for one hour, and read and record the temperature of the material in each jar after 30 minutes and again after one hour. Which material collected the most solar energy (i.e., showed the greatest temperature increase)? Which material held its collected energy the longest (i.e., showed the least temperature decrease when the box was removed from sunlight)? Students will discover that the water collected heat more readily but also lost it more readily. The material with the largest particles (the pebbles or gravel) collected heat more slowly but also lost it more slowly.

Science and Math

Create (or ask students to create) math problems such as the following for the class to solve: If the temperature of one cup of water increases 10° in 40 minutes, how much will the temperature of one quart of water increase in 45 minutes? (about 2.5°) How long will it take to produce a 10° increase in the temperature of one gallon of water? (720 minutes, or 12 hours)