WHAT MAKES THE BEST INSULATOR?

BENCHMARKS and TASKS

SC.B.1.2.1 The student knows how to trace the flow of energy in a system (e.g., as in an ecosystem).

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

- The student measures the gain or loss of energy using a variety of tools (e.g., thermometer, electric meter, meter stick).
- The student experiments to discover that some materials conduct heat much better than others, and poor conductors can reduce heat loss.
- The student experiences that heat energy moves from one place to another in three different ways: radiation, convection, and conduction.

KEY QUESTION

What kind of material makes the best insulator?

BACKGROUND INFORMATION

Thermal **energy** moves quickly in some materials. These materials are called conductors. A frying pan is made of metal because the metal allows the thermal energy to move easily from the hot stove to the pan and to the food. Metals are good conductors of thermal energy. An insulator is a material through which thermal energy cannot move easily. Insulators are poor conductors of heat and can reduce heat loss. We use insulators to keep things warm (keep the heat in) and to keep things cool (keep the heat out).

MATERIALS

Per group

300 mL of hot water (about 75º C)
1 measuring cup for measuring at least 300 mL of water
1 aluminum soda can with the pull-tab removed
1 thermometer (must fit in soda can opening)
1 larger can, such as a coffee can (The soda can will be placed in the center of the large can with insulation all around.)
variety of materials to be used as insulators (e.g., Styrofoam peanuts, bubble plastic, sand, cotton balls, vermiculite, newspaper, shredded paper)
graph paper
1 timer
What Makes the Best Insulator? data sheet

TEACHING TIPS

1. Students need to be able to place the thermometer in the soda can opening to measure the water temperature. Delta or AIMS makes an affordable metal, v-back, classroom alcohol thermometer that easily fits into the opening. Another option is a glass classroom thermometer. Nasco has one in the elementary catalog that is affordable.
2. If individual timers are not available, a classroom timer can be used. Students can begin their investigation at the same time, and the teacher can call time each minute for 15 minutes to let students know when to read their thermometers.

ENGAGE

Ask students what they do to keep warm on a cold day. Point out that when we wear a coat or sweater we are covering our body with an insulator to keep warm. Insulators can help us keep heat in or keep heat out. Ask students to think of insulators they have used to keep heat out and begin a list. (Students might mention such things as Styrofoam coolers, etc.)**.** Tell the students they will be doing an investigation to learn more about insulators.

EXPLORE

1. Tell students that they will be doing an investigation to discover which materials make the best insulators. On the board, list the insulating materials that will be used. Have students predict which material they think will make the best insulator. Tally the predictions on the board.
2. Give each group of students one type of insulating material (see Materials list) to test for the class, a large can, a soda can, a thermometer, and a timer.
3. Show students how to place 2-3 cm of insulating material in the bottom of the outer container (large can). Set the soda can on this, centering it in the outer container.
4. Students should pack the space between the soda can and the larger can with insulation.
5. When the class is ready to start the investigation, have students add 300 mL of hot water to the soda can, insert the thermometer into the water, and start the timer.
6. After one minute has passed, students should record the first temperature on the group's data table.
7. Students should continue to record the temperature every minute for 15 minutes.
8. Have each group calculate the temperature change that occurred in the soda can by subtracting the 15-minute temperature reading from the 1-minute temperature reading.
9. Tell the groups to construct a line graph showing the temperature of the water during the fifteen-minute time period.
10. As groups report the results of their experiment, students should record the name of the insulating material and the temperature change in the class data table section of the observation sheet.

EXPLAIN

1. Discuss:
   What does the line graph show happened to the temperature of the water during the experiment?

Which insulating material let the water cool off the fastest? How do you know? (It was the material that insulated the can in which the water showed the greatest change in temperature.)
Which material kept the water warm the longest? How do you know? (It was the material that insulated the can in which the water showed the smallest change in temperature.)
Which material was the best insulator?. . . the poorest insulator?
How do the results of the experiment compare with the predictions you made earlier?

2. Discuss with students that heat travels slowly through good insulators because the particles they are made of do not move much when particles from hot objects bump into them. Insulators can be used to keep things hot or to keep things cold.

EXTEND/APPLY

Return to the class list started in the Engage section and have students think of other examples of insulators to add to the list, including insulation that is used around their houses (e.g., insulation used around outside pipes, insulation in the attic, thermos bottles).

EXTENSIONS

1. Have students construct a bar graph comparing the temperature changes for the different insulating materials that were tested.
2. Ask students to bring in other materials to test in order to extend the investigation to find the best possible insulator.

ASSESSMENT

Have students reflect on this question: Animals that have wool keep warm because of their wool. A sweater or coat made of wool will keep you warm, too. Why?

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Group Data Table

	Temperature														
Insulator	**1 min.**	**2 min.**	**3 min.**	**4 min.**	**5 min.**	**6 min.**	**7 min.**	**8 min.**	**9 min.**	**10 min.**	**11 min.**	**12 min.**	**13 min.**	**14 min.**	**15 min.**

Class Data Table

Insulating Material	Temperature Change