Heat Transfer

BROWARD COUNTY ELEMENTARY SCIENCE BENCHMARK PLAN

Grade 3—Quarter 2
Activity 20

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

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 40 hands-on activities at this grade level.

1. Ask, Why do scientists control all the variables except one in an experiment? (If many variables were allowed to change, the scientists wouldn't know which variable was responsible for the results.)

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.
Heat Transfer

OBJECTIVES

Students investigate the rate of heat transfer from hot water through metal spoon handles of different lengths. They follow accepted scientific methodology in carrying out and reporting on the experiment.

The students

► hypothesize on which spoon a dab of margarine will melt first when the spoons are placed in hot water
► test the amount of time it takes for margarine on spoons of different lengths to melt when the spoons are placed in hot water
► compare their results to their hypotheses

SCHEDULE

About 40 minutes

VOCABULARY

conclusion
conduction
controlled variable
data
dependent variable
hypothesis
independent variable
variable

MATERIALS

For each student
1 Activity Sheet 20, Parts A–D
1 pr safety goggles*

For each team of four
1 beaker, 250-mL
1 knife, plastic
1 spoon, metal, long*
1 spoon, metal, short*
1 sq wax paper*

For the class
1 carafe, large, insulated*
1 clock or watch with a second hand*
½ lb margarine, soft*
paper towels*
1 pr scissors*
water, hot tap*

*provided by the teacher

PREPARATION

1 Make a copy of Activity Sheet 20, Parts A–D, for each student.
2 Cut a small square of wax paper for each team and place a dab of margarine on it. Keep the margarine refrigerated or in a cool place until students are ready to begin the experiment.
3 Fill the carafe with hot tap water. The water should be quite hot but not so hot that students might burn themselves if they touched it accidentally.
4 Cover the distribution table with newspaper. Place all the materials on the distribution table.

BACKGROUND INFORMATION

Heat is a form of energy resulting from the movement of the molecules of matter in a substance. The faster the molecules move,
the more heat energy there is in the substance. Temperature is a measure of the amount of heat in a substance.

Heat flows from warmer objects to cooler objects. Heat can be transferred in three ways: by conduction, convection, and radiation. Conduction is the transfer of heat energy from molecule to molecule or atom to atom through a substance. Heat moves up a metal spoon in a cup of hot coffee through conduction. Conduction is most effective in solids but also occurs in fluids.

Convection is the transfer of heat energy by the movement of currents of the heated matter. Heat leaves the coffee cup as the currents of steam and air rise. Convection occurs in both liquids and gases and sometimes in solids.

Radiation is the movement of heat energy through empty space by means of electromagnetic waves. Sunlight is a form of radiation that travels through the vacuum of space to our planet without the aid of solids, liquids, or gases.

In this activity, students will observe the movement of heat energy through a solid by means of conduction.
Give each student a copy of Activity Sheet 20, Parts A–D. Explain to students that heat energy can move from one place to another. Tell them that they are going to do an experiment to observe one of the ways heat can move. Explain that they will place a small amount of margarine on the ends of two spoon handles of different lengths and place the spoons’ bowls in hot water. They will measure how long it takes the margarine on each spoon to melt.

Have students come up with a title for the experiment and record it in step 1 on Part A of the activity sheet. Then have them state the problem in their own words in step 2.

Help students as needed to formulate a title and state a problem. You may choose to do this as a class exercise.
## Guiding the Activity

### 2. Give students time to research the following terms: heat, conduction. Have them record the information they collect in step 3 on the activity sheet.

### Additional Information

*Students can use reference books or the Internet to research terms.*

### 3. Gather students around the distribution table. Show students the two spoons that each team will use for this activity. Ask, How are these spoons like each other? How are they different from each other?

Write the term *hypothesis* on the board. Explain that a *hypothesis* is an educated guess about what the answer to a stated problem might be.

Ask, *What do you think the answer to your stated problem might be?* Have students record their hypotheses in step 4 of the activity sheet.

### 4. Write the following terms on the board: controlled variable, dependent variable, and independent variable.

Explain that a *variable* is anything that can change in an experiment. Controlled variables are variables that are kept the same. In any experiment, all the variables are controlled except one. The variable that is not controlled is called the independent variable. The dependent variable is the variable that changes in response to changes in the independent variable.

Discuss the role of variables in this experiment. Explain that students will place a small amount of margarine on the end of each spoon and place the spoons in hot water. They will measure how long it takes the margarine on each spoon to melt and slide down the spoon. Ask, *What variables are controlled in this experiment?*

Help students see that variables such as the material the spoons are made of, the amount of margarine placed on both spoons, and the temperature of the water are controlled because they are the same for both spoons.

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*Students should point out that both spoons are made of metal, but their handles are of different lengths.*

*Encourage class discussion. Help students look for factors that are the same for both spoons.*
### Guiding the Activity

**Ask, What is the independent variable in this experiment?** Help students see that the length of the spoon is the independent variable.

**Ask, What is the dependent variable in this experiment?** Help students see that the amount of time it takes the margarine to melt is the dependent variable.

Have students record the variables for this experiment in step 5 of the activity sheet.

| **5** | Divide students into teams of four. Ask each group to examine the materials on the distribution table and list which materials they will need for their experiment. Have students record the list of materials in step 6 on Part B of the activity sheet. | Each team of four will need a beaker of hot water, two metal spoons of different lengths, a plastic knife, a small amount of margarine, and access to a watch or clock with a second hand. They will also need paper towels for clean-up. |
| **6** | Give students the following directions for doing the experiment: Use the plastic knife to place a small amount of margarine on the end of each spoon handle. Make sure to place the same amount on each one. Place the bowls of the spoons in the beaker. Make sure that they do not touch each other. See Figure 20–1. Record the start time. Carefully watch the margarine on the spoons. When the margarine melts and slides down a spoon, record the end time. Continue observing until the margarine on the other spoon has slid down it. After collecting all of your data, calculate the amount of time it took for the margarine on each spoon to melt and slide down. Have students write out their procedure on the activity sheet. | Review with students which variables are being controlled in the experiment. |

*Figure 20-1. The experiment set-up.*
Guiding the Activity

7 Write the term *data* on the board. Explain that *data* are observations and measurements that are collected in an experiment. Data can be observations that you write down in sentences. Or they can be numbers, as in the time in hours, minutes, and seconds.

Tell students to conduct their experiments and record their data in step 8 on Part C of the activity sheet.

As needed, help students calculate the elapsed time needed for the margarine on each spoon to melt (end time minus start time). Also help them construct a bar graph of their results in step 8 of the activity sheet.

8 After everyone has completed their bar graphs, ask, **On which spoon did the margarine melt and slide down first?**

Ask, **Why do you think the margarine melted on the spoons?**

Ask, **Why do you think the margarine melted on the short spoon first?**

Write the word *conduction* on the board. Explain that heat moved from the hot water to each spoon and up its handle to the margarine, causing it to melt. This process of heat transfer through materials is known as *conduction*. Since there is less distance for the heat to travel to reach the margarine on the short spoon, that margarine melted first.

Write the term *conclusion* on the board. Explain that a *conclusion* is a statement that describes what an experiment showed, based

Additional Information

Fill each team’s beaker half full with hot water.

**Safety Note:** Warn students to be careful with the hot water.

Data should include the time of starting observations and the time that each bit of margarine slides down the spoon.

The bar graph will compare the amount of time it took for the margarine to melt on each spoon.

Students should have observed that the margarine melted first on the shorter spoon.

Accept all reasonable explanations. Encourage class discussion.

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on data collected. Have students record their conclusions in step 10 of Part D of the activity sheet.

Explain that scientists always review their experiments and try to come up with ways of improving them. Ask, **If you could do the experiment over again, what might you do differently?** Have students record their recommendations in step 11 of the activity sheet.

Have students complete steps 12 and 13 of their activity sheets by listing the people that helped them in the experiment and the resources they used in their research.

**Students may suggest other variables that need to be controlled that they hadn’t thought of before. Or they may come up with a better testing procedure. They may also offer ideas for other investigations that could provide more useful data.**

### REINFORCEMENT

Have students feel the spoons to observe that they have become warm.

### SCIENCE JOURNALS

Have students place their completed activity sheets in their science journals.

### CLEANUP

Pour the water from the beakers down the sink. Dry the beakers and return them to the kit. Wash the spoons thoroughly with soap and water.
**Connections**

**Science Challenge**

Have students repeat the experiment, but this time have them use three spoons of the same length but of different materials—metal, plastic, and wood. Guide them to conclude that heat travels easily through some materials but not through others.

**Science Extension**

- Have students repeat the experiment with spoons of different thicknesses. Have them predict and compare the rate of conduction in a thin metal spoon and a thick metal spoon. Have them make a bar graph of their results.

- To model how heat energy moves by conduction, have students sit in rows. Tell all those in the first row to start wiggling their fingers. Have them keep wiggling their fingers. Then have the students in the next row begin wiggling their fingers, and so on until all the students are wiggling their fingers. Explain that the particles in the spoon also wiggle—a very little bit—and that the wiggling increases as the heat moves up the spoon.

- Have students observe the movement of heat energy by convection. Have them cut a spiral out of paper and dangle it over a heat source. The movement of the spiral indicates movement of the air.

**Science and Language Arts**

Ask students to identify the root of the word *conduction*. Have them suggest various meanings for the word *conduct*, including leading an instrumental or vocal group and guiding someone along the way. Then have them write sentences using each of these meanings.

**Science, Technology, and Society**

Explain to students that materials through which heat travels easily are called conductors. Materials through which heat does not easily pass are called insulators. Have students suggest ways that conductors and insulators might be used in everyday life. Have them investigate which materials are used as conductors and which as insulators and where they are used.