

THE HEAT IS ON

BENCHMARKS and TASKS

SC.A.1.2.2 The student knows that common materials (e.g., water) can be changed from one state to another by heating and cooling.

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.1.2.2 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.1.2.6 The student knows ways that heat can move from one object to another.

- The student demonstrates that heating and cooling cause changes in the properties of materials and that many kinds of changes occur faster under hotter conditions.
- 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

How does heat energy travel?

BACKGROUND INFORMATION

Heat is the name given to the **energy** that is transferred from one object to another by virtue of a difference in their temperatures. Whenever two samples of matter having different temperatures come into contact, energy is transferred from the one of higher temperature to the one of lower temperature until both have the same temperature.

The flow of heat through a substance from areas of higher temperature to areas of lower temperature is called conduction. Conduction can be explained by the **kinetic energy** of **atoms** within the material. Heat causes the atoms to vibrate more rapidly. These atoms vibrate against nearby atoms, which do the same until the kinetic energy moves throughout the object. The faster the atoms vibrate, the warmer the object becomes.

Metals, such as silver and copper, are best among common metals in conducting heat. A list of common substances in the order of their ability to conduct heat is shown. They are listed from the first, being the most efficient conductor of heat, to the last, being the least efficient conductor of heat: copper, gold, iron, glass, brick, water, nylon, wood (oak), concrete, wool, air.

MATERIALS

Per group

2 cans the same height

clock or timer

2 sheets of heavy-duty aluminum foil
(about 24 cm x 30 cm each)

1 piece of foil to wrap around the candle

1 votive candle

10 chocolate chips

paper towels

matches

toothpicks

water (for fire extinguisher)

Per student

The Heat is On activity sheet
safety goggles

Teacher

Graham Crackers
Hershey Bar
marshmallows

TEACHING TIPS

1. **Ask for parents or other adult volunteers to help supervise groups while they are using open flames.**
2. All loose clothing and hair should be secured, and students should wear safety goggles.
3. Water should be available.

ENGAGE

Hold up some Graham Crackers, marshmallows, and Hershey chocolate squares. Ask: *How is heat energy related to these three foods?* Those students who have eaten S'mores will, at this point, want to tell you that they have done so. Tell students you will be returning to the question after the activity. (Heat radiated from the campfire to a marshmallow held above it on a stick. The hot marshmallow was placed on a chocolate square that was on a Graham Cracker square. Through conduction, the chocolate was heated and melted.)

EXPLORE

1. Distribute student materials.
2. Have students put on their safety goggles and make sure all loose clothing and hair have been secured.
3. Students should fold one piece of foil in half four times. They should bend the ends of the foil down about 2 centimeters and hook the ends over the tops of the two cans to create a bridge.
4. Next, students should evenly place five chocolate chips along the foil bridge.
5. Students should wrap foil around the candle to create a cylinder.
6. Place the candle in the center under the bridge.
7. Have students refer to the activity sheet, Trial #1. They should predict the order in which they think the chips will melt.
8. Have students number the chips on the diagram to show the predicted melting pattern.
9. Students should predict the total melting time of the chips and write that time on the activity sheet in the space provided. (Total melting time is the time needed for the last chip to start melting.)
10. One student should volunteer to be the timer. That student will watch the clock and call out the time when group members report that the last chip has melted.
11. The adult helper should light the candle while students record the starting time.
12. Have students observe the chips as they melt, paying attention to the order in which they melt and how their physical properties change. They should continue to observe the chips until the last one is melted. (They may need to use a toothpick to gently touch the chips to check for melting.)
13. Students should record the ending time on the activity sheet while the adult safely extinguishes the candle.
14. Have students discard the used foil bridge.

15. Next students will record the actual melting pattern and the actual total melting time on the activity sheet for Trial #1.
16. Have students discuss with their groups how the closeness to the flame affected the chips and write their responses on the activity sheet.
17. Ask students to share some of their responses with the class.
18. Students should use the remaining sheet of foil to fold another bridge, once again evenly placing 5 chips along the bridge.
19. This time, place the candle at the far left under the bridge.
20. Have students refer to the activity sheet, Trial #2. They should predict the order in which they think the chips will melt and number them that way on the activity sheet.
21. They should again predict the total melting time and record it on the activity sheet.
22. The adult helper should light the candle while students record the starting time on the activity sheet.
23. The student timer will need to watch the clock carefully. Group members will observe and call out as each chip melts. The timer will need to report the amount of time that has passed so students can draw a chip on the timeline to show the time it took for each chip to melt.
24. Students will record the actual melting pattern on the activity sheet while the adult helper safely extinguishes the candle.
25. Students should clean up their work areas.

EXPLAIN

What caused the chocolate chips to melt? (heat energy from the candle)

The heat from the candle never touched the chocolate chips, so how did it heat them? (Heat radiated from the candle to the foil. Vibrating atoms bumped other atoms and the heat energy traveled along the foil bridge by means of conduction.)

What melting pattern did you observe when the candle was in the middle? (The chip right above the flame melted first and then the two chips beside the middle one melted, followed by the outer two chips.)

What melting pattern did you observe when the candle was placed to the far left? (The chip under the flame melted first and then the chips melted in order from left to right.)

Why did those melting patterns occur? (Heat energy travels outward from the area closest to the heat source.)

Did the heat energy travel from warm to cool or from cool to warm? (The conduction of heat through a solid will always be from a warmer object to a cooler one, which was the pattern that occurred in both trials.)

EXTEND/APPLY

Have students brainstorm both negative and positive examples of ways heat is conducted through materials in their daily lives (e.g., hot pavement burns bare feet; hot chocolate heats the sides of a ceramic mug and they can't hold it; items in the oven require a pot holder in order to be lifted off oven racks; a heating pad warms and soothes sore muscles).

ASSESSMENT

How does heat energy enable us to enjoy S'mores? (Heat radiates from a campfire to a marshmallow held above it on a stick. The hot marshmallow is placed on a chocolate square that is lying on a Graham Cracker. Through conduction, the chocolate is heated and melted.)

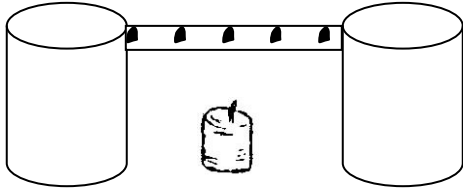
Name _____

THE HEAT IS ON

Trial #1

Number the chips to show the melting pattern.

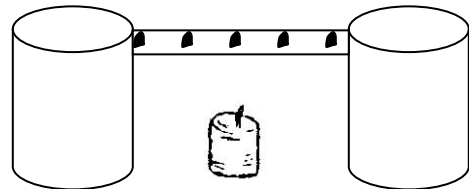
Predicted Melting Pattern



Predicted total melting time: _____

Starting time: _____

Actual Melting Pattern



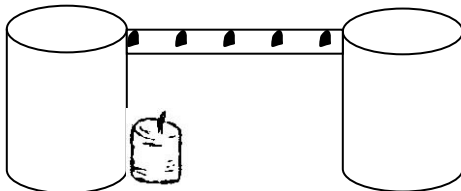
Actual total melting time: _____

Ending time: _____

Trial #2

Number the chips to show the melting pattern.

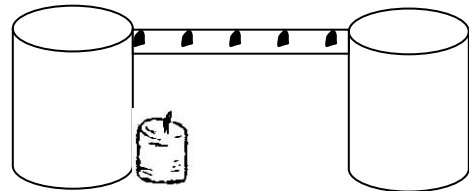
Predicted Melting Pattern



Predicted total melting time: _____

Starting time: _____

Actual Melting Pattern



Actual total melting time: _____

Ending time: _____

Draw chips on the timeline to show when each started to melt in Trial #2.

Melting Time in Minutes

