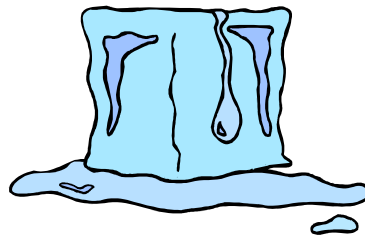


GET A RISE OUT OF HEAT



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

- The student recognizes that energy comes in many different forms: (e.g., **mechanical**, energy of position and motion; **electrical**, energy of moving electrons; **chemical**, energy stored in chemical bonds; **thermal**, heat energy - the energy of moving and vibrating molecules; **nuclear**, energy contained in the nuclei of atoms; and **radiant**, energy that travels in waves like sunlight).
- 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 experiences that heat energy moves from one place to another in three different ways: radiation, convection, and conduction.

KEY QUESTION

How does temperature affect the speed of molecules?

BACKGROUND INFORMATION

Convection is the transfer of **heat** (thermal **energy**) in a fluid through currents. The fluid can be any substance that flows—**liquids** such as water, coffee, molasses, and even **gases**, such as air. An example of convection in a liquid would be a pot of coffee heating. Fluid right above the heat source rises, spreads out, then cools, sinks and is heated again in a continuous cycle. This continuous cycling of a fluid is called a convection current.

On the earth, parts near the **equator** receive more direct rays of sunlight than do parts of the earth near the poles. The sunlight is concentrated, and therefore warms the earth more near the equator than it does farther north or south. This uneven heating sets up convection currents in the **atmosphere**.

MATERIALS

Per group

red food coloring in a dropper bottle
1 cup of ice water
1 cup of hot water
1 baby food jar
1 rubber band
1 blue ice cube
1 plastic 6-liter container of water
1 piece of aluminum foil
2 identical jars – one filled with ice water and one filled with hot water, colored red
1 index card

Per student

science journal

Teacher

hot water or hot plate for heating water
cooler for ice

TEACHING TIPS

1. Ahead of time, freeze blue-colored water in an ice tray to make blue ice cubes.
2. Fill the 6-liter containers with water (to within 2-3 inches of the top). Allow the water to stand that it is at room temperature for the activity.

ENGAGE

1. Have ten students come to the front of the room and simulate water molecules in a solid (ice). They should jiggle in place.
2. Then have them simulate cool water. (They move a little more freely now.)
3. Next, have them simulate hot water. (They move very freely now.)
4. Distribute materials. Have each group prepare two cups of water: pour cold water into a cup with ice and pour hot water into the second cup. While students are thinking about the simulation, ask them to predict what will happen when a drop of food coloring is dropped into the cup of ice water and another drop is dropped into the cup of hot water.
5. Students should observe while one member of the group adds the drops to the cups.
6. Ask: *How did the food coloring react in the different temperatures of water? Why do you think so?*

EXPLORE (Part 1)

1. Using two identical jars, have students fill one with very cold water (drained from ice water) and the other with hot water, colored red. (Baby food jars work well.)
2. Next, they should place an index card over the jar of cold water and turn it over on top of the jar of warm water, matching the mouths of the jars on either side of the card.



3. Ask students to predict what will happen when the index card is removed. Have one student carefully pull the card out while another student keeps the mouths of the two jars aligned.
4. Discuss what happened.

EXPLAIN (Part 1)

Discuss:

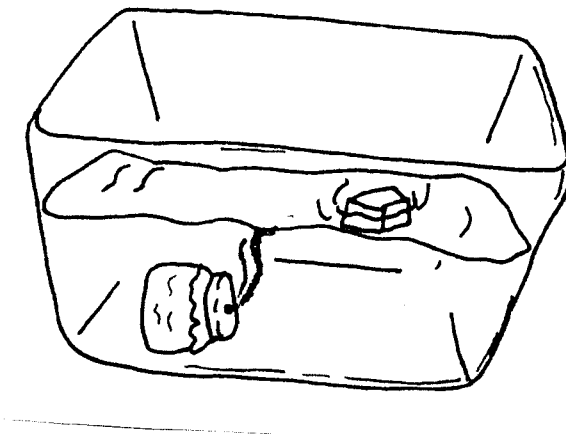
What did you observe?

What made the warm water rise into the cold water? (The cold water sank to the bottom, pushing the red hot water up toward the top.)

After seeing this, what do you think happens to the hot water at the bottom of a pan sitting on a hot burner?

EXPLORE (Part 2)

1. Give each group a 6-liter container of water (filled and set aside several hours earlier).
2. Tell each group to fill a small baby food jar with hot water and add three drops of red food coloring. Students should cover the jar opening with aluminum foil and secure it with a rubber band.
3. Have students gently lower the small jar into the 6-liter container (toward one side). The jar should be on its side.
4. Ask students to predict what will happen when they puncture the aluminum foil with a pencil point so the colored hot water can flow out. Discuss their responses before letting them puncture the foil. (As the foil is punctured, a fountain of hot water will be released.)
5. Have students gently place a blue ice cube at the side of the container opposite the jar and observe what happens.



EXPLAIN (Part 2)

What is happening to the red food coloring? (It is rising and beginning to stream toward the ice cube.)

What is causing this to happen? (The cold water around the ice cube sinks to the bottom of the container, setting up a convection current.)

How is this an example of a convection current? (Convection is the transfer of thermal energy in a fluid. The warm water is less dense than the cold water, and the warm water rises and displaces the cold water. The cold water, in turn, sinks. The movement of water that results is called a convection current.)

How do you know the cold water is sinking? (The ice cube is melting, and the blue water is falling to the bottom.)

What does this tell you about cold water? (It is dense and sinks to the bottom.)

What does the blue dye do when it falls to the bottom? (It slowly slides across the bottom of the container.)

What makes this happen? (The cool, blue water pushes against the warm, red water because the warm water is lighter and can be pushed by the cooler, heavier water.)

What is causing the ice cube to stay at its own end of the container? (The warm water current is flowing toward that end.)

EXTEND AND APPLY

Discuss with students how, when uneven heating of the ocean occurs, it results in convection currents, which are the major currents on our globe.

ASSESSMENT

Have students respond to the key question in their journals: *How does temperature affect the speed of molecules?*