Science

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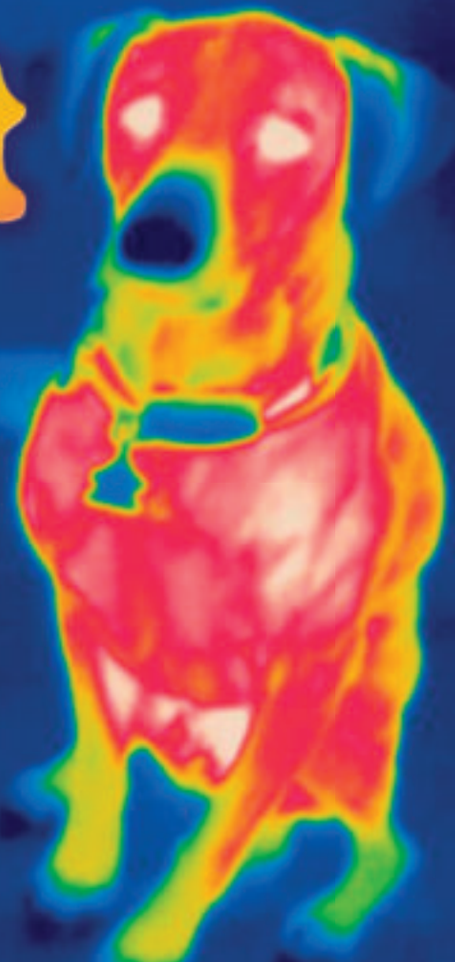
Physical Science

Energy from Heat



by Peggy Bresnick Kendler

Genre	Comprehension Skill	Text Features	Science Content
Nonfiction	Cause and Effect	• Captions • Labels • Diagrams • Glossary	Heat

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Vocabulary

conduction
conductor
convection current
insulator
radiation
thermal energy

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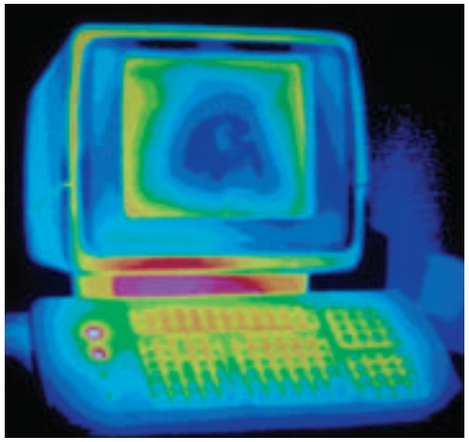
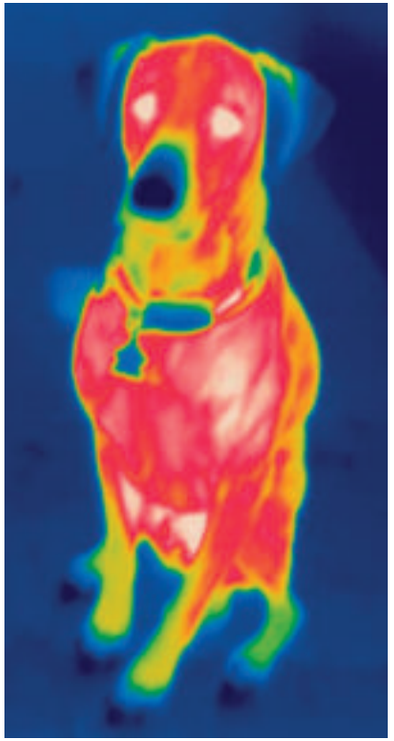
Energy in Matter

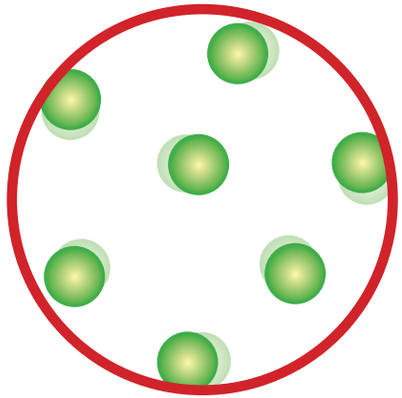
Have you ever rubbed your bare foot back and forth across a carpet? You made heat by using energy! Energy is the ability to bring about change. It is needed for all things to work. In order for something to change in any way, it needs energy. Heat is the total energy of moving particles in matter.

All matter is made up of very small particles. These particles are always moving, even if the object that they make up is not moving.

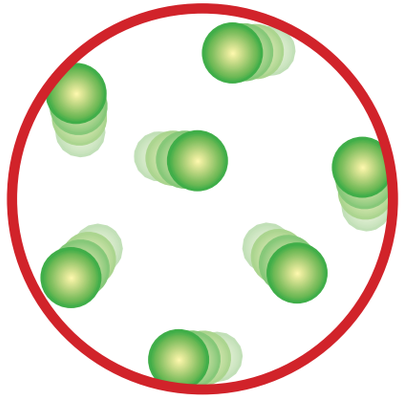




Energy is in all matter. These pictures show heat energy in a computer and a dog. Red and orange areas have more heat energy than green and blue areas.



Particles in a cold liquid do not have enough energy to move quickly.



As the liquid heats up, the particles get the energy they need to move more quickly.

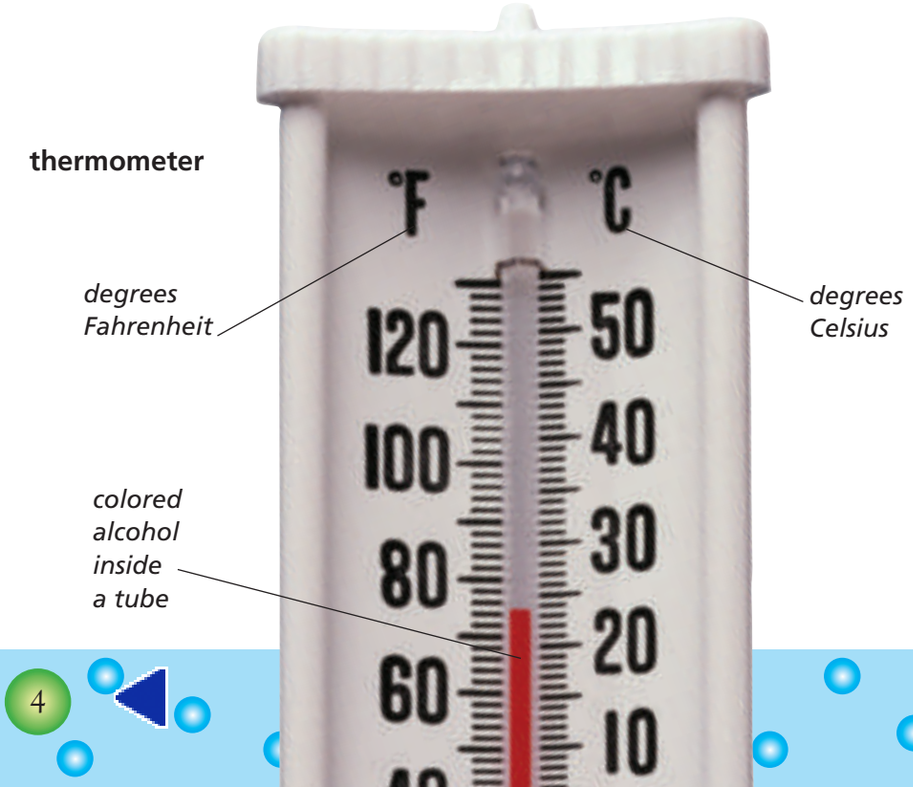
The particles that make up a solid are tightly packed together. They move very little. In liquids the particles are close together and move freely around each other. In gases the particles are spaced very far apart. They move in many different directions.

If you warm an object, you will cause its particles to move faster. Cooling the object will make its particles slow down. It takes energy to make these particles move around. **Thermal energy** is energy caused by matter's moving particles. We feel thermal energy as heat.

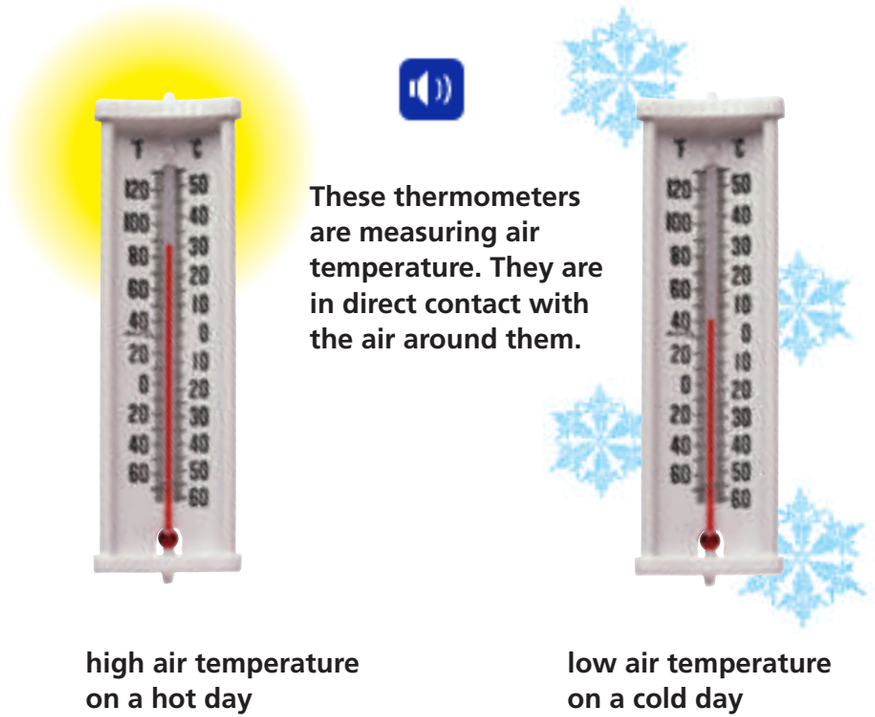
Measuring How Particles Move

Thermometers are used to measure temperature. Many thermometers have a thin glass tube attached to a bulb. The bulb holds colored alcohol. This liquid moves up and down the tube depending on the temperature of what is being measured. There are number lines on the sides of the tube. The line on one side measure degrees Celsius. The line on the other side measure degrees Fahrenheit.

The particles in a thermometer's liquid speed up if the thermometer touches matter with fast-moving particles. The particles in the liquid move apart. This makes the liquid expand and move up the tube. The liquid rises higher on the thermometer's scale. This shows a greater number of degrees.



Suppose the particles in the matter that the thermometer is touching slow down. Then the particles in the thermometer's liquid also slow down. The liquid contracts and reaches a lower number on the thermometer's scale. This shows fewer degrees.



These thermometers are measuring air temperature. They are in direct contact with the air around them.

high air temperature on a hot day

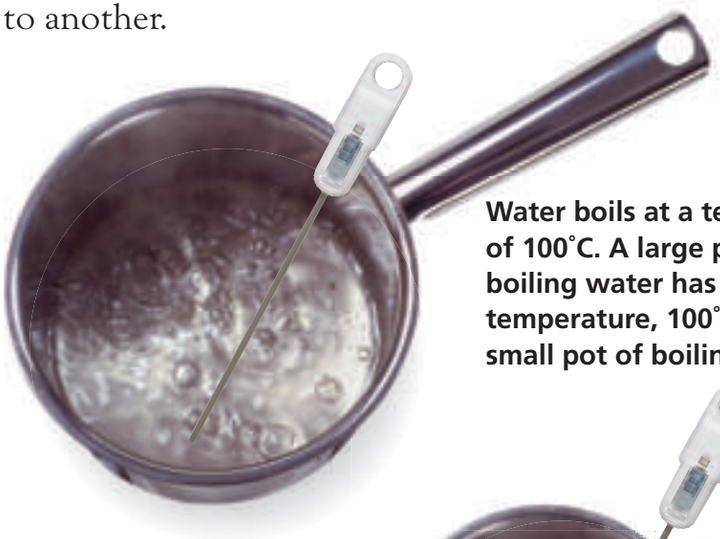
low air temperature on a cold day

A thermometer must touch the material it measures. If it is not in direct contact with what it is measuring, it might measure the movement of the particles incorrectly.

Temperature and Heat

An object's particles move very quickly when its temperature is high. But temperature does not tell you how much heat the object has.

Heat and temperature are not the same thing. Temperature measures the average amount of motion that particles in matter have. It tells the average energy. Thermal energy is the measure of the total energy that the particles have. It tells both how fast the particles move and how many are moving. Heat is the movement of thermal energy from one object to another.



Water boils at a temperature of 100˚C. A large pot of boiling water has the same temperature, 100˚C, as a small pot of boiling water.

The water in the large pot has more thermal energy than the water in the small pot because it has more particles of water.

Ice cubes have less thermal energy than an iceberg because they are smaller.

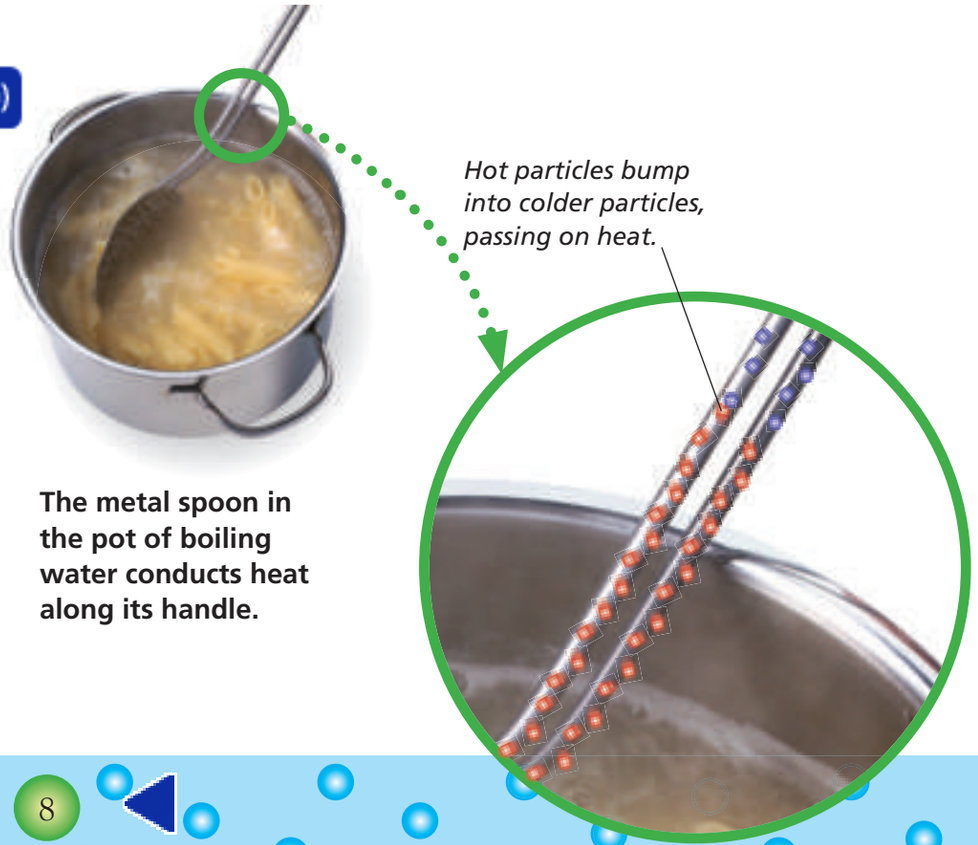
Think about an iceberg and an ice cube. The iceberg contains more water than the ice cube does. Therefore it has more water particles. There is more energy of motion because there are more particles. This means the iceberg has more thermal energy. The temperature of both objects, however, is the same. This is because the water in both objects is frozen. The average amount of motion of the water particles is the same as well. This shows that the size of the ice does not affect temperature.

The Movement of Heat

Thermal energy moves from a warm object to a cool object. The movement of thermal energy between objects with different temperatures is heat. Anything giving off energy that particles of matter can take in is a heat source.

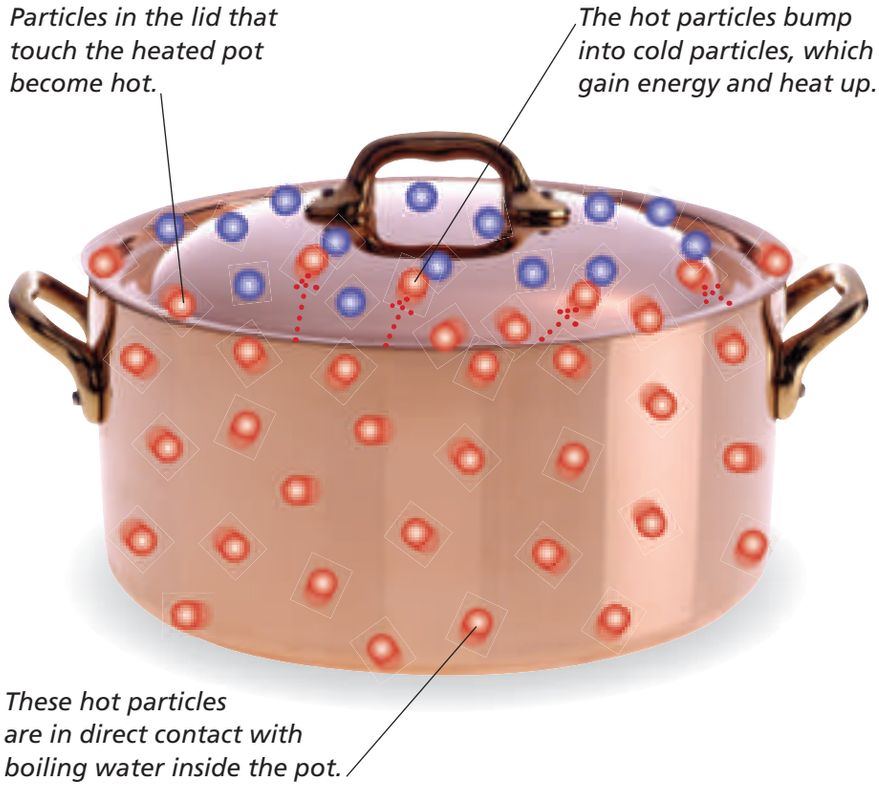
Conduction

Do you remember rubbing your feet on the carpet earlier? You produced heat using mechanical energy. Heat energy moves by conduction when two solids are in direct contact. **Conduction** is the movement of heat energy that takes place when one object touches another.



The metal spoon in the pot of boiling water conducts heat along its handle.

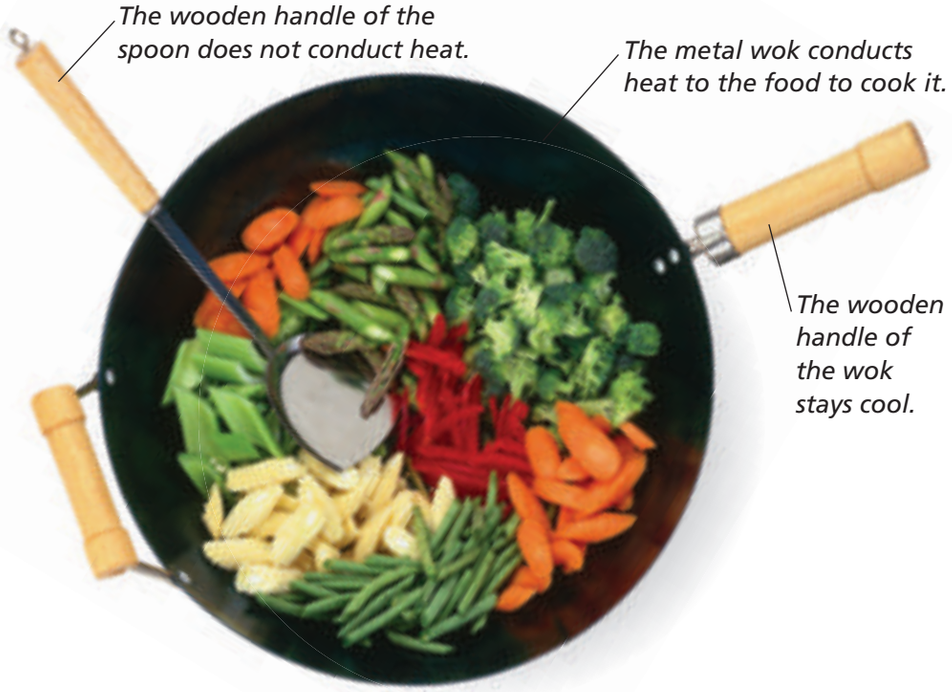
Have you ever put a lid on top of a pot that holds boiling water? Did you notice what happens? The cool lid becomes hot! The particles in the lid that are in direct contact with the heated pot begin to move faster. These fast-moving particles crash into the particles in the parts of the lid that are not touching the heated pot. Heat energy from the pot begins to travel all over the lid. Soon the lid and the pot are the same temperature. The fact that the entire lid is hot tells us this has happened.



Insulators and Conductors

Heat moves through some materials more easily than others. A **conductor** is a material that heat moves through easily. Many metals, such as iron, aluminum, and tin, are good conductors. Heat travels through them very well. If you put a tin tray in the oven, it gets hot quickly.

Wood is not a good conductor. Heat does not travel through it easily. Wood is known as an insulator. An **insulator** is a material that limits how much heat goes through it. Many cooking tools have wooden handles. This is so the handles of the tools are not too hot for a person to touch with bare hands.



Marble was often used in ancient times to create buildings and monuments. Marble is strong and looks beautiful. It can survive fires and erosion with little damage. Marble is an insulator. This makes it a very good material for buildings. It can keep buildings warm or cool.

Plastic is another insulator. But it does not work alone in keeping its temperature. Plastic usually has many little air pockets. Air is an insulator as well. Together the plastic and air that make up a container help food and drinks keep their temperature, while the container's temperature does not change.

ancient Greek temple made of marble

These refrigerated mushrooms will stay cool, insulated by the plastic container and the air inside it.

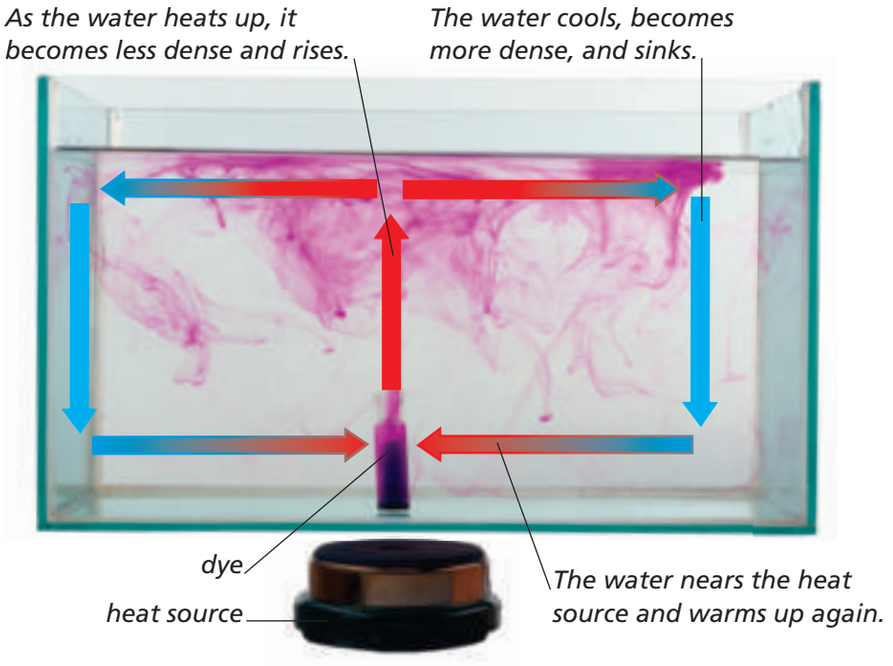
Convection

Radiators can heat the air. Convection moves the warm air from the radiator throughout the room. Convection is a process in which a fluid moves from place to place. A fluid is a substance that flows but has no definite shape. Air and water are fluids.

A **convection current** is a pattern of flowing heat energy. Hot air rising and cool air falling is a convection current. Warm air from the ground expands and rises up toward the sky. At the same time, cold air sinks, causing a convection current. This cool air then becomes warm and is forced upward. The pattern continues in this way. Boiling water in a pot is another example of a convection current.

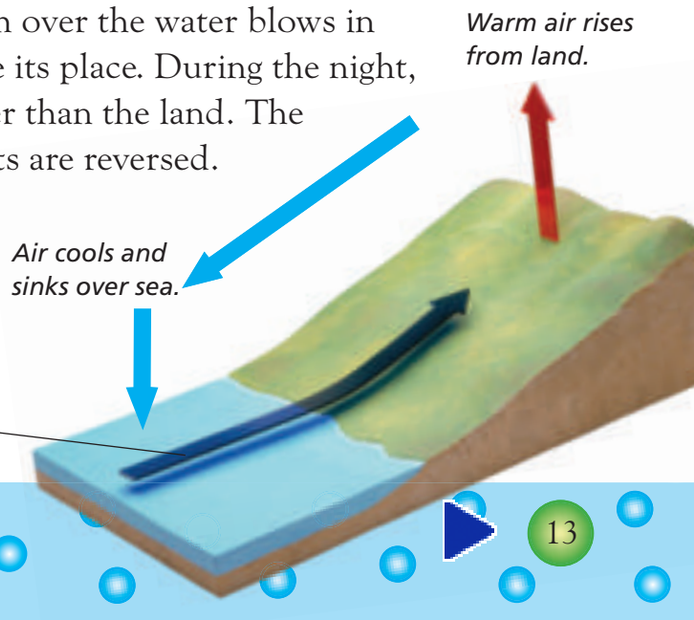
Look at the tank of water on the next page. The dye allows us to see the convection current. The heat source warms the water, which mixes with the dye. The warm water rises because it is less dense than cold water. As it moves away from the heat source, it cools and sinks to the bottom of the tank. It then moves back toward the heat source. This will make it rise again.

A convection current causes a pot of water to boil.



The dye in the water shows how the convection current moves.

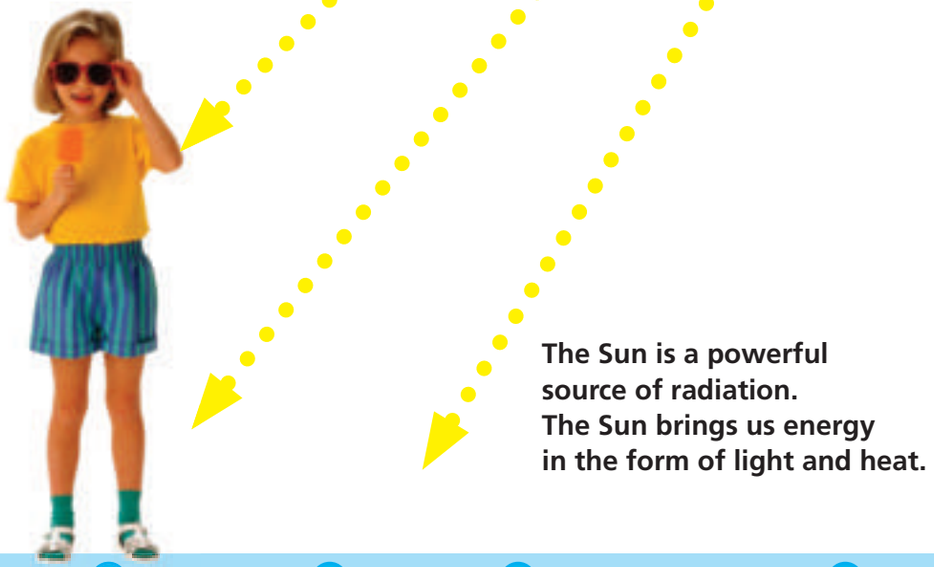
Large convection currents shape our weather. During the day, air over the land is heated and rises. Cool air from over the water blows in underneath to take its place. During the night, the water is warmer than the land. The convection currents are reversed.



Radiation

Radiation is energy that is sent out in waves. This method does not need the heat source and heated object to be touching in any way. It does not rely on currents. Radiation travels in a straight line from a source to an object. It can move through air, glass, and even empty space. An object on the other side of a window can still receive heat from radiation.

Some objects that give off light also give off heat. The best example is the Sun, which sends out vast amounts of both light and heat. This heat energy moves from the Sun to Earth by radiation. Radiation, like all thermal energy, moves from warm areas to cool areas.



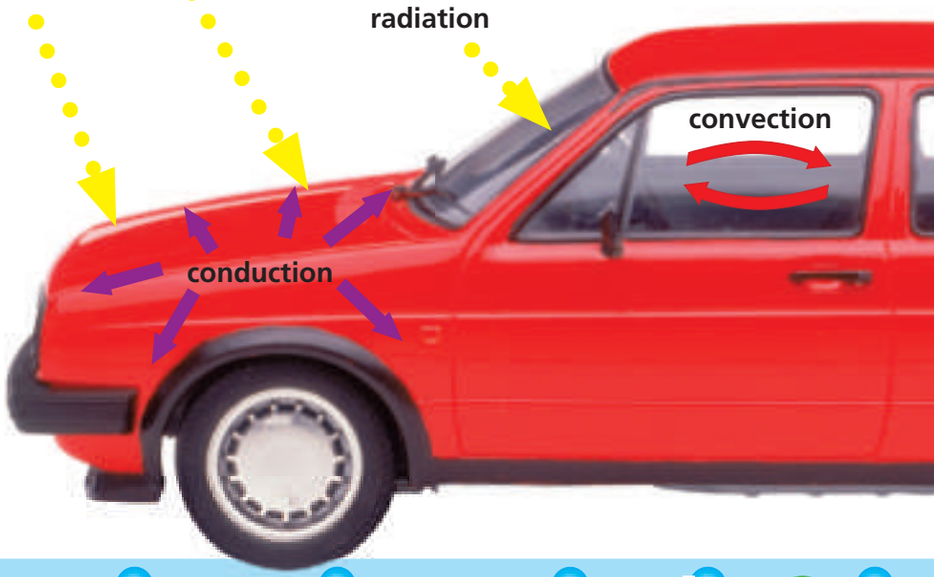
The Sun is a powerful source of radiation. The Sun brings us energy in the form of light and heat.

Conduction, Convection, And Radiation

Suppose a car has been outside on a sunny day. You might be able to see all three kinds of heat transfer at work!

Radiation from the Sun heats the car's roof and hood. If you touch the roof or the hood, the heat passes to you by conduction. Heat also passes through the glass of the windows and windshield to the inside of the car by radiation. If you were inside the car, you might notice that the air near the ceiling would be very warm, while the air near the floor would be cooler. This happens because of convection.

You have learned how different objects and materials become warm. Now you know that heat is the movement of thermal energy. Thermal energy is always on the move all around you!



Glossary

conduction	the movement of heat energy that takes place when one object touches another
conductor	a material that heat moves through easily
convection current	a pattern of flowing heat energy
insulator	a material that limits how much heat goes through it
radiation	energy sent out in waves that can heat an object without touching it
thermal energy	energy caused by matter's moving particles

What did you learn?

1. Describe the difference between heat and temperature.

2. How is radiation different from conduction and convection?

3. Look at some objects in your classroom. Which ones would be good conductors? Which ones would be good insulators?

4. **Writing** in Science Warm air and cool air can form a convection current. Explain how this happens. Use details from the book to support your answer.

5. **Cause and Effect** What causes a metal spoon to become hot in a pot of boiling water?