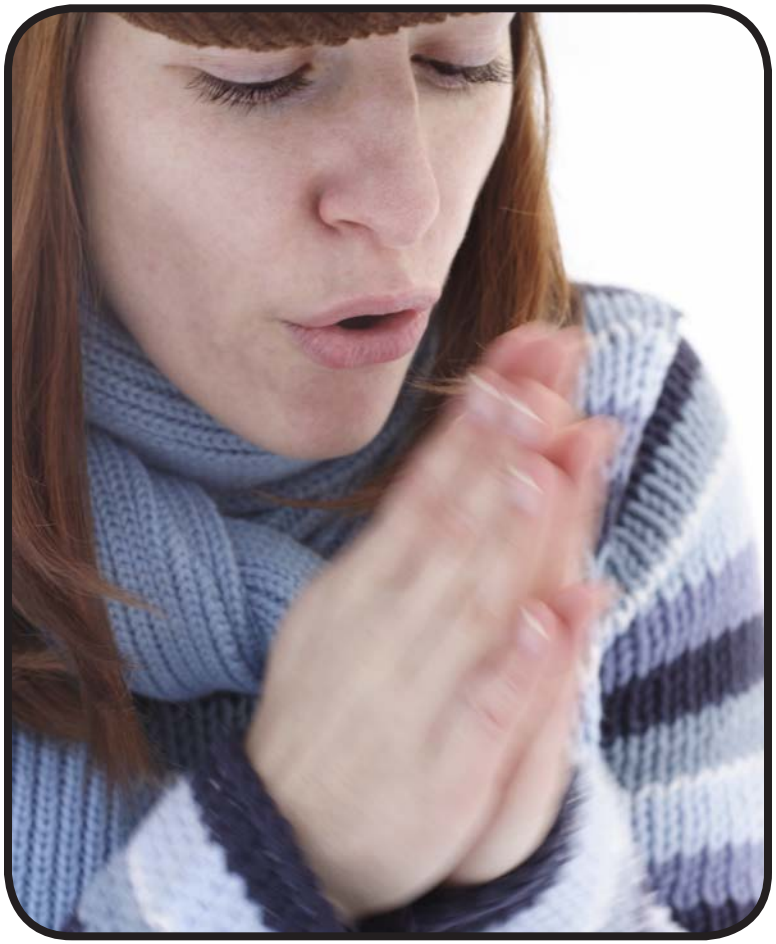
Heat Energy

A Science A–Z Physical Series

Word Count: 1,585



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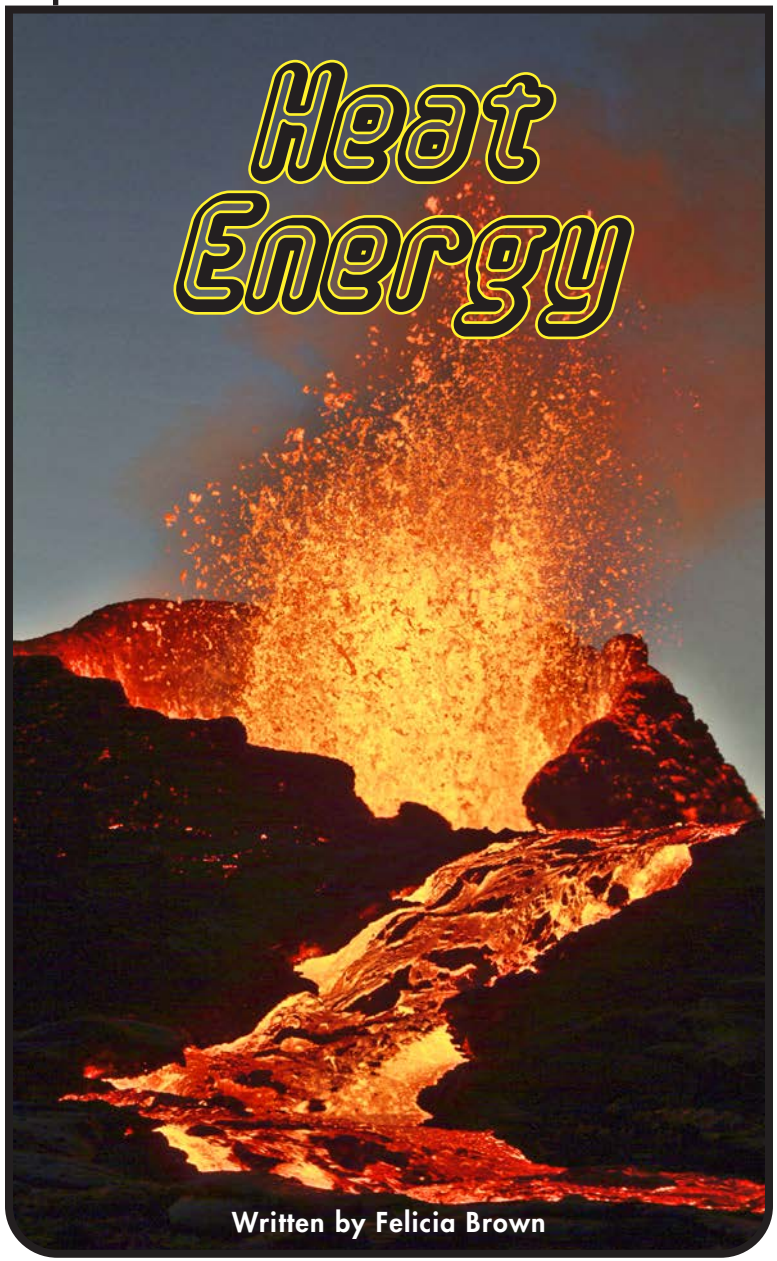

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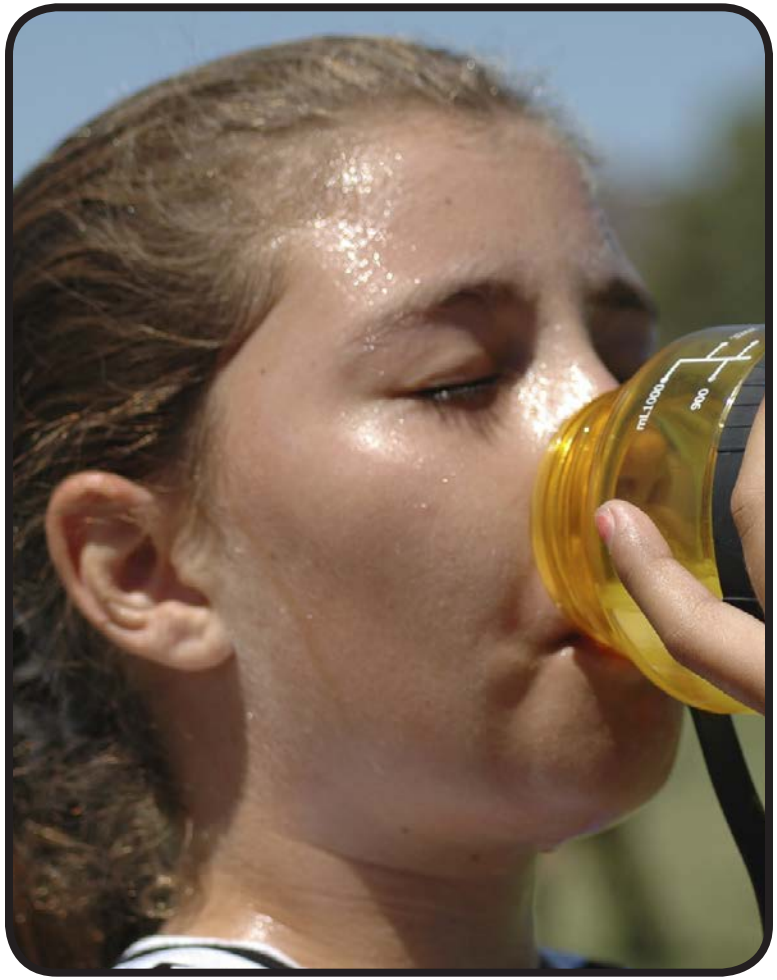

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KEY ELEMENTS USED IN THIS BOOK

The Big Idea: One of the most important types of energy on Earth is heat energy. A great deal of heat energy comes from the Sun's light hitting Earth. Other sources include geothermal energy, friction, and even living things. Heat energy is the driving force behind everything we do. This energy gives us the ability to run, dance, sing, and play. We also use heat energy to warm our homes, cook our food, power our vehicles, and create electricity.

Key words: cold, conduction, conductor, convection, energy, evaporate, fire, friction, fuel, gas, geothermal heat, geyser, heat energy, hot, insulation, insulator, lightning, liquid, matter, particles, radiate, radiant energy, solid, Sun, temperature, thermometer, transfer, volcano

Key comprehension skills: Cause and effect
Other suitable comprehension skills: Compare and contrast; classify information; main idea and details; identify facts; elements of a genre; interpret graphs, charts, and diagrams

Key reading strategy: Connect to prior knowledge
Other suitable reading strategies: Ask and answer questions; summarize; visualize; using a table of contents and headings; using a glossary and bold terms

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Heat energy cooks these marshmallows.

Introduction

Whether we stand next to a blazing bonfire, step barefoot across a sun-baked parking lot, or watch a pot of soup boil or an ice cube melt, we are experiencing the effects of **heat energy**. There are many kinds of energy in addition to heat energy. Sound energy and electrical energy are two kinds. Light energy and chemical energy are two others. But heat energy is one form of energy we experience every moment of our lives. We use it to warm our bodies, cook our food, heat our houses, dry our clothes, and run our cars.

In this book, you will learn about heat energy. You'll learn how it is produced, used, and measured, as well as how it moves from place to place.

Sources of Heat Energy

You know that heat is useful. But did you ever take time to think about all the sources of heat energy?

One of the easiest ways to produce heat is to rub your hands together very fast. The rubbing of two objects together produces **friction**. Rubbing rough objects together usually produces more friction than rubbing smooth objects together. More friction produces more heat.

Rubbing your hands and wearing warm clothing help keep you warm.

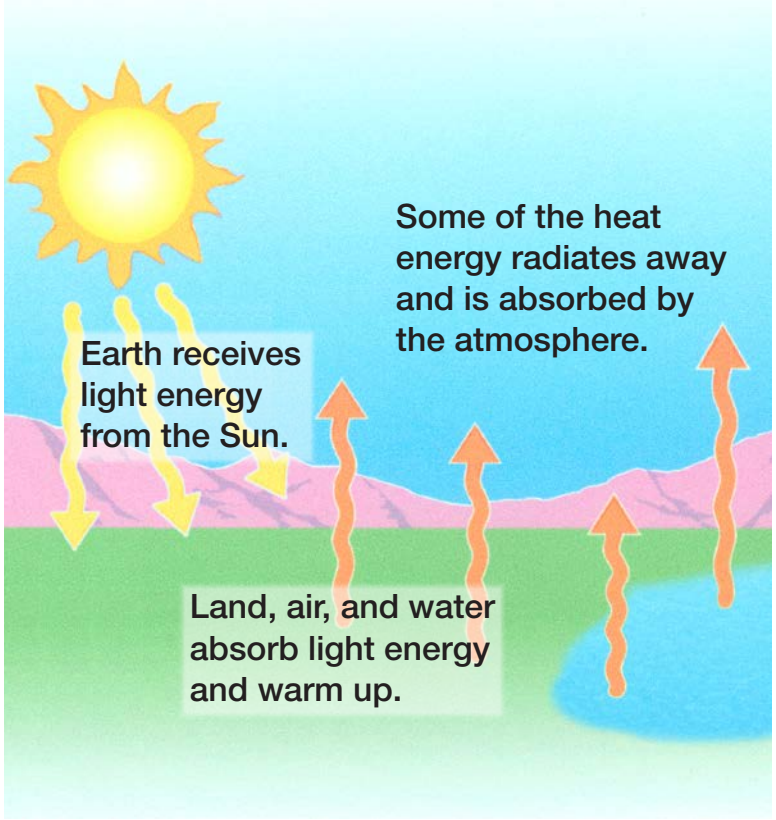
Fuel makes cars run and makes the electricity we use every day.

One of the most common sources of heat is **fuel**. When fuels such as coal, gasoline, and wood burn, they make heat energy. A forest of trees produces huge amounts of heat energy when it burns during a forest fire. Heat from burning gasoline makes cars and trucks run.

Electricity is another source of heat energy. Electric furnaces heat our homes and schools. Toasters, irons, and hair dryers are just a few other things that use electricity to produce heat.

There are also natural sources of heat energy. For example, lightning is a natural form of heat (and light) energy. It produces tremendous amounts of heat, which makes air expand very fast. This expanding air causes thunder. And did you know that Earth has its own heat buried deep underground, called **geothermal heat**? It's so hot under Earth's crust that rocks melt. Sometimes the molten rock erupts on the surface from a volcano. In other places, the molten rock stays underground and heats water trapped there. The heated water later shoots out of the ground as a **geyser**.

Nature can melt rocks, heat water underground, and make gorgeous displays of heat energy.



Our most important source of heat is the Sun. Have you ever stepped from the shade into sunlight and felt warmer? You may think that heat travels from the Sun to Earth, but it doesn't. Sunlight is **radiant energy**. Radiant energy travels to Earth in waves of tiny particles. When sunlight hits your skin or other things on Earth, it gets absorbed. Then it turns into heat. Your microwave uses another kind of radiant energy to cook your food.

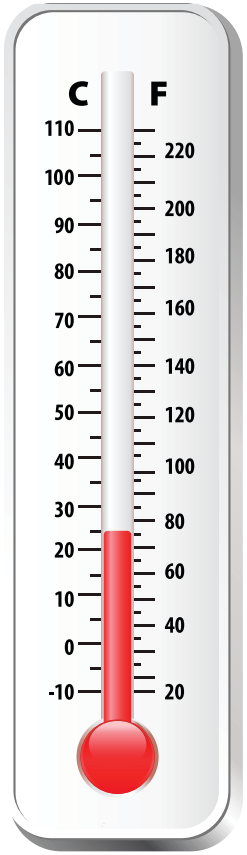
An important rule about heat energy is that it always moves from a warmer place to a cooler place. For example, Earth absorbs the Sun's radiant energy, which turns to heat. The heat in Earth's surface moves to the cooler air above it. That's what keeps our planet warm enough to live on.

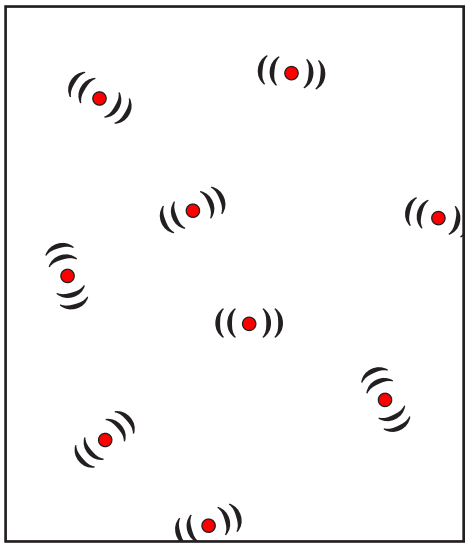
Do You Know?

Dark surfaces absorb the Sun's energy better than light-colored surfaces. The more of the Sun's energy an object absorbs, the more heat it can **radiate**, or give off. This explains why darker surfaces feel warmer than lighter surfaces.

Temperature

All **matter**—everything that has weight and takes up space—is made of particles too tiny to see. These particles are always moving a minuscule amount. The speed at which these particles move is affected by the amount of heat energy of an object. (All objects have heat energy.) An object with less heat energy has particles that move slowly, and an object with more heat energy has particles that move more quickly.



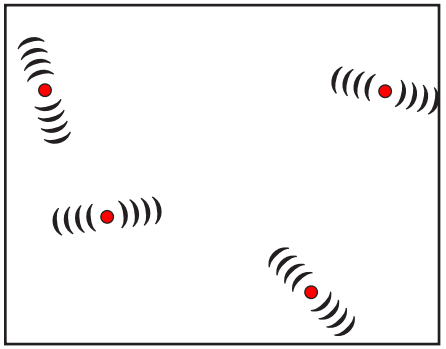


The heat energy of each particle affects how fast it moves.

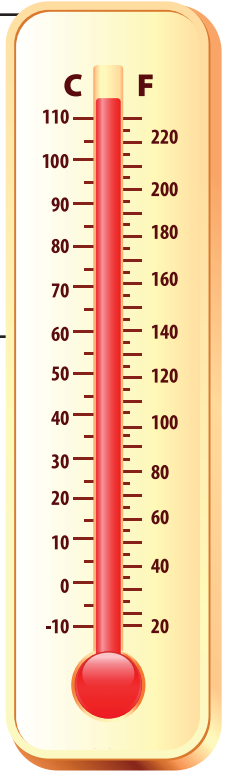
We use **temperature** to know how much heat energy things have. The less heat energy an object has, the more slowly its particles move and the colder its temperature. The more heat energy an object has, the faster its particles move and the hotter its temperature. We use a **thermometer** to measure temperature. Temperature is measured in degrees (°) according to either the Celsius (C) or Fahrenheit (F) scale.

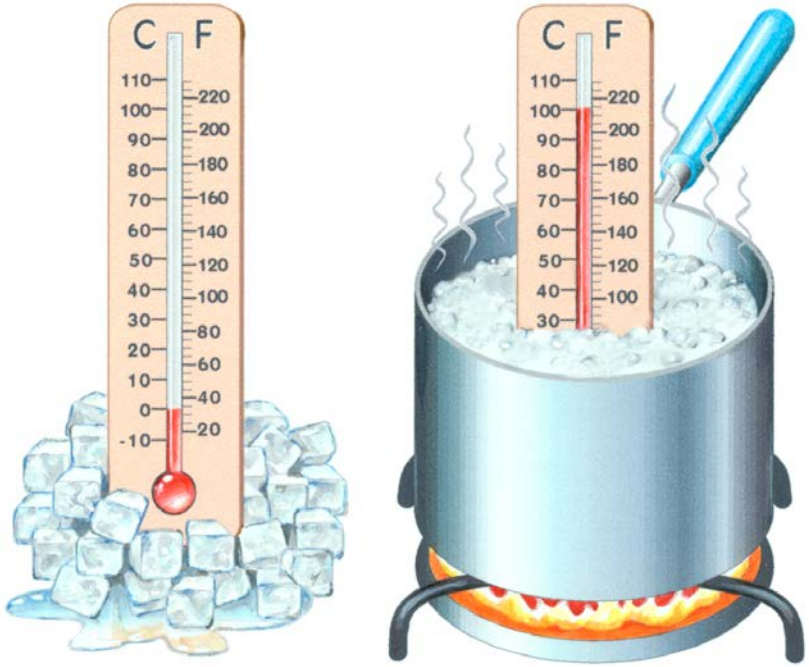
Word Wise

Thermometer comes from two words: *thermo*, which means "heat," and *meter*, which means "an object used to measure." So a thermometer is an object used to measure how hot something is.



When particles have more heat, they move faster.





Water freezes at 0°C (32°F), and it boils at 100°C (212°F). A thermometer can tell you how hot or cold the water is.

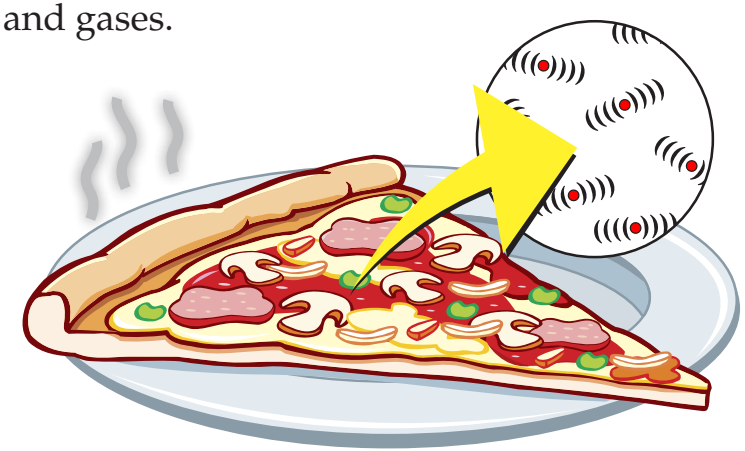
For example, let's look at water. If you add heat energy to water, its particles move faster. Boiling water churns because heat energy makes the water particles move very fast. Boiling water has a temperature of 100°C (212°F).

Then think about ice, which is frozen water. When enough heat energy is lost from liquid water, its particles slow way down, making solid ice. Water freezes when the temperature drops to 0°C (32°F).

Heat Moves Through Things

You know that the temperature of an object can change. Heat doesn't stay in one place—it moves through things. Water that boils at 100°C (212°F) will freeze solid if you leave it in the freezer long enough. And if you leave an ice cube out on a plate, it will melt. Other objects change temperature, too. Pizza that's hot from the oven will get cold over time. The water and pizza both change temperature because heat energy moves through them.

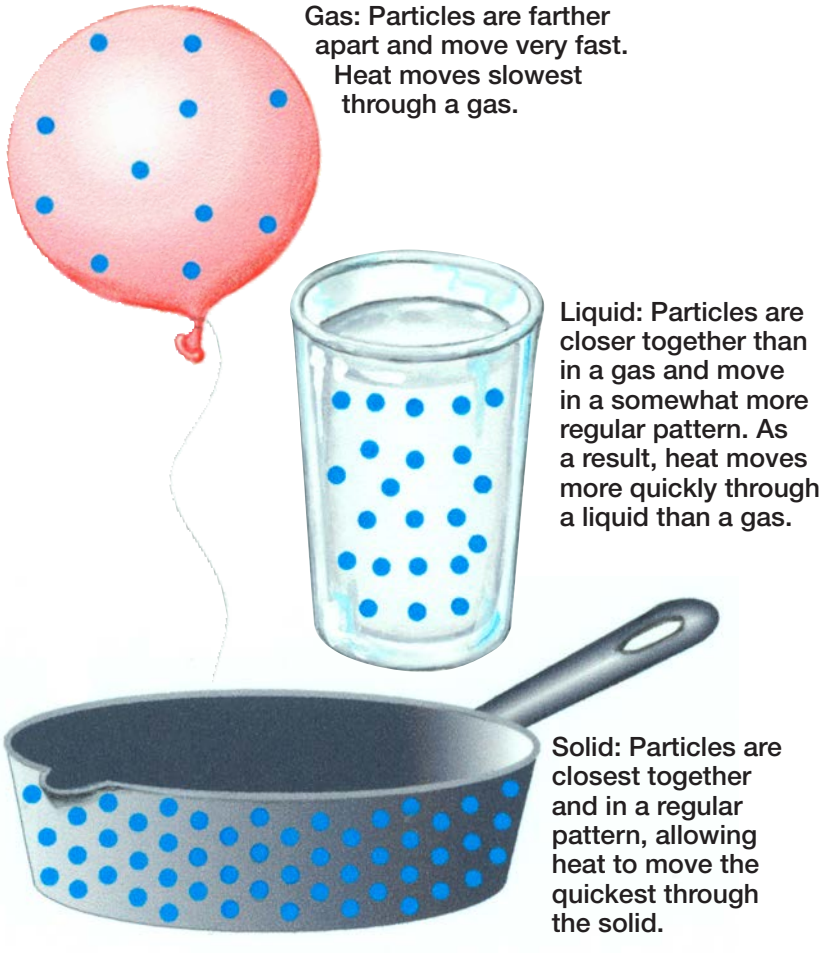
Heat energy moves through solids (such as ice and pizza) as well as liquids and gases (such as water and air). But it moves differently through solids than it moves through liquids and gases.

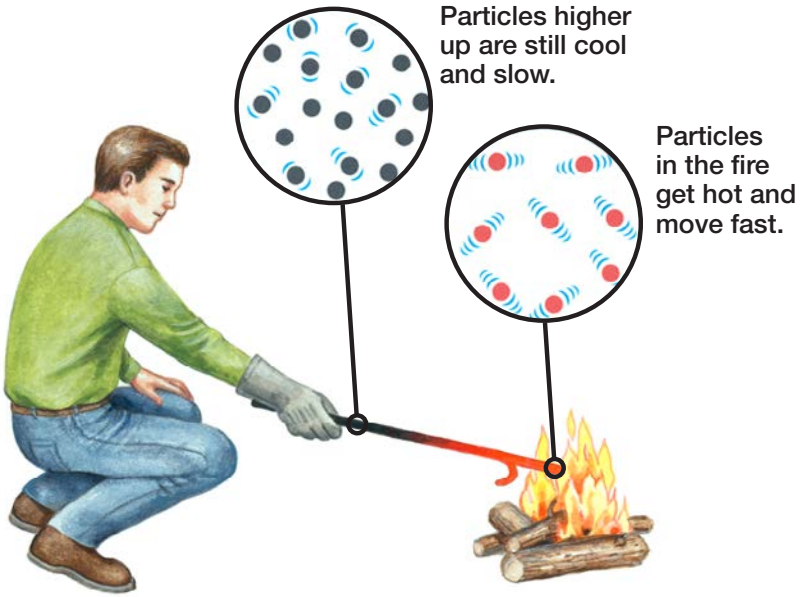


Heat moves through particles in pizza, making them move fast. Then heat moves to the air, causing the pizza to cool down.

Conduction

Heat moves most easily through solids. This is because the particles in solids are closer together than the particles in gases or liquids. Heat can quickly **transfer** from one particle to another when they are close together. Heat moves through solids by **conduction**.





Look at the picture of the man holding a metal rod. The particles in the rod that are in the fire are gaining heat energy. As they gain energy, they move faster and bump into particles next to them. Those particles begin to move, too, and bump into more particles, transferring heat energy to them. In this way, heat energy moves up the iron rod. The more heat that is added to the rod, the farther up the rod the heat energy moves. In time, the heat energy reaches the end of the rod the man is holding. He feels the rod getting warm. In time, it gets so hot, he cannot hold it. This movement of heat through a solid is *conduction.*


A metal pot is a good conductor.

A good **conductor** is a material that heat can move through easily. Metal is a good conductor. Metal is used to make pots and pans because it conducts heat well, so food cooks faster.

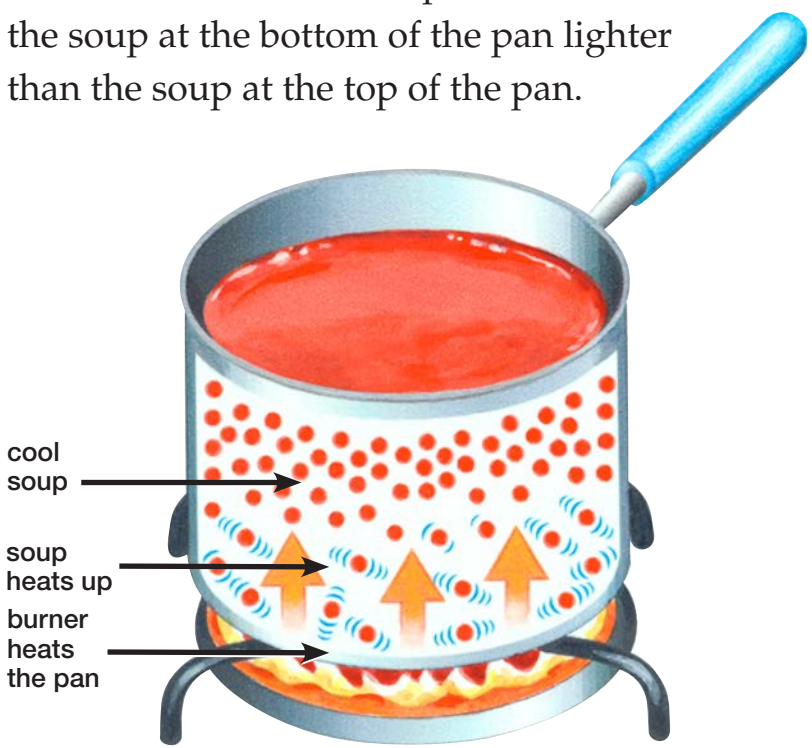
Other solids, such as wood and plastic, are not good conductors. Heat energy does not move as quickly from particle to particle through them. Solids that are poor conductors are called **insulators**. Wood and plastic are used for handles on cooking pans because they do not conduct heat well. They are good insulators.


Insulated cups keep heat in, and oven mitts keep heat out.

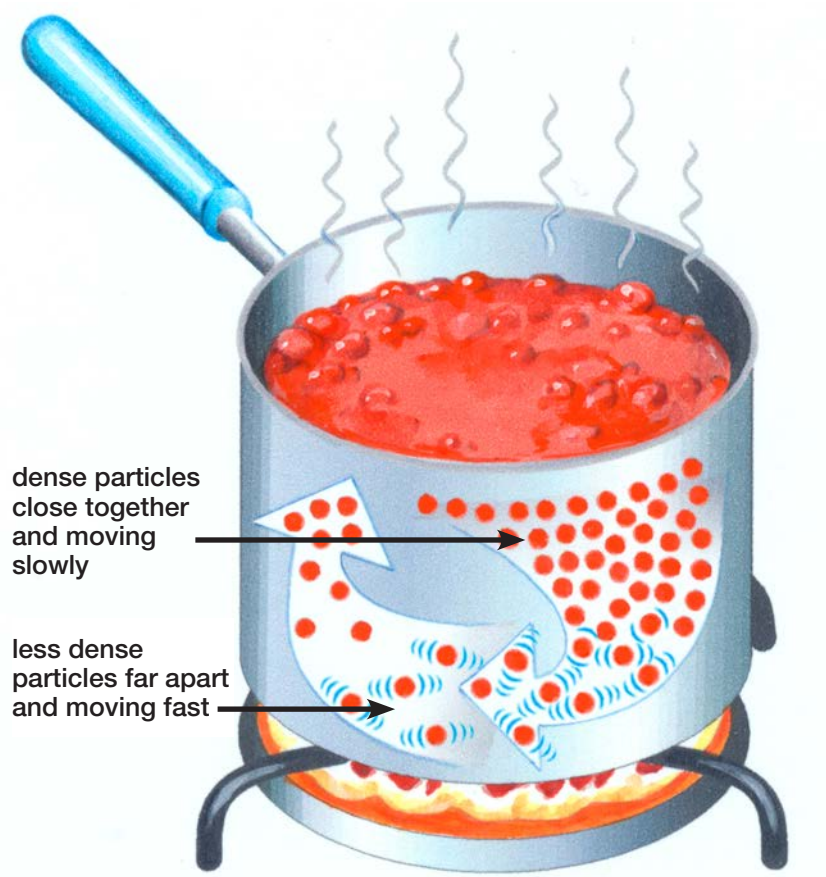
Convection

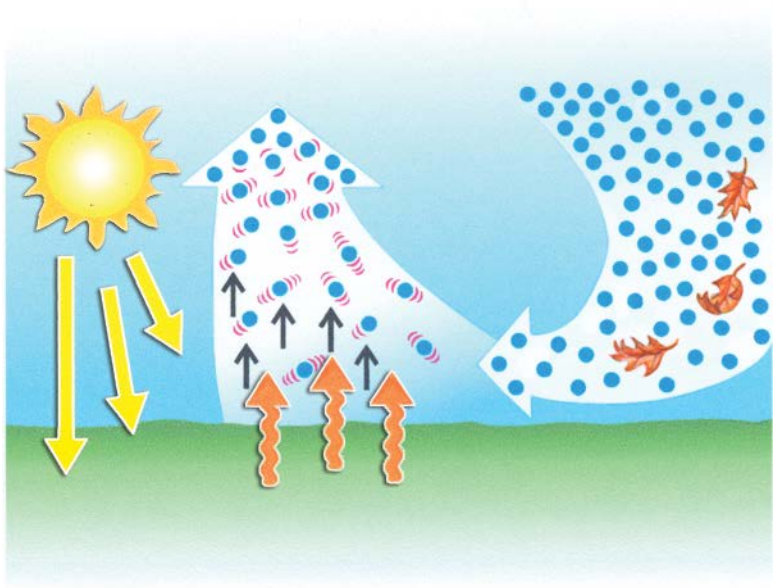
When liquids (such as water) and gases (such as air) absorb heat energy, their particles also move faster. As the particles gain energy and move faster, they also move farther apart. When the particles move farther apart, the liquid or gas becomes lighter.

Let's look at a pot of soup that is being heated. As the soup at the bottom of the pan gets heat energy from the hot pan, the soup particles move faster and farther apart. This makes the soup at the bottom of the pan lighter than the soup at the top of the pan.



The cooler, heavier soup at the top of the pan begins to sink and pushes the lighter, hotter soup to the top. Over time, this heavier, cooler soup absorbs heat energy from the bottom of the pan. Eventually, the once-cool soup gets warmer and lighter than the once-warmed soup at the top, and the soup from the bottom begins to rise again. This rising and sinking causes a pot of hot soup to boil and churn.



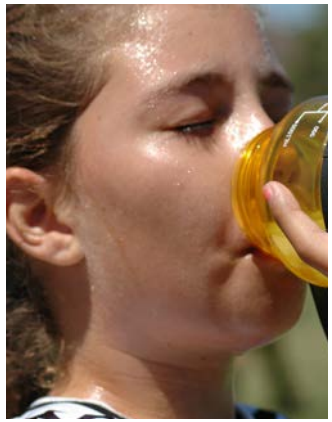


Energy from the Sun turns to heat when it is absorbed by the ground. Then heat from the ground warms the air above the ground. Cooler air from above pushes the warm air up.

The same thing happens when heat moves through a gas, such as air near the ground. As the hot ground warms the air, the warmer air rises. Heavier, cooler air from above sinks and pushes the warmer air up. As the warmer air rises away from the warmer ground, it begins to cool. At the same time, the cooler air that sank toward the ground is getting heated. In this way, cooler air is always sinking and pushing up warmer air. This movement causes wind. The movement of heat energy through liquids and gases is called **convection**.

Heat Energy and You

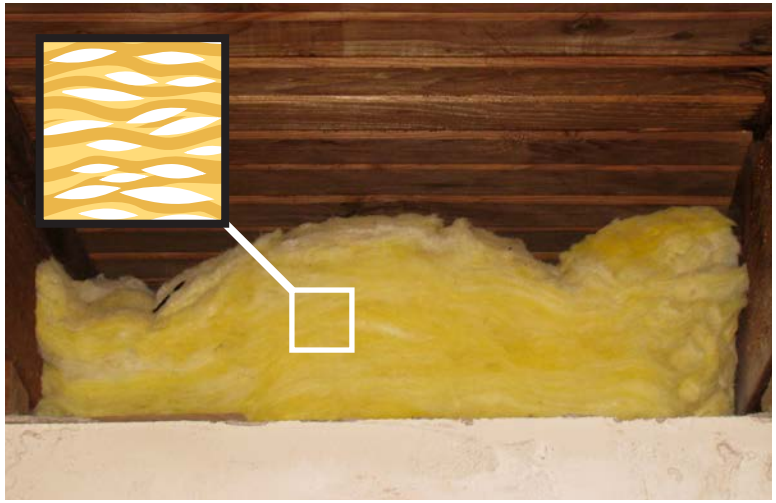
Your body works to keep a constant temperature of 37°C (98.6°F). This temperature helps all your body parts work best. The food you eat is your body's fuel, and some of it gets turned into heat energy. When you get too hot, you sweat.



Sweating is your body's way of losing heat energy.

Clothes keep you warm.

As sweat **evaporates** from your skin, it takes heat from your body and releases it into the air. This lowers the temperature of your skin and leaves your body feeling cooler. To keep heat in, you wear clothing. The thick clothing you wear when it is cold outside is a good insulator. It prevents heat from escaping from your body.

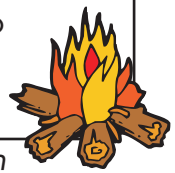


Insulation contains many tiny air pockets. Air is a good insulator.

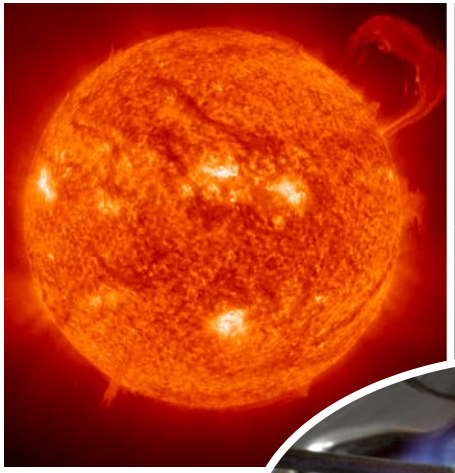
We build shelters to protect ourselves from hot and cold temperatures outside. We use fuel to heat our homes. Putting insulation in the walls and ceilings of our homes keeps heat energy out during hot summers and keeps heat from escaping during cold winters.

Think About It

If you were lost outdoors in the woods with no matches to start a fire and it began to get cold, how would you stay warm?



Answers will vary. Possible answers: Build a shelter from tree branches and brush, rub sticks together to make enough friction to cause them to burn, or pile up leaves and grass, and crawl under them to stay warm.



Whether it comes from lightning, energy from the Sun, or a burner, heat energy behaves the same.

You have learned that heat is one of many kinds of energy. It is an important form of energy that we use every day. You have also learned that heat moves through solids, liquids, and gases by passing from particle to particle. You know it moves from hotter areas to cooler areas. We use temperature to measure how hot or cold something is.

Heat energy has many sources, including fuels, electricity, the Sun, lightning, geysers, and volcanoes. Without heat energy, life on Earth would not exist!

Glossary

conduction the transfer of heat from one object to another (p. 14)

conductor a material, usually a metal, that transfers heat, electricity, or sound from one object to another (p. 16)

convection the transfer of heat by movement in a liquid or gas (p. 19)

evaporate to change from a liquid state to a gas state (p. 20)

friction a force that builds up when two objects rub against each other (p. 5)

fuel any material used to produce heat or power (p. 6)

geothermal heat heat energy from inside Earth in the form of steam or hot water that is sometimes used to produce power (p. 7)

geyser a hot spring that boils from time to time, sending a column of water and steam into the air (p. 7)

heat energy a form of energy that is transferred from an object with a higher temperature to an object with a lower temperature (p. 4)

insulator a material that reduces or prevents the transfer of heat (p. 16)

matter anything that takes up space and has weight (p. 10)

radiant energy energy that travels in waves (p. 8)

radiate to travel outward in every direction (p. 9)

temperature the measure of hot and cold, usually measured on a thermometer (p. 11)

thermometer a tool used for measuring temperature (p. 11)

transfer to move from one place to another (p. 14)

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