

## How Can We Describe Thermal Energy?

Have you ever used a thermometer to measure temperature? You have learned that thermal energy is a form of energy that describes the motion of atoms and molecules. Temperature tells us how fast the particles in matter are moving. High temperatures mean the molecules are moving fast and have a lot of energy. Lower temperatures mean the molecules are moving more slowly and have less energy. The movement of molecules is what makes things feel hot or cold.

Heat is the transfer of thermal energy from one object to another.

Heat flows when an object is warmer than its surroundings. Heat always flows from hotter materials to cooler materials, never the other way. Heat flows until objects and their surroundings have the same temperature.

When you hold your hands around a mug of hot chocolate, your body gets warmed. This happens because heat flows from the hot mug into your skin. Thermal energy is transferred from the cup to your hands. Your body gains energy, and your temperature rises as a result. Energy is lost from the mug, however. Its temperature decreases.

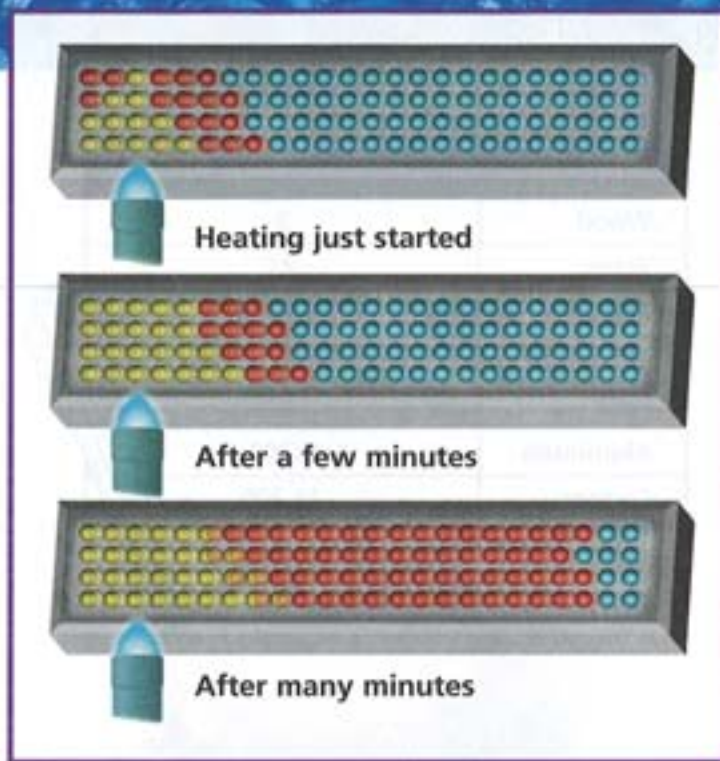
### ▶ How are temperature and heat related?

The Sun is the most important source of heat for life on our planet.



These heating coils in an oven are warmed by an electric current. The space inside the oven is warmed by heat flowing from the hot coils.





## How Does Heat Move?

When heat flows, it can move in three ways—conduction, convection, and radiation. In **conduction** thermal energy flows through objects as their particles vibrate. Conduction, as shown above, is the way your hand is warmed

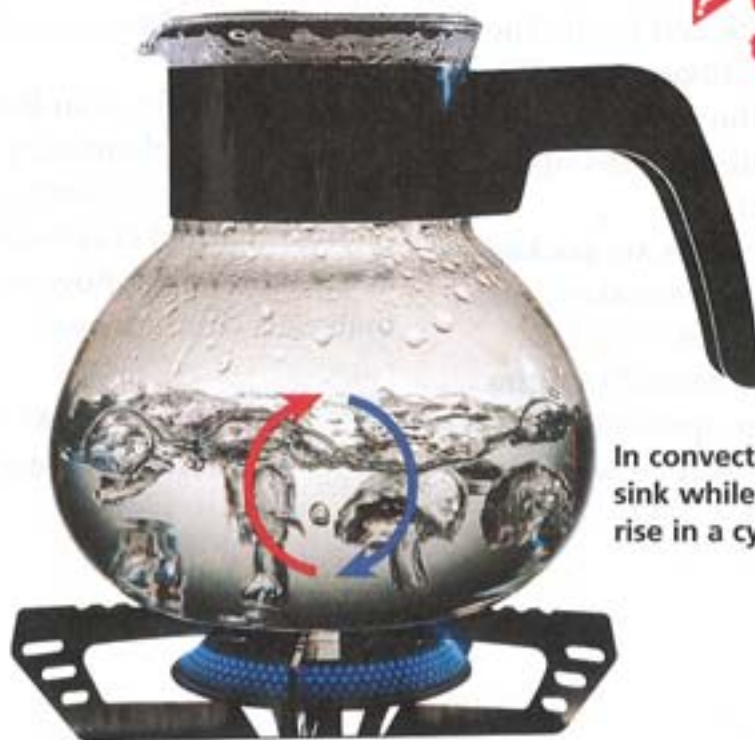
by a mug of hot chocolate. It usually occurs in solids and between objects that are touching.

In **convection** thermal energy is transferred by the movement of matter. Convection occurs in liquids and gases. In convection hot parts of a material rise, while cooler parts sink. There is a flow of material and heat.

A pot of water is heated by convection, for example. As water is heated on a stove, the water near the burner gets hot and rises to the top of the pan. The cooler water near the top then sinks and gets warmed. Thermal energy is transferred by a cycle of rising and sinking matter.

In **radiation** heat is transferred through electromagnetic rays. Matter is not needed at all in this energy transfer. All objects around us give off radiation. Radiation can travel through space. Radiation from the Sun warms Earth, for example.

▶ **What are three ways that heat can move?**



In convection, cooler materials sink while warmer materials rise in a cycle of motion.

## What Materials Conduct Heat Well?

The photograph shows very hot tea in a foam cup. A metal spoon has been sitting in the tea for some time. The outside of the cup is slightly warm. However, the spoon's handle is almost too hot to hold. Why has more heat flowed into the handle of the spoon than into the walls of the cup?

As you learned in Lesson 1, some materials are better at conducting heat than others. The metal spoon is a good conductor of heat. However, the foam cup is a poor conductor of heat. As a result, heat flows quickly from the hot bowl of the spoon to its handle. However, heat flows very slowly from the tea into the foam.

Metals are the best conductors of heat. Why do metals conduct heat so well?

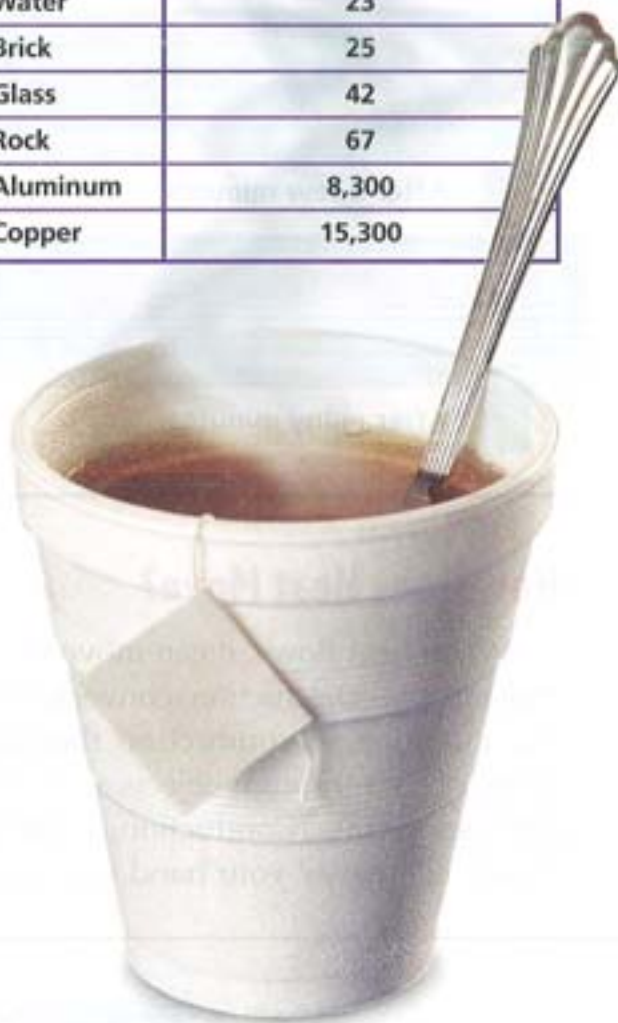
Heat is carried through a material by the motion of molecules. When a metal is heated at one end, the hot molecules vibrate back and forth. They collide with their neighbors, spreading the motion through the material. The spreading of the motion warms up other parts of the material.

The molecules in solids are packed very closely together. This makes transferring energy easier.

In Chapter 10 you learned that the molecules in gases are spread apart. They cannot transfer heat between one

### How Materials Conduct Heat

Material	How Many Times Better Than Air It Conducts Heat
Wood	5
Water	23
Brick	25
Glass	42
Rock	67
Aluminum	8,300
Copper	15,300



another as easily as in liquids and solids. This explains why air is such a poor conductor of heat. Gases are the poorest thermal conductors of all. Look at the table to see how well common materials conduct heat.

**▶ What materials are the best conductors?**