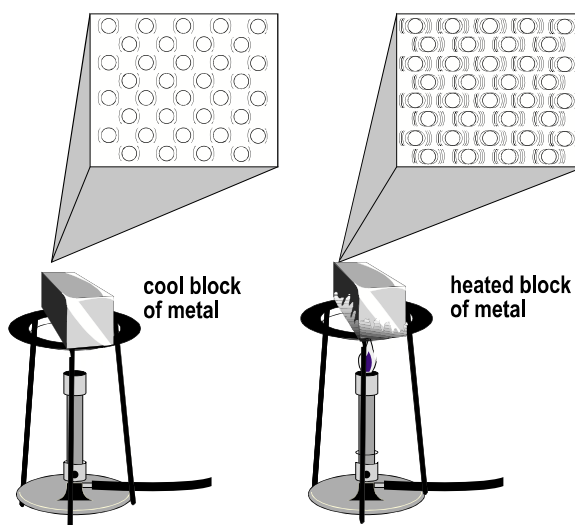


Introduction

When you sit next to a campfire, you notice **heat**. Heat is all around us, and all matter has some heat. In this unit, the properties of heat will be discussed.

What Is Heat?

You have learned that many things produce heat. Chemical reactions give off heat. **Friction** generates heat. Whenever energy changes form, some of it is always lost as heat. Heat is a form of energy. It causes molecules in matter to **vibrate**. We feel this vibration as heat. If the molecules vibrate fast, the object will be hot. As the molecules slow down, the object will become cooler.



From Where Does Heat Come?

Most of the heat on Earth comes from the sun. When the sun's light reaches Earth it produces heat. This heat is needed for life. Heat also comes from burning fuels. Coal and oil give off heat as they burn. Remember that when fuels are burned, this is a chemical change. The heat produced by friction is usually not wanted. This heat can damage machines. Lubrication, as you learned, is to help prevent this heat. Also, you have seen how **radiation** can be used to produce heat.

It is important to remember that every time energy is changed, some of it becomes heat. When we do work, we change forms of energy. These changes of energy are another source of heat. When heat energy enters matter, it causes the molecules or atoms to vibrate. The laws of thermodynamics describe interesting aspects of heat and energy. The **first law of thermodynamics** states that the amount of work done, plus the amount of heat produced, is equal to the energy used; as energy is changed, some of it will become heat. The more we change forms of energy, the more of it becomes heat. This also means that less is available for work. The total amount of energy, though, is still the same.

Heat Affects the Phases of Matter

Heat has some interesting effects on matter. Heat can cause objects to **expand** or get larger. When the molecules in matter vibrate, they move away from one another. This causes the heated matter to become a little larger or expand. When the matter is cooled, it has lost some heat. In cooled matter the molecules move closer together or **contract**. Imagine that a lid is stuck on a jar. How could you remove it? Put the lid under hot water. The lid will expand a little. Now it will be easier to remove the lid. This effect of heat can be a problem. Road surfaces can expand and crack during hot summer days.

A gas will expand as it is heated. Liquids expand as they are heated. As liquids and gases cool, they contract. The movement of the molecules makes matter expand and contract.

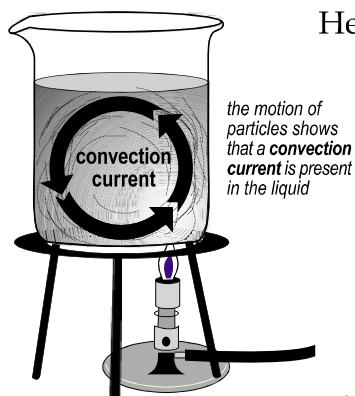
Ice seems like an exception to the idea that as objects cool, they contract. As water cools from around room temperature (25°C), it does contract. Finally, at 4°C , it finishes contracting. Because the water molecules have slowed, they begin to stick. As they stick to each other, they form ice. The ice takes up more volume than the water. The ice is also a different phase of matter than liquid water.



Heat can change the size of matter. It can also change the phase of matter. Heat can turn a liquid into a gas. It can also turn a solid into a liquid.

Movement of Heat

Feel the handle of a spoon resting in a cup of hot coffee. It will feel warm. Why? Heat can travel through solids. The molecules in the solid that are closest to the heat will begin to vibrate. These vibrating molecules push against other molecules close to them. These new molecules begin to vibrate. Soon, most of the molecules will be vibrating. This is the way heat moves through a solid. It is called **conduction**. Objects that heat up easily are called **conductors**. Metals are good conductors of heat. Poor conductors of heat are called **insulators**. Wood, Styrofoam, and plastic are insulators.



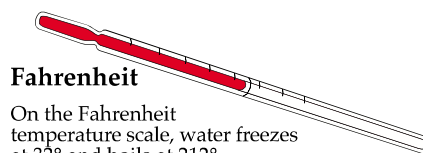
Heat can also move through a liquid or a gas. This process is called **convection**. When a liquid or a gas is heated, the molecules closest to the heat begin to vibrate. They move faster and faster and move away from the heat. Cooler molecules take their place. As this happens over and over, all of the molecules are heated. This process helps to explain how air moves. When air is heated, it rises. Cooler air moves in to take its place. This type of air movement is called a **convection current**. Convection

currents are important to meteorologists. People who design air conditioning and heating systems must also think about convection.

Most of the heat on Earth comes from the sun. How does it get here? The sun is about 150 million kilometers away from Earth. Its heat must pass through empty space. It moves by radiation. No matter is needed. Heat from other sources also travels by radiation. For instance, coal stoves and electric heaters also radiate heat.

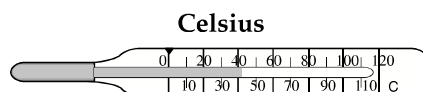
Temperature

Temperature and heat are not the same. Temperature tells the amount of heat in matter. It is a measure of how fast the molecules are moving. Temperature is the average of how many molecules are moving and how fast they move. A **thermometer** measures temperature. Thermometers are filled with substances



Fahrenheit

On the Fahrenheit temperature scale, water freezes at 32° and boils at 212°.



Celsius

On the Celsius temperature scale, water freezes at 0° and boils at 100°.

that expand when they are heated. You have learned about **Fahrenheit** and **Celsius** scales. Scientists use the Celsius scale to measure temperature. Water boils at 100°C and freezes at 0°C.

Uses for Heat

Heat is a very common form of energy. It was one of the first forms used by early man. Heat cooks food and warms our houses. High temperatures will kill germs that cause disease. Heat is needed to produce glass and other products. Metals are heated to a liquid state. They are combined with other elements to form stronger materials. Steel, for example, is formed this way. Heat is used to run generators. You can probably think of many other ways heat energy is used.

Summary

Heat is a form of energy. It causes matter to expand and contract. Heat also causes matter to change phase. Temperature measures the amount of heat. Whenever energy changes form, some of it becomes heat. Heat moves through matter by conduction and convection. Heat moves through space by a process called radiation. There are many important uses for heat energy.