

section ● Thermal Energy

What You'll Learn

- what temperature is
- how thermal energy depends on temperature
- how to calculate the change in thermal energy

Study Coach

Make an Outline Make an outline of the information you learn about in this section. Use the headings in the reading as a starting point. Include the boldface vocabulary terms in your outline.

Reading Check

1. **Define** What is the temperature of a substance?

● Before You Read

You wake up in the morning and get out of bed. Does the floor feel cold or warm on your bare feet? On the lines below, write a sentence that compares how it feels to step on a bare floor and on a rug on a cold morning.

● Read to Learn


The Kinetic Theory of Matter

All around you objects are getting warmer and cooler. What is temperature? What causes objects to change temperature? The temperature of an object depends on the motion of the particles in the object.

The **kinetic theory** is an explanation of how particles behave and move. There are three parts to the kinetic theory.

1. All matter is composed of particles—atoms, molecules, and ions.
2. The particles are in constant random motion. They move in all directions at different speeds.
3. The particles have kinetic energy because they are moving. The particles collide with one another and transfer kinetic energy between them.

Temperature

The particles in matter are moving at various speeds and have a range of kinetic energies. The **temperature** of a substance is a measure of the average kinetic energy of its particles. As the temperature of something increases, the average speed of its particles increases. The temperature of hot tea is higher than the temperature of iced tea. The reason is that on average the particles in the hot tea are moving faster than in the iced tea. 

What are the temperature scales?

The SI unit for temperature is kelvin (K). Two common temperature scales are the Celsius scale and the Fahrenheit scale. To convert a temperature from Kelvin to Celsius, subtract 273 from the kelvin temperature. To convert temperatures measured in the Celsius and Fahrenheit scales from one to the other use these equations:

$$\text{To convert temperature in } ^\circ\text{F to } ^\circ\text{C: } ^\circ\text{C} = \left(\frac{5}{9}\right) (^\circ\text{F} - 32)$$

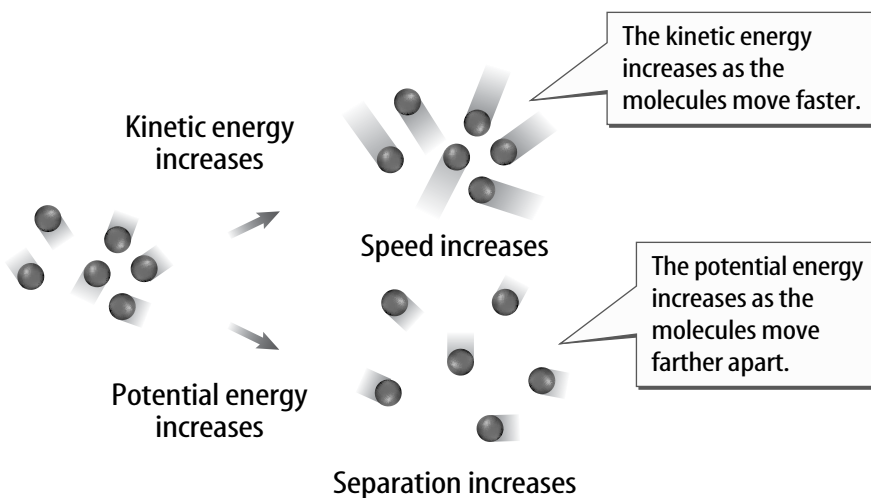
$$\text{To convert temperature in } ^\circ\text{C to } ^\circ\text{F: } ^\circ\text{F} = \left(\frac{9}{5}\right) (^\circ\text{C}) + 32$$

For example, to change 68°F to degrees Celsius, first subtract 32, multiply by 5, then divide by 9. So $68^\circ\text{F} = 20^\circ\text{C}$

Thermal Energy

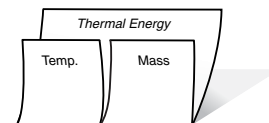
Atoms and molecules that make up matter are constantly moving, so they have kinetic energy. Molecules also have potential energy that can be changed into kinetic energy. How can molecules have potential energy? Think about a ball held high above your head. Earth exerts an attractive gravitational force on the ball. When you hold the ball above your head, the ball and Earth are separated. This gives the ball potential energy. The particles in a substance also exert attractive forces on each other. The particles have potential energy when they are separated.

As particles in an object move farther apart, their potential energy increases. As they move faster, their kinetic energy increases. **Thermal energy** is the sum of the kinetic and potential energy of all the particles in an object. The figure shows that if either potential or kinetic energy increases, thermal energy increases.



FOLDABLES™

● **Relate** Make the following Foldable to tell how temperature and mass are related to thermal energy.



Picture This

2. Use Scientific Illustrations

In the space below, sketch the particles in the figure if separation increased even more.

