

LEARN ABOUT

Matter and Energy

FIND OUT

- what thermal energy is
- the difference between thermal energy and temperature

VOCABULARY

energy
thermal energy
temperature

Thermal Energy

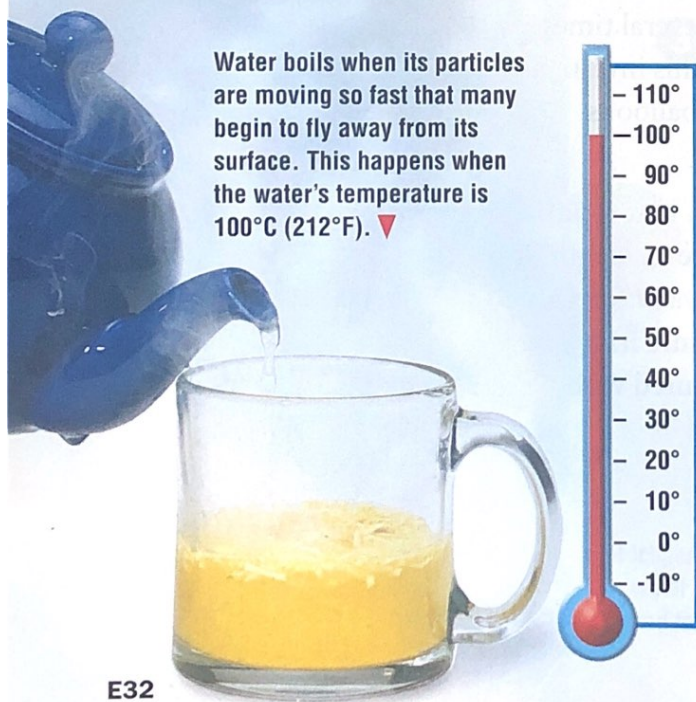
Have you ever thrown a ball? Pushed a grocery cart? Run in a race? All these activities need energy. **Energy** is the ability to cause a change. In each of these cases, the thing that changed was the position of an object. You threw the ball from one place to another. You pushed the grocery cart through the store. You moved yourself along the racetrack. Moving anything from one place to another takes energy.

The particles in matter are always moving from one place to another. The particles in a solid jiggle back and forth like balls on a spring. The particles in a liquid slide past each other. The particles in a gas move quickly in many directions. All of this movement requires energy. The energy of the motion of particles in matter is called **thermal energy**. The word *thermal* means "heat." We feel the thermal energy of the particles in matter as heat.

✓ What is thermal energy?

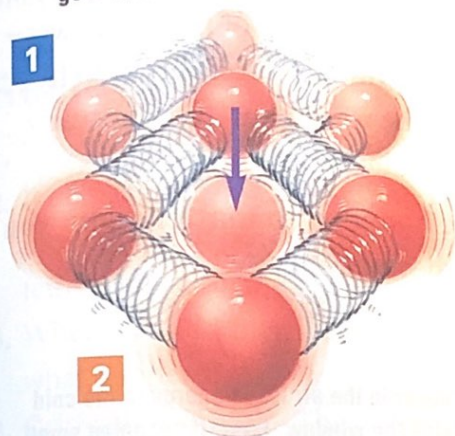
When liquid water freezes, its particles settle into an arrangement as a solid. This happens when the temperature of the water is 0°C (32°F). The ice cubes and lemonade are 0°C . ▼

Water boils when its particles are moving so fast that many begin to fly away from its surface. This happens when the water's temperature is 100°C (212°F). ▼



1 These balls stand for particles in a solid. The springs stand for the forces holding the solid together. Particles in a solid keep their arrangement, but they move back and forth around a point.

2 When you add thermal energy, the particles move faster. The solid gets hotter.



Temperature

Most people think that temperature is a measure of heat. Actually, **temperature** is a measure of the average energy of motion of the particles in matter. At 50°F (about 10°C) the particles in the air move more slowly than they do at 80°F (about 27°C). They have less thermal energy.

In the investigation you heated a balloon and observed how its volume changed. You can measure temperature by observing how the volume of a liquid changes as it is heated or cooled. One kind of thermometer has liquid in a narrow tube. When the liquid gets hotter, its volume changes and it moves up the tube. When it gets colder, it moves back down the tube.

✓ **What does temperature measure?**



▲ The water in this cup is the same temperature as the nearly boiling water in the hot spring. But the water in the spring has more thermal energy because it has more water and, therefore, more moving particles of matter.

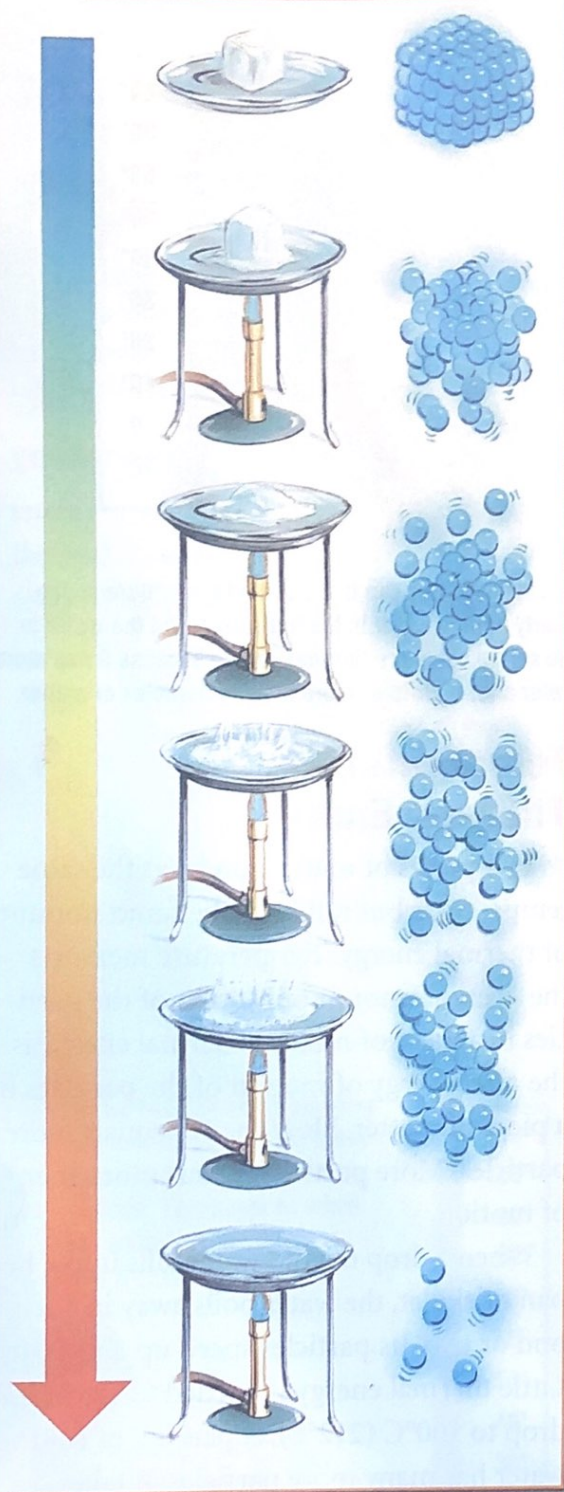
Temperature and Thermal Energy

Two pieces of matter can be at the same temperature but not have the same amount of thermal energy. Temperature measures the *average* amount of motion of the particles in a piece of matter. Thermal energy is the *total* energy of motion of the particles in a piece of matter. More matter equals more particles. More particles equals more energy of motion.

When a drop of cold water falls into a hot pan or skillet, the water boils away in a second or two. Its particles speed up and fly off. Little thermal energy is needed to warm the drop to 100°C (212°F). A pan full of cold water has many more particles. It takes much more thermal energy to boil the water.

✓ **What is the difference between temperature and thermal energy?**

Adding Thermal Energy



▲ When thermal energy is added to frozen water, the water slowly changes from a solid to a liquid and then from a liquid to a gas. When thermal energy is removed from water vapor, this process is reversed.

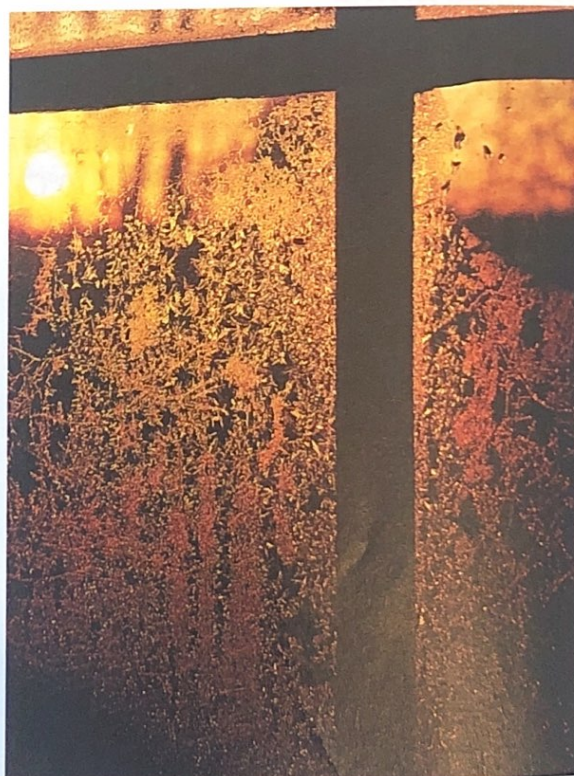
Adding Thermal Energy

When thermal energy is added to matter, the particles in the matter move faster. Below 0°C (32°F) water is solid ice. The particles move back and forth around one point. As you add thermal energy, the particles move faster and faster. At 0°C (32°F) the particles begin to move past and around each other. The ice melts.

After ice melts, adding energy causes the particles of liquid water to move faster and faster. The temperature of the liquid water rises. After a while, particles begin to fly away from the water's surface. The water boils, or rapidly becomes a gas.

✓ **What happens to matter when you add thermal energy?**

Water vapor in the air loses energy to the cold air outside the window. First, it becomes small water droplets on the glass. Then, it becomes a solid and forms these ice crystals. ▼



Summary

Energy is the ability to cause change. Energy is needed to move something from one place to another. The total energy of motion of the particles in matter is thermal energy. Temperature is a measure of the average motion of these particles. Adding thermal energy causes the particles of matter to move faster. More matter equals more particles. More particles mean more total thermal energy.

Review

1. What does temperature measure?
2. If all particles in a metal spoon start moving faster, how has the spoon's temperature changed?
3. When you add thermal energy to matter, what happens?
4. **Critical Thinking** The water in two glasses has the same average energy of motion. One glass holds 250 mL, and one holds 400 mL. Which glass of water has more thermal energy? Why?
5. **Test Prep** The particles in two pieces of chocolate have the same average energy of motion. One piece has more mass than the other. Which piece is at a higher temperature?
 - A the piece with more mass
 - B the piece with less mass
 - C the piece with more thermal energy
 - D They are the same temperature.



LINKS



MATH LINK

Thermometers On a Fahrenheit temperature scale, water freezes at 32°F and boils at 212°F . How many Fahrenheit degrees are between the two temperatures? Now think about the boiling and freezing temperatures in Celsius degrees. Are degrees Celsius bigger or smaller units of measure than degrees Fahrenheit?



WRITING LINK

Expressive Writing—Poem Write a poem for your family that describes a hot day and a cold day. You could describe how your neighborhood looks, things people do, and how you feel.



SOCIAL STUDIES LINK

Early Thermometers Find out who invented the first thermometers and temperature scales and how the thermometers worked. Make a time line that shows what you learned.



TECHNOLOGY LINK

Visit the Harcourt Learning Site for related links, activities, and resources.

www.harcourtschool.com/ca

