Energy and Matter

States of Matter

Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	While a substance is melting or freezing, the temperature remains constant.	
	Thermal energy is the same as temperature.	

Read to Learn

What happens to temperature during a change in state?

When energy is added to a solid, it can melt. What happens to temperature as a substance melts?

Changes Between Solids and Liquids What happens when a solid reaches its melting point? The temperature, or average kinetic energy, stops increasing. Freezing is a process that is the opposite of melting—liquid changes to solid. The temperature at which matter changes from the liquid state to the solid state is its freezing point. The melting point and freezing point are always the same for a given substance. While a substance is freezing or melting, the temperature stays the same until the phase change is complete.

Changes Between Gases and Liquids When a gas loses enough thermal energy, the gas changes to a liquid, or condenses. *The change of state from a gas to a liquid is called* **condensation.**

Earth Science Connection When water vapor in the atmosphere condenses, it forms clouds. Overnight, water vapor often condenses on blades of grass and forms dew.

Key Concept

- How does energy determine the state of matter?

Mark the Text

Building Vocabulary Skim this lesson and circle any words you do not know. If you still do not understand a word after reading the lesson, look it up in the dictionary. Keep a list of these words and definitions to refer to when you study other chapters.

Scientific Vocabulary

solid
(noun) matter with a definite shape and a definite volume

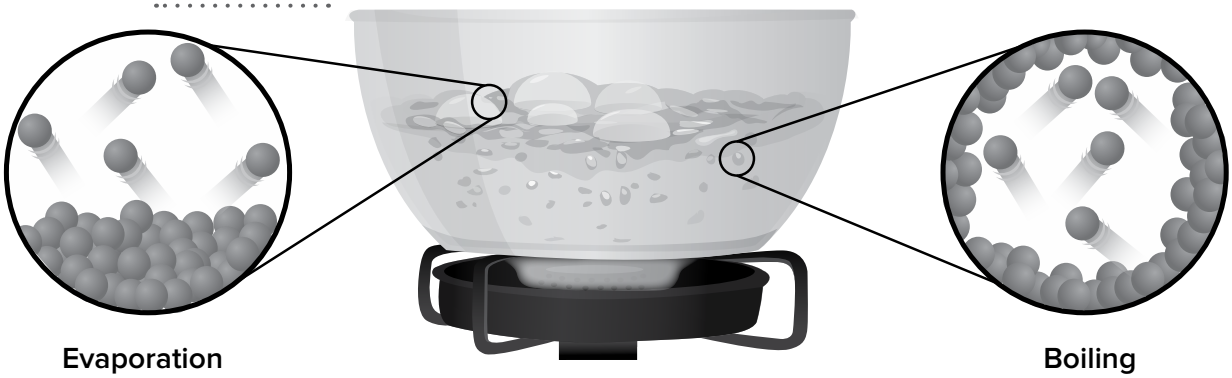
Scientific Vocabulary

liquid
(noun) matter with a definite volume, but no definite shape

Scientific Vocabulary

gas
(noun) matter with no definite volume and no definite shape

Vaporization *The change in state of a liquid into a gas is* **vaporization**. Vaporization is the opposite of condensation. There are two ways vaporization occurs: boiling and evaporation, shown in the figure below.



Evaporation Boiling

Evaporation and Boiling Vaporization that happens on the surface of water is called evaporation. Evaporation can happen during boiling. It can also happen at lower temperatures. A small amount of liquid in an open container will disappear after several days due to evaporation.

Academic Vocabulary

occur
(verb) to happen

Vaporization that occurs within a liquid is called boiling. During boiling, vaporization takes place throughout the liquid. The temperature at which boiling occurs in a liquid is called its boiling point. Bubbles form within a liquid as it boils.

The boiling point and the condensation point are the same for a given substance. When a substance is boiling or condensing, its temperature does not change until the phase change is complete.

What happens to particles and energy during a change in state?

Science Use v. Common Use

state
Science Use a condition or physical property of matter

Common Use an organized group of people in a defined territory, such as one of the fifty states in the United States

Think about the particles in a substance. How do they move during a phase change?

Particle Arrangement When energy is added to a substance, the particles move faster and faster. At some point, they cannot go any faster without changing to another state of matter. Recall that the particles in gases are fast moving and spread out. The particles in a liquid are closely packed, but they can slide past each other. The particles of solids are packed close together and are in a rigid shape.

Particle Attraction When energy is added and the particles of a substance cannot move any faster, the energy is used to overcome the attraction between particles and cause a change in state. **Potential energy** *is stored energy due to the interactions between particles or objects*. The potential energy of particles is due to their position relative to other particles. The potential energy of particles increases and decreases as the distances between particles increase or decrease. That means, particles that are farther apart have greater potential energy than particles that are closer together. The potential energy of particles is part of the total amount of energy of a substance.

Academic Vocabulary

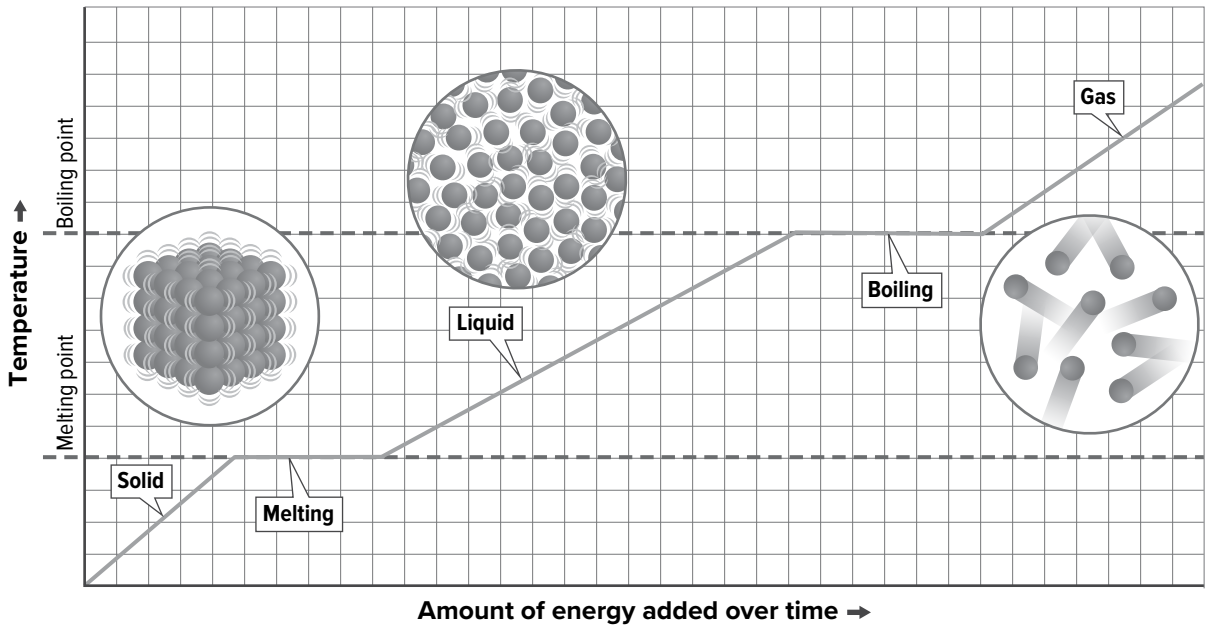
attraction
(noun) a force that brings things together

Contrasting Kinetic Energy and Potential Energy There are many differences between kinetic energy and potential energy. Kinetic energy relates to particle speed; potential energy relates to the distance and attractions between particles. Kinetic energy is measured by temperature; potential energy is measured by state of matter.

Scientific Vocabulary

kinetic energy
(noun) energy due to motion

Heating Curves The graph shown below is the heating curve for water. It shows what happens to temperature as energy is added to water. As energy is added, temperature increases when the state of matter is not changing. The kinetic energy of the particles increases. When a substance is changing state, the temperature stays the same. The potential energy of the particles increases.



How do the melting and boiling points of different substances compare?

You know that ice melts at 0°C. You know that liquid water boils at 100°C. Other substances have different melting and boiling points.

Particles and Melting Points Every substance has its own melting and boiling points. The greater the attractions between particles, the higher the melting and boiling points. The type of particles that make up a substance affect how much energy is needed to cause a phase change. That is why different substances can be at different phases when they are at the same temperature.

Scientific Vocabulary

phase
(noun) a particular stage of, in this case, matter

What factors determine the total energy of a substance?

The particles that make up substances are constantly in motion. Think about the factors that could change how much energy a substance has.

Thermal Energy The total energy of a substance depends on the following four things:

- Kinetic energy of the particles
- Potential energy of the particles
- Total number of particles
- Type of matter that makes up the substance

Word Origin

matter
from Latin *materia,* means "material, stuff"

Thermal energy *is the total energy of a system that is dependent on the number of particles in the system, the state of the material, and the temperature*. Thermal energy is not the same as temperature. Recall that temperature is the measure of the average kinetic energy of the particles.

After You Read

Reread the statements at the beginning of the lesson. Fill in the *After* column with an A if you agree with the statement or a D if you disagree. Did you change your mind?