States of Matter

Solids, Liquids, and Gases

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
	1. Particles moving at the same speed make up all matter.	
	2. The particles in a solid do not move.	

Key Concepts

- How do particles move in solids, liquids, and gases?
- How are the forces between particles different in solids, liquids, and gases?

Read to Learn

Describing Matter

Picture yourself blowing bubbles by the seaside. Do you see matter in this scene? The three most common forms, or states, of matter on Earth are solids, liquids, and gases. The bubbles you blow hold air, which is a mixture of gases. The soap mixture used to make the bubbles and the ocean water are liquids. The sand, your shoes, and nearby seashells are a few of the solids you might see by the seaside.

There is a fourth state of matter, plasma. Plasma is high-energy matter made up of particles that have positive and negative charges. Plasma is the most common state of matter in space. Plasma also is in lightning flashes, fluorescent lights, and stars, such as the Sun.

Matter can be described in many ways. You can describe matter using your senses. You can describe its state, color, texture, and smell. You also can describe matter using measurements, such as mass, volume, and density. Mass is the amount of matter in an object. The units for mass are often grams (g) or kilograms (kg). Volume is the amount of space that a sample of matter takes up. The units for liquid volume are usually liters (L) or milliliters (mL). The units for solid volume are usually cubic centimeters (cm^3) or cubic meters (m^3). Density is a quantity calculated by dividing an object's mass by its volume. The units of density are usually g/cm^3 or g/mL.

Study Coach

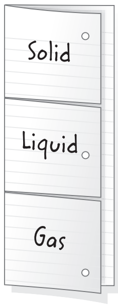
Make a Table with three columns to contrast solids, liquids, and gases. Label one column *Particle Motion and Forces.* Label the second column *Definite Shape?* Label the third column *Definite Volume?* Complete the table as you read this lesson.

Reading Check

1. Name the four states of matter.

FOLDABLES®

Make a three-tab Foldable to record information about each state of matter under the tabs.



Particles in Motion

Have you ever wondered what makes something a solid, a liquid, or a gas? Two main factors that determine the state of matter are particle motion and particle forces.

Atoms, ions, or molecules make up all matter. These particles can move in different ways. In some matter, they are close together and vibrate back and forth. In other matter, the particles are farther apart. Sometimes, they slide past each other. At other times, they move freely and spread out. It does not matter how close the particles are to each other. All particles have random motion. Random motion is movement in all directions and at different speeds. If particles are free to move, they move in straight lines until they collide with something. Collisions usually change the speed and direction of the particles' movements.

Think it Over

2. Relate How does particle speed relate to the distance between particles?

Forces Between Particles

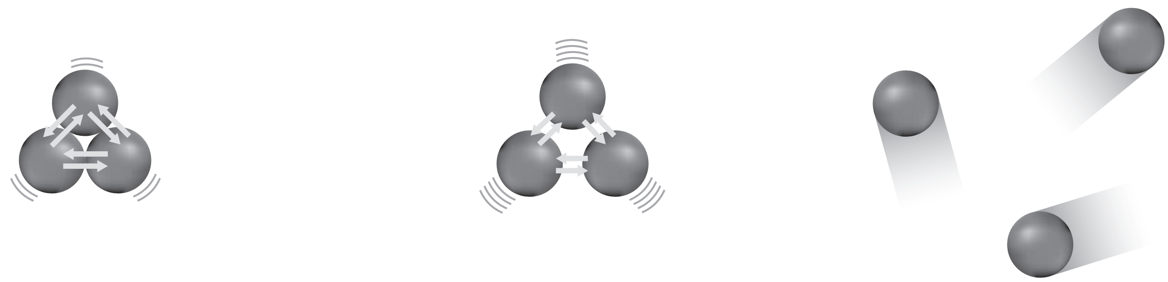
Recall that atoms that make up matter have positively charged protons and negatively charged electrons. These opposite charges attract each other. They create attractive forces between any two particles. Attractive forces pull particles together.

Strong attractive forces hold slow-moving particles close together, as shown in the figure below. As the motion of particles gets faster, particles move farther apart. When they get farther apart, the attractive forces between particles have a weaker effect. The spaces between them increase. This bigger space lets other particles slip past. As the motion of particles gets even faster, particles move even farther apart. In time, the distance between particles is so great that there is little or no attractive force between them. The particles move randomly and spread out.

Visual Check

3. Draw Circle the particles that show the weakest attractive forces between them.

Particle Motion



Particles move slowly and can only vibrate in place. Therefore, the attractive forces between particles are strong.

Particles move faster and slip past each other. The distance between particles increases. Therefore, the attractive forces between particles are weaker.

Particles move fast. The distance between the particles is great, and therefore, the attractive forces between particles are very weak.

Solids

If a skateboard moves from one place to another, its shape and volume do not change. A skateboard's shape and volume do not change because a skateboard is a solid. *A **solid** is matter that has a definite shape and a definite volume.*

Particles in a Solid

Why doesn't a solid change shape or volume? Remember that the particles in a solid are close together. The particles are touching neighboring particles. The attractive forces between them are strong. Their strong attractive forces and slow motion hold the particles tightly in their positions. The particles still move, but they do not get away from each other. They simply vibrate back and forth in place. This arrangement gives solids a definite shape and volume.

Types of Solids

All solids are not the same. For example, a diamond and a piece of charcoal do not look alike. However, they are both solids made of carbon atoms. They both have particles that strongly attract each other and vibrate in place. What makes them different is the arrangement of their particles. A diamond is a crystalline solid. It has particles arranged in a specific, repeating order. Charcoal is an amorphous solid. It has particles that are arranged randomly. Different particle arrangements give these materials different properties. For example, a diamond is a hard material. Charcoal is brittle.

Liquids

Have you ever seen a waterfall flowing into a riverbed? Water is a liquid. *A **liquid** is matter with a definite volume but no definite shape.* Liquids flow and can take the shape of their containers. Water from a waterfall takes the shape of the riverbed that it fills.

Particles in a Liquid

How can liquids change shape? The particle motion in liquids is faster than the particle motion in solids. This faster motion causes the particles to move slightly farther apart. As they move farther apart, the effect of the attractive forces between them decreases. The faster motion also causes gaps to form between the particles. The gaps allow particles to slip past each other. The slightly weaker attractive forces and gaps between particles let liquids flow and take the shape of their containers.

Think it Over

4. Infer If a skateboard was not a solid and did not have a definite shape, what might happen when you tried to ride it?

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Key Concept Check

5. Describe the movement of particles in a solid and the forces between them.

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Reading Check

6. Contrast What is the difference between crystalline and amorphous solids?

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Viscosity

If you have ever poured or dipped honey, you know what a liquid with a high viscosity is like. **Viscosity** (vihs KAW sih tee) *is a measurement of a liquid's resistance to flow.* Honey has high viscosity. Water, on the other hand, has low viscosity. This property of a liquid is due to the strength of attraction between particles, particle mass, and particle shape.

- Strong forces between particles slow particle movement as particles slip past each other. In general, the stronger the forces are between particles, the higher the viscosity. For many liquids, viscosity decreases as the liquid becomes warmer.
- The mass of a particle also affects its ability to slip past other particles. More massive particles tend to move more slowly.
- Particles with complex shapes, such as long chains, also have high viscosity. Such long particles have difficulty slipping past other particles.

Key Concept Check
7. Describe the movement of particles in a liquid and the forces between them.

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Surface Tension

Have you ever seen an insect that can walk on water? Believe it or not, some insects can do this because of the forces between molecules.

Water molecules below the surface of water are surrounded on all sides by other water molecules. Therefore, they have attractive forces, or pulls, in all directions. The attraction between similar molecules, such as water molecules, is called cohesion.

Think it Over
8. Predict whether an insect could walk on a liquid such as rubbing alcohol, which has a smaller attraction between molecules than water.

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Water molecules at the surface of a liquid do not have liquid water molecules above them. As a result, there is a greater downward pull on the molecules. This downward pull causes the surface particles of water to become tightly stretched like the head of a drum. Molecules at the surface of a liquid have **surface tension,** *the uneven forces acting on the particles on the surface of a liquid.* Surface tension makes it possible for some insects to walk on water. In general, the stronger the attractive forces are between particles, the greater the surface tension of the liquid.

Think about the bubbles you were blowing in the imaginary scene at the beginning of the lesson. The thin water-soap film surrounding the bubbles formed because of surface tension between the particles.

Reading Check
9. Explain What causes surface tension?

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Gases

Think about a beach ball. To make it big and round, you have to fill it with a gas. *A* **gas** *is matter that has no definite volume and no definite shape.*

It is not easy to identify the gas in a beach ball because you cannot see it. In fact, there are gas particles inside and outside a beach ball. Air is all around us all the time. Air is a mixture of gases, including nitrogen, oxygen, argon, and carbon dioxide.

Particles in a Gas

Why don't gases have definite volumes or definite shapes? Compared to the particles in the solid and the liquid states, the particles in gases are very far apart.

The distances between the particles in a solid are small. The particles touch each other. The distances between the particles in a liquid are greater, and the particles can slip past each other. The distances between the particles in a gas differ from those in solids and liquids. In a gas, the forces of attraction between the particles are not strong enough to keep the particles close together. As a result, distances between particles are greater in the gas state.

Forces Between Particles

Particles in the gas state have greater motion than the same particles in the solid or liquid state. Because the particles are moving quickly, the distances between particles increase. As the distances increase, the attractive forces between particles have less of an effect.

The distances are so great and the effect of the attractive forces so small that gas particles act like they have little or no attraction to each other. As a result, the particles spread out to fill their container. Gases have no definite shape or volume.

Vapor

Have you ever heard the term *vapor? The gas state of a substance that is normally a solid or a liquid at room temperature is called* **vapor.** For example, water is normally a liquid at room temperature. When it is a gas, such as in air, it is called water vapor. Other substances that can form a vapor are rubbing alcohol, grain alcohol, iodine, mercury, and gasoline.

Reading Check

10. Identify What is a gas, and what is another object that contains a gas?

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Reading Check

11. Generalize Which state of matter has the greatest distance between particles?

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Key Concept Check

12. Describe How do particles move and interact in a gas?

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After You Read

Mini Glossary

gas: matter that has no definite volume and no definite shape

liquid: matter with a definite volume but no definite shape

solid: matter that has a definite shape and a definite volume

surface tension: the uneven forces acting on the particles on the surface of a liquid

vapor: the gas state of a substance that is normally a solid or a liquid at room temperature

viscosity (vihs KAW sih tee): a measurement of a liquid's resistance to flow

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains the differences between liquids and gases.

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2. Using what you have learned about the states of matter, draw lines to connect two characteristics (shown in ovals) to each state of matter (shown in boxes).

Definite Shape | Definite Volume | No Definite Shape | No Definite Volume

SOLID | **LIQUID** | **GAS**

3. Which state of matter is a vapor? From what states of matter does a vapor form?

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What do you think NOW?

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?

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END OF LESSON

Name ______________________ Date ______________ Class __________

Content Vocabulary

LESSON 1

Solids, Liquids, and Gases

Directions: *Unscramble each word. Then write each term on the line before its definition.*

1. ovarp ______________________

2. usefarc nonstie ______________________

3. sga ______________________

4. tartem ______________________

5. dilqui ______________________

6. sivistyco ______________________

7. dolis ______________________

______________________ **8.** matter with no definite volume and no definite shape

______________________ **9.** matter with a definite volume, but no definite shape

______________________ **10.** matter with a definite volume and a definite shape

______________________ **11.** the uneven forces acting on the particles on a liquid's surface

______________________ **12.** the gas state of a substance that is a solid or liquid at room temperature

______________________ **13.** a measurement of a liquid's resistance to flow

______________________ **14.** anything that takes up space and has mass

Lesson Outline **LESSON 1**

Solids, Liquids, and Gases

A. Describing Matter

1. A form of matter is another name for a(n) ____________________ of matter.
   - **a.** The three most common states of matter on Earth are solids, ____________________, and gases.
   - **b.** Most of the matter in space is in a fourth state of matter called ____________________, which is high-energy matter consisting of positively and negatively charged particles.
2. ____________________ can be described in many ways.
   - **a.** Some descriptions, such as color and odor, involve using your ____________________.
   - **b.** Other descriptions, such as mass or volume, are ____________________.
3. Particle ____________________ and particle ____________________ determine a substance's state of matter.
   - **a.** No matter how close they are to each other, all particles have ____________________ motion.
   - **b.** Particles that are free to move will move in a(n) ____________________ line until they ____________________ with something.
4. There is a force of ____________________ between positively charged ____________________ and negatively charged ____________________.
   - **a.** When particles move ____________________, they move closer together, and the attractive forces between them are ____________________.
   - **b.** When particles move ____________________, they move farther apart, and the attractive forces between them are ____________________.

B. Solids

1. A solid has a definite ____________________ and a definite ____________________.

Lesson Outline continued

2. The type of solid depends on how the ______________ in the solid are arranged.
   a. When the particles are arranged in a specific, repeating order, the solid is a(n) ______________ solid.
   b. If the particles are randomly arranged, the solid is a(n) ______________ solid.

C. Liquids

1. A liquid has a definite ______________ but no definite ______________.
2. Unlike solids, liquids flow and can take the ______________ of their container.
3. The particle motion in a liquid state of a substance is ______________ than the particle motion in substance's solid state.
4. The attractive forces between the particles in a liquid are ______________ than they are in a solid.
5. A measurement of a liquid's resistance to flow is its ______________.
6. The attraction between molecules that are alike, such as water molecules, is called ______________.
7. Molecules at the surface of a liquid also have ______________, which involves the uneven forces acting on the particles on the surface of a liquid.
8. Usually, stronger ______________ forces between particles is linked to a greater ______________ of a liquid.

D. Gases

1. A gas has no definite ______________ and no definite ______________.
2. The distances between gas particles are so ______________ and the attractive forces so ______________ that gas particles spread out to fill their container.
3. The gas state of a substances that is usually a solid or a liquid at room temperature is called a(n) ______________.

States of Matter

Changes in State

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
	3. Particles of matter have both potential energy and kinetic energy.	
	4. When a solid melts, thermal energy is removed from the solid.	

Key Concepts

- How is temperature related to particle motion?
- How are temperature and thermal energy different?
- What happens to thermal energy when matter changes from one state to another?

Read to Learn

Kinetic and Potential Energy

When snow melts after a snowstorm, all three states of water are present. The snow is a solid, the melted snow is a liquid, and the air above the snow and ice contains water vapor, a gas. What causes particles to change state?

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.

Kinetic Energy

Recall that the particles that make up matter are always moving. These particles have **kinetic energy,** *the energy an object has due to its motion.* The faster particles move, the more kinetic energy they have. Within a given substance, such as water, particles in the solid state have the least amount of kinetic energy. This is because they only vibrate in place. Particles in the liquid state move faster than particles in the solid state. Therefore, they have more kinetic energy. Particles in the gaseous state move quickly. They have the most kinetic energy of particles of a given substance.

Temperature *is a measure of the average kinetic energy of all the particles in an object.* Within a given substance, a rise in temperature means that the particles, on average, are moving at greater speeds. Therefore, the particles have more kinetic energy. For example, water molecules at 25°C are moving faster and have more kinetic energy than water molecules at 10°C.

Key Concept Check

1. Relate How is temperature related to particle motion?

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Potential Energy

In addition to kinetic energy, particles have potential energy. Recall that potential energy is stored energy due to the interactions between particles or objects. Think about holding a basketball and then letting it go. The gravitational force between the ball and Earth causes the ball to fall toward Earth. Before you let the ball go, it has potential, or stored, energy.

Potential energy typically increases when objects get farther apart. It decreases when objects get closer together. When you hold up a basketball, it is farther off the ground than when it is falling from your hands. It has a higher potential energy than when it is falling. When the basketball is touching the ground, it has no more potential energy. The farther an object is from Earth's surface, the greater its gravitational potential energy is. As the ball gets closer to the ground, its potential energy decreases.

Reading Check

2. Apply Which has more potential energy: a baseball held 1 m above the ground or a baseball held 2 m above the ground?

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You can think of the potential energy of particles in a similar way. The chemical potential energy of particles is due to their position relative to other particles. The chemical potential energy of particles increases and decreases as the distances between particles increase or decrease. Thus, particles that are farther apart have greater chemical potential energy than particles that are closer together.

Thermal Energy

Changes in state are caused by changes in thermal energy. **Thermal energy** *is the total potential and kinetic energies of an object.* You can change an object's state of matter by adding or removing thermal energy. When you add thermal energy to an object, these things can happen:

- Particles move faster (increased kinetic energy).
- Particles get farther apart (increased potential energy).
- Particles get faster and move farther apart (increased kinetic and potential energy).

The opposite is true when you remove thermal energy:

- Particles move slower (less kinetic energy).
- Particles get closer together (less potential energy).
- Particles move slower and closer together (less kinetic and potential energy).

If enough thermal energy is added or removed, a change of state can occur.

Think it Over

3. Model Imagine two balls connected by a spring. In which arrangement do the balls have more potential energy: when they are pulled apart or when they are closer together?

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Key Concept Check

4. Contrast How do thermal energy and temperature differ?

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Solid to Liquid or Liquid to Solid

After you drink a beverage from an aluminum can, do you recycle the can? Aluminum recycling is one example of a process that involves matter changing from one state to another by adding or removing thermal energy.

Melting

The first part of the recycling process involves melting aluminum cans. To change matter from a solid to a liquid, thermal energy must be added. The graph below shows the relationship between increasing temperature and increasing thermal energy (potential energy + kinetic energy).

At first, the thermal energy and the temperature increase. The temperature stops rising when it reaches the melting point of the matter. The melting point is the temperature at which the solid changes to a liquid. As aluminum changes from solid to liquid, the temperature does not change. However, energy changes still occur. ✓

Energy Changes

What happens when a solid reaches its melting point? Notice that the line on the graph below is horizontal. This means that the temperature, or average kinetic energy, stops increasing. However, the amount of thermal energy continues to increase. How is this possible?

Once a solid reaches the melting point, additional thermal energy causes the particles to overcome their attractive forces. The particles move farther apart and potential energy increases. Once a solid completely melts, the addition of thermal energy will cause the kinetic energy of the particles to increase again, as shown by a temperature increase.

Reading Check

5. Infer What must be added to matter to change it from a solid to a liquid?

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Visual Check

6. Analyze During melting, which factor remains constant?

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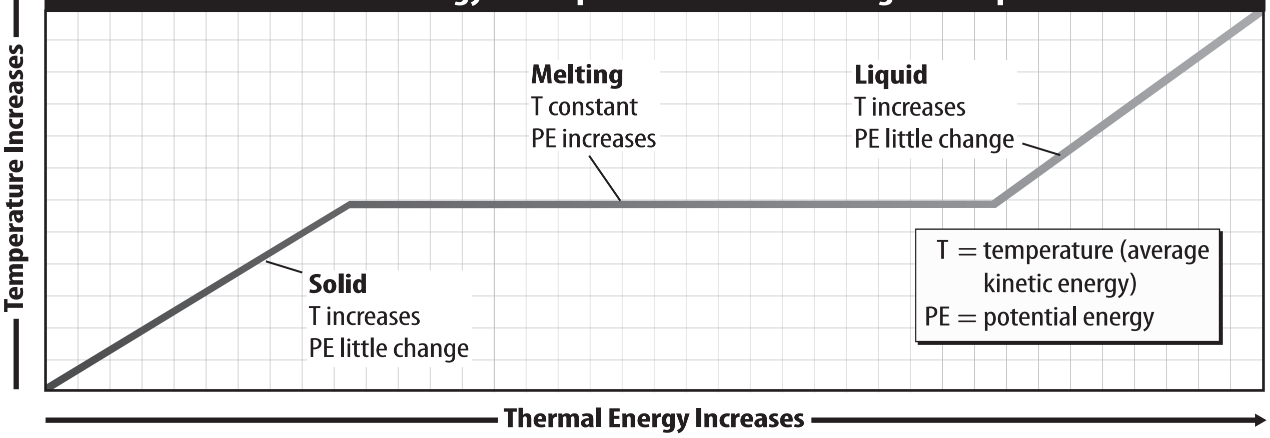
Thermal Energy v. Temperature as Solid Changes to Liquid



Freezing

After the aluminum melts, it is poured into molds to cool. As the aluminum cools, thermal energy leaves it. If enough energy is removed, the aluminum will freeze. 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. You can look at the graph of melting on the previous page to follow the process of freezing as thermal energy is removed. To observe the temperature and thermal energy changes that take place as liquid aluminum forms solid blocks, move from right to left on the graph on the previous page. ✓

Reading Check

7. Define *freezing.*

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Liquid to Gas or Gas to Liquid

When you heat water, do you ever notice how bubbles begin to form at the bottom and rise to the surface? The bubbles contain water vapor, a gas. As the water heats, it changes from the liquid state to the gaseous state. *The change in state of a liquid into a gas is* **vaporization.** The figure below shows two types of vaporization—evaporation and boiling. The two types of vaporization differ in where they take place in the liquid.

Visual Check

8. Explain Why doesn't the evaporation flask have bubbles below the surface?

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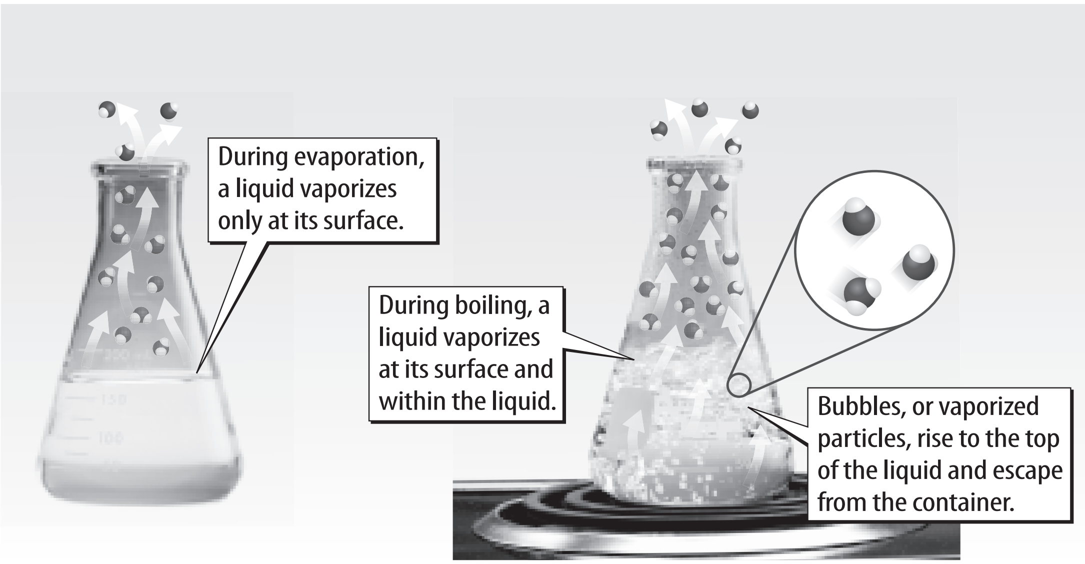
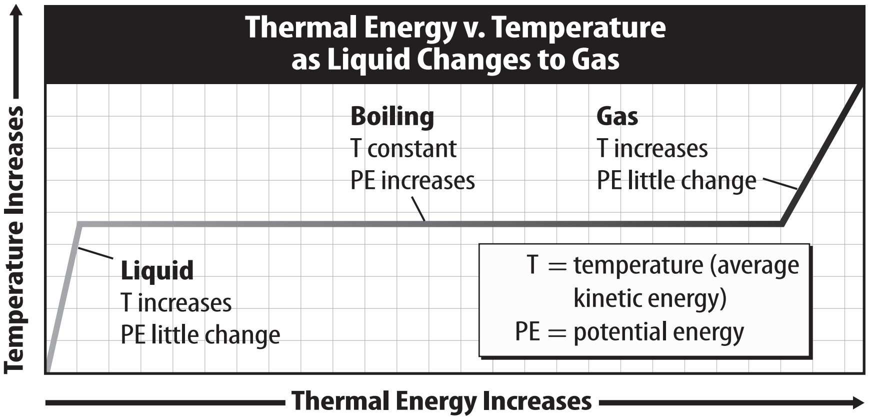
Boiling

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.

Boiling and Evaporation





In the graph above, notice the energy changes that occur as thermal energy is added. The kinetic energy of particles increases until the liquid reaches its boiling point. At the boiling point, the potential energy of particles begins increasing. The particles move farther apart until the attractive forces no longer hold them together. At this point, the liquid changes to a gas. When boiling ends, if thermal energy continues to be added, the kinetic energy of the gas particles begins to increase again. Therefore, the temperature begins to increase again as shown on the graph above.

Evaporation

Unlike boiling, **evaporation** *is vaporization that occurs only at the surface of a liquid.* A small amount of liquid in an open container will disappear after several days due to evaporation.

Condensation

Boiling and evaporation are processes that change a liquid to a gas. The opposite process also occurs. 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.** Overnight, water vapor often condenses on blades of grass and forms dew.

Solid to Gas or Gas to Solid

A solid can become a gas without turning into a liquid. Also, a gas can become a solid without turning into a liquid.

Solid to Gas Dry ice is solid carbon dioxide. It turns immediately into a gas when thermal energy is added to it. The process is called sublimation. **Sublimation** *is the change of state from a solid to a gas without going through the liquid state.* As dry ice sublimes, it cools and condenses the water vapor in the surrounding air, creating a thick fog.

Visual Check

9. Explain Why does the liquid change to a gas?

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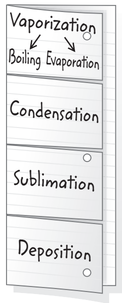
FOLDABLES®

Make a four-tab Foldable and record what you learn about each term under the tabs.



Think it Over

10. Apply Clouds can form when water vapor in the air condenses. Clouds are what state of matter?

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Reading Check

11. Evaluate Why are sublimation and deposition unusual changes of state?

Key Concept Check

12. Describe the changes in thermal energy as water goes from a solid to a liquid.

Visual Check

13. Locate Circle the location on the graph where water reaches its boiling point.

Gas to Solid The opposite of sublimation is deposition. **Deposition** *is the change of state of a gas to a solid without going through the liquid state*. For deposition to happen, thermal energy must be removed from the gas. Frost on grass on a fall morning is often the result of deposition. As water vapor loses thermal energy, it changes into solid frost.

States of Water

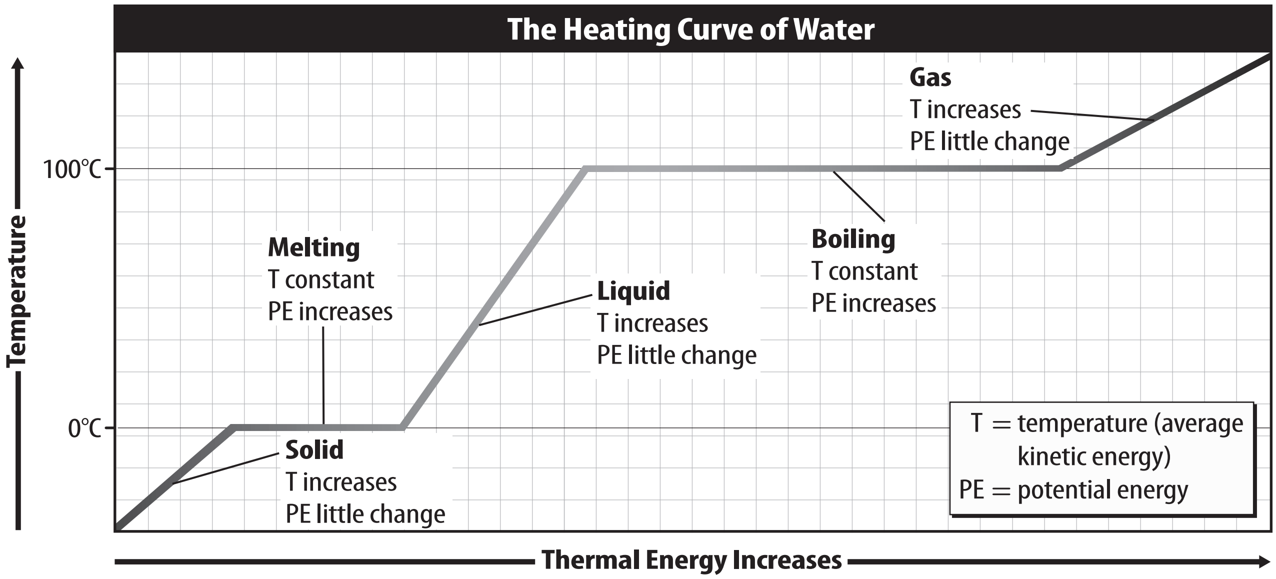
Water is the only substance that exists naturally as a solid, a liquid, and a gas within Earth's temperature range. To better understand the energy changes during a change in state, look at the heating curve of water shown in the graph below.

Adding Thermal Energy

Suppose you place a beaker of ice on a hot plate. The hot plate moves thermal energy to the beaker and the ice. The temperature of the ice increases. Recall that this means the average kinetic energy of the water molecules increases.

At 0°C, the melting point of water, the water molecules vibrate so rapidly that they begin to move out of their places. At this point, any added thermal energy causes the particles to overcome their attractive forces, and melting occurs. Once melting is complete, the kinetic energy of the particles begins to increase again as more thermal energy is added. Then the temperature begins to increase, too.

When water reaches 100°C, its boiling point, liquid water begins to change to water vapor. Again, kinetic energy stays the same as vaporization occurs. When the change of state is complete, the kinetic energy of molecules increases again, and so does the temperature.



Removing Thermal Energy

The removal of thermal energy is the reverse of the process shown in the heating curve of water. You can follow what happens to water vapor as you remove thermal energy by following the graph on the previous page from right to left. Cooling water vapor changes the gas to a liquid. Cooling the water further changes it to ice.

Reading Check

14. Describe what happens to water vapor when thermal energy is removed from it.

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Conservation of Mass and Energy

The diagram below shows the energy changes that take place as thermal energy is added or removed from matter. Notice that there are three sets of opposite processes:

- melting and freezing
- vaporization and condensation
- sublimation and deposition

During all of these changes of state, matter and energy are always conserved.

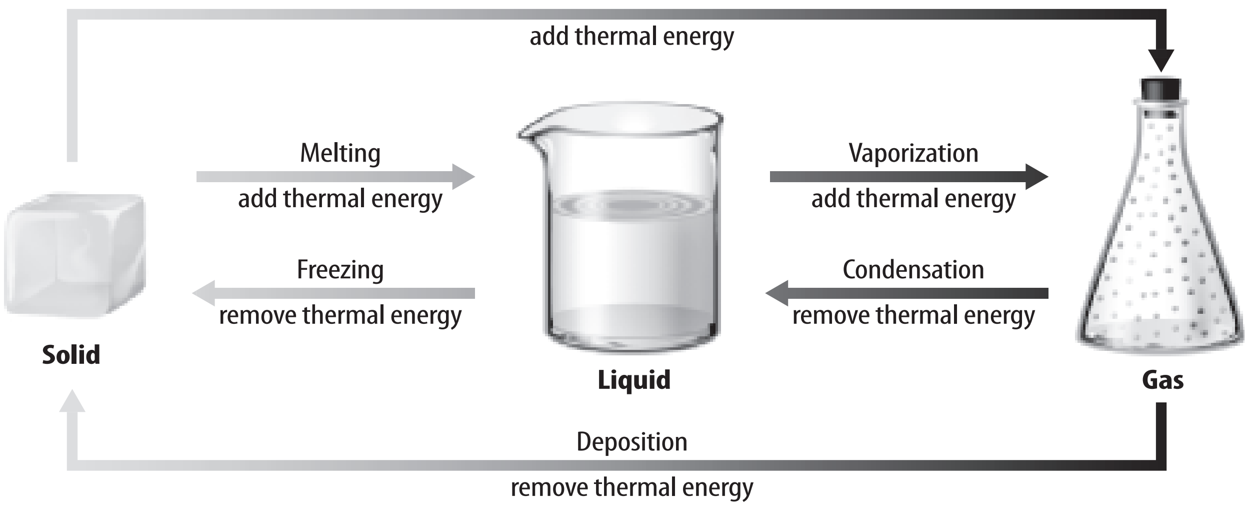
Sometimes, such as when water vaporizes, it seems to have disappeared. However, it has just formed an invisible gas. If the gas were captured and its mass added to the remaining mass of the liquid, you would see that matter is conserved.

The same is true for energy. Surrounding matter often absorbs thermal energy. If you measured thermal energy in the matter and the surrounding matter, you would find that energy is also conserved.

Visual Check

15. Draw Circle the state of matter that results when thermal energy is added to a liquid.

Changes of State



After You Read

Mini Glossary

condensation: the change of state from a gas to a liquid

deposition: the change of state of a gas to a solid without going through the liquid state

evaporation: vaporization that occurs only at the surface of a liquid

kinetic energy: the energy an object has due to its motion

sublimation: the change of state from a solid to a gas without going through the liquid state

temperature: a measure of the average kinetic energy of all the particles in an object

thermal energy: the total potential and kinetic energies of an object

vaporization: the change in state of a liquid into a gas

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that includes an example of one change of state and its opposite process.

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2. Write the correct term next to its opposite term in each row of the table below.

Happens When Thermal Energy Is Added	Happens When Thermal Energy Is Removed
melting	
	condensation
sublimation	

3. Name two types of vaporization. How are they different?

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What do you think NOW?

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?

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END OF LESSON

Name ______________________________ Date ____________ Class ______

Content Vocabulary

LESSON 2

Changes in State

Directions: *Each of the sentences below is false. Make the sentence true by replacing the underlined word(s) with a term from the list below. Write your changes on the lines provided.*

condensation	**deposition**	**evaporation**	**kinetic energy**
sublimation	**temperature**	**thermal energy**	**vaporization**

______________ **1.** The process of <u>thermal energy</u> is the opposite of the process of evaporation.

______________ **2.** The average kinetic energy of the particles in a substance is measured by the substance's <u>condensation</u>.

______________ **3.** It rained yesterday; however, due to <u>vaporization</u>, the puddles are all gone today.

______________ **4.** The gaseous state of a given substance has greater <u>deposition</u> than the liquid or solid states because the particles of the substance are moving more in the gaseous state than in the other states.

______________ **5.** The process of <u>thermal energy</u> is the opposite of the process of deposition.

______________ **6.** <u>Kinetic energy</u> is different from temperature because it includes the total potential energy and kinetic energy of an object.

______________ **7.** <u>Temperature</u> results in matter changing from a gas directly to a solid, without going through the liquid state.

______________ **8.** Evaporation and boiling result in <u>sublimation</u> of a liquid.

Lesson Outline

Changes in State

A. Kinetic and Potential Energy

1. All objects in motion have ________________ energy, which is energy due to its ________________.

2. Within a given substance, particles in the substance's ________________ state have the least amount of kinetic energy and particles in the ________________ state have the most kinetic energy.

3. ________________ is the measure of the average kinetic energy of all the particles in an object.

4. A temperature increase within a given substance a means that the particles, on average, are moving at ________________ speeds and have ________________ kinetic energy in that substance.

5. Particles have ________________ energy as well as kinetic energy.

a. Potential energy is ________________ energy.

b. Chemical potential energy ________________ as particles get farther apart and ________________ as the particles become closer together.

B. Thermal Energy

1. The total kinetic and potential energy of an object is a measure of its ________________.

2. An object's state of matter can be changed by adding or removing ________________.

3. Adding thermal energy to an object causes the particles to move faster (increased ________________ energy), or to get farther apart (increased ________________ energy), or to do both.

C. Solid to Liquid or Liquid to Solid

1. When enough thermal energy is added, a solid changes to a(n) ________________; this process is called ________________.

2. When enough thermal energy leaves a liquid, the liquid changes to a(n) ________________; this process is called ________________.

Lesson Outline continued

D. Liquid to Gas or Gas to Liquid

1. A liquid changes to a gas during the process of ______________________.
2. If the vaporization occurs within a liquid, the process is called ______________________.
3. Vaporization that occurs only at the surface of the liquid is called ______________________.
4. The change of state from a gas to a liquid is called ______________________.

E. Solid to Gas or Gas to Solid

1. ______________________ is the change of state from a solid to a gas without going through the liquid state.
2. ______________________ is the change of state from a gas to a solid without going through the liquid state.

F. States of Water

1. The only substance that exists naturally on Earth in all three states is ______________________.
2. When you add ______________________ energy to ice, the temperature of the ice increases, which means that the ______________________ energy of the water molecules increases.
    - **a.** At the ______________________ point of water (0°C), water molecules vibrate so fast that they begin to move out of their places and melting occurs.
    - **b.** Once a substance melts, the average ______________________ energy of its particles begins to increase again as more ______________________ energy is added.
    - **c.** When water reaches its ______________________ point (100°C), liquid water begins to change to water ______________________.
3. When thermal energy is removed from water vapor, it ______________________ at 100°C, and the liquid water ______________________ at 0°C.

G. Conservation of Mass and Energy

1. Matter and ______________________ are always conserved during a change of state.
2. Matter changes form during a change of state, but it is ______________________.
3. Energy is ______________________ or released during a change of state, but it is conserved during this change.