CHAPTER 18 States of Matte



Changes of State

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What is a change of state?
- What happens during a change of state?
- What can happen when a substance loses or gains energy?

National Science Education Standards PS 1a, 3a

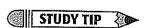
How Are Changes of State and Energy Related?

It can be tricky to eat a frozen juice bar outside on a hot day. In just minutes, the juice bar begins to melt. As it melts, the juice bar changes its state from a solid to a liquid. A change of state happens when matter changes from one physical form to another. A change of state is always a physical change. Remember that in a physical change, the substance does not change into a new substance.

Energy must be added or removed in order for a substance to change its physical state. It is important to remember that the particles of every substance move differently. This movement of particles depends on the state of the substance (solid, liquid, or gas).

For example, the particles in frozen water or ice (a solid) only vibrate. The particles in liquid water move faster and have more energy than particles in ice. To change ice into liquid water, energy must be added. To change liquid water into ice, energy must be removed.

The figure below shows changes of state that water can undergo.



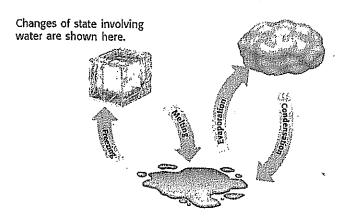
Compare As you read the chapter, complete a table with the following headings:

- name of change
- · states that are changing
- energy (added or removed).

READING CHECK

1. Identify What must be added or removed when a substance changes state?

Energy



TAKE A LOOK

2. Describe What happens to water in a puddle before it forms droplets of liquid water in a cloud?

The water

evaporates

SECTION S Changes of State continued

STANDARDS CHECK

PS 3a Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

Word Help: chemical of or having to do with the properties or actions of substances

3. Identify What must be added to melt a substance?

Energy

READING CHECK

4. Describe What is the melting point of a substance?

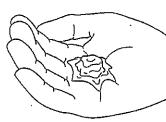
READING CHECK

5. Identify If the freezing point of a substance is 68°C. what is its melting point?

68°C

What Is Melting?

When energy is added to a solid, it can melt. Melting is the change of state from a solid to a liquid. For example, an ice cube in a glass of lemonade melts as it absorbs heat from the lemonade.



Gallium is a metal that can melt in your hand. Even though gallium is a metal, it would not be very useful as jewelry!

MELTING POINT AND ENERGY

The melting point of the substance is the temperature in which it changes from a solid to a liquid. As the temperature of the solid becomes greater, its particles move faster. When a certain temperature is reached, the solid will melt. The melting point of a substance is a physical property of the substance.

Melting point depends on the composition of, or material that makes up, the substance. It can be used to help identify a substance. For example, copper has a melting point of 420.7°C. Other substances may look like copper, but they will likely have different melting points.

For a solid to melt, particles must absorb energy. The energy makes the particles move faster and have less attraction to each other. This allows the particles to move past each other. The solid melts and becomes a liquid.

What Are Freezing and Freezing Point?

The freezing point is the temperature at which a substance changes from a liquid to a solid state. When a liquid freezes, its particles have less energy and become closely locked in position. Energy is removed from the substance during freezing.

Freezing is the exact opposite of melting. The freezing point of a substance is exactly the same as the melting point of the substance. They both happen at the same temperature. For example, liquid water freezes and becomes solid ice at temperatures below 0°C. Solid ice melts and becomes liquid water at temperatures above 0°C. ☑

SECTION Changes of State continued

What Is the Process of Evaporation?

When you get out of a swimming pool on a windy day, your body sometimes feels cold. Why? The water on your skin is evaporating. **Evaporation** is the change of state from the liquid state to the gas state. The reason you feel cold is because evaporation requires energy. The energy in this case goes from your body into the liquid water. The liquid water changes state to a gas called *water vapor*.

This change of state also happens when you sweat. Sweat is mostly water. When sweat appears on your skin, the water absorbs heat (energy) from your skin. This causes the water to evaporate, and you feel cooler.

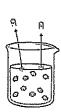
EVAPORATION AND BOILING

Evaporation can occur at low temperatures. Water can evaporate at temperatures near 0°C, but it will evaporate very slowly. For water to evaporate quickly in an open container, it must be heated. If the water is heated to a high enough temperature, it will boil.

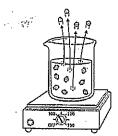
Boiling occurs when a liquid evaporates quickly. The particles leave the liquid state and change to vapor (gas) particles. This change creates a vapor pressure. A liquid boils when the vapor pressure equals the air pressure in the room. The temperature at which boiling occurs is known as the *boiling point* of the substance.

Like melting point, boiling point can help identify a substance. For example, the normal boiling point of water is about 100°C. Many liquids that look like water boil at different temperatures.

The figure below shows water evaporating at room temperature and water boiling.



Evaporation can happen in a liquid below its boiling point. Some particles at the surface of the liquid move fast enough to break away from the particles around them. When they break away, they become a gas (or vapor).



Boiling happens in a liquid at its boiling point. As energy is added to the liquid, particles throughout the liquid move faster. When they move fast enough to break away from other particles, they evaporate. The bubbles you see when water boils contain water vapor.

Say It

Investigate People usually feel warmer on a warm, humid day than on a warm, dry day. Investigate why most people feel warmer on humid days and report to the class.

READING CHECK

6. Describe Why does sweating help cool your body?

The sweat absorbs heat from the skin when it evaporates.

READING CHECK

7. Identify When the vapor pressure of a liquid equals the air pressure in the room, what will the liquid do?

Boil

TAKE A LOOK

8. Identify Are there more water vapor molecules above a beaker of water at room temperature or a beaker of water at its boiling point?

Above the	boiling
water.	J

SECTIONS Changes of State continued

Critical Thinking

9. Describe How does water from a lake become part of a cloud in the sky?

The water evaporates



10. Identify Which process requires energy, condensation or evaporation?

Evanora

What Is the Process of Condensation?

On a hot day in the summer, a glass of ice water might look like it is sweating. The water drops on the outside of the glass have formed because of condensation. Condensation is the change of state from a gas to a liquid. The water vapor in the air (sometimes called humidity) hits the cold glass. The particles of water vapor lose energy and change into the liquid state.

Condensation happens when a gas is cooled. When the gas cools, the particles lose energy, move slower, and have a greater attraction for each other. The particles begin to clump together. Condensation and evaporation are the opposites of each other. When condensation happens, the particles of gas lose energy and move more slowly. For evaporation to occur, the particles of a liquid must gain energy, and move faster.

The condensation point of a substance is the temperature at which a gas becomes a liquid. Under most conditions, the condensation point of a substance is the same temperature as the boiling point of the substance. Condensation can occur when the temperature of a surface is below the condensation point of the gas.

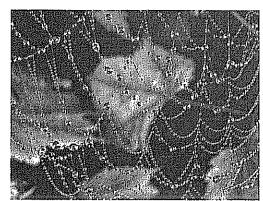
For example, water drops form a haze on a bathroom mirror when you take a shower. The water drops condense from the water vapor in the air. The mirror is at a temperature well below water vapor's condensation point, 100°C.

Take a close look at the spider web in the figure below. Notice the beads of water that have formed on it. This happens because water vapor (a gas) has condensed to form liquid water.

Critical Thinking

11. Explain As the day gets warmer, the water droplets on a spider web are no longer seen. Why?

The warmer air
evaporates the dew
droplets.



Beads of water form when water vapor in the air contacts a cool surface, such as this spider web.

SECTION Changes of State continued

What Is the Process of Sublimation?

The electric company in your community sometimes hands out dry ice when a storm knocks out power. Dry ice keeps groceries cold, but does not melt like ice. Dry ice can change directly from a solid state to a gas state. This process in known as sublimation.

Dry ice is frozen carbon dioxide. Its temperature is -78.5°C or lower. When it sublimes, it pulls energy from substances around it. This makes substances around it become cold. The energy it pulls weakens the attraction of the particles in the solid dry ice. When the attraction weakens enough, the solid changes into a gas. It does not melt into a liquid.

READING CHECK
12. Describe What occurs
when a substance sublimes?



Dry ice is a substance that will change directly from a solid to a gas at atmospheric pressure.

How Are Changes of State and Temperature Related?

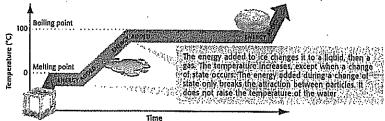
Two things can happen to a substance when it gains or loses energy. Either the temperature of the substance changes, or the state of the substance changes. During a change of state, the temperature of a substance will not change until the change of state is complete.

Take a close look at the figure below. The figure shows the effects and state changes that happen when energy is added to ice.



Demonstrate Put an ice cube in the freezer compartment of a refrigerator. Allow it to sit. undisturbed, for about two weeks. Report to the class on . how its size changed.

Changing the State of Water



TAKE A LOOK

13. Describe What is the shape of the graph at the melting and freezing points of water? What does this shape tell you about the temperature?

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Section 3 Rev	iew		NSES	PS 1a, 3a
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6. Complete Fill in th	* 1	22	gas to liquid	1
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attraction between	Stronges	weaker than in a	Weakest	
particles	close	solid		
distance between	close	close	Far Apart	J

Property	Solid	Liquid	Gas
attraction between particles	Stronges	weaker than in a solid	Weakest
distance between particles	close	close	Far Apart
movement of particles	They are locked In Place	they can move past each other	They can move anywhere