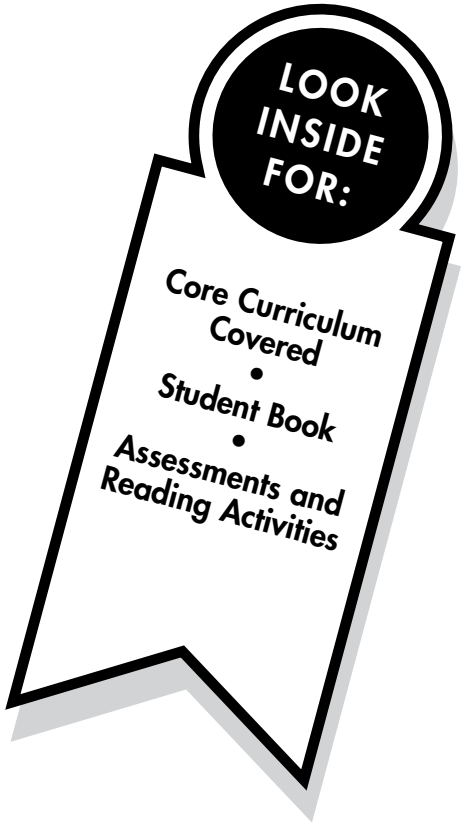

Earth Science

Water

Advanced Level

# Physical Changes in Water






FOCUScurriculum

866-315-7880 • www.focuscurriculum.com

# Physical Changes in Water

## What makes water so special?

### CORE CURRICULUM STATEMENTS

**Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.**

Water is recycled by natural processes on Earth: evaporation: changing of water (liquid) into water vapor (gas); condensation: changing of water vapor (gas) into water (liquid)

**Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.**

The material(s) an object is made up of determine some specific properties of the object (sink/float, conductivity, magnetism).

Properties can be observed or measured with tools such as hand lenses, metric rulers, thermometers, balances, magnets, circuit testers, and graduated cylinders.

Objects and/or materials can be sorted or classified according to their properties.

Matter exists in three states: solid, liquid, gas: solids have a definite shape and volume; liquids do not have a definite shape but have a definite volume; gases do not hold their shape or volume

Temperature can affect the state of matter of a substance.

Changes in the properties or materials of objects can be observed and described.

**Energy exists in many forms, and when these forms change energy is conserved.**

Energy and matter interact: water is evaporated by the Sun's heat; a bulb is lighted by means of electrical current; a musical instrument is played to produce sound; dark colors may absorb light, light colors may reflect light.


Earth Science

Water

Advanced Level

# Student Book

## *Physical Changes in Water*

# Physical Changes in Water

AL

## What makes water so special?

### CORE CURRICULUM STATEMENTS

**Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.**

Water is recycled by natural processes on Earth: evaporation: changing of water (liquid) into water vapor (gas); condensation: changing of water vapor (gas) into water (liquid)

**Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.**

The material(s) an object is made up of determine some specific properties of the object (sink/float, conductivity, magnetism).

Properties can be observed or measured with tools such as hand lenses, metric rulers, thermometers, balances, magnets, circuit testers, and graduated cylinders.

1f Objects and/or materials can be sorted or classified according to their properties.

Matter exists in three states: solid, liquid, gas: solids have a definite shape and volume; liquids do not have a definite shape but have a definite volume; gases do not hold their shape or volume

Temperature can affect the state of matter of a substance.

Changes in the properties or materials of objects can be observed and described.

**Energy exists in many forms, and when these forms change energy is conserved.**

Energy and matter interact: water is evaporated by the Sun's heat; a bulb is lighted by means of electrical current; a musical instrument is played to produce sound; dark colors may absorb light, light colors may reflect light.



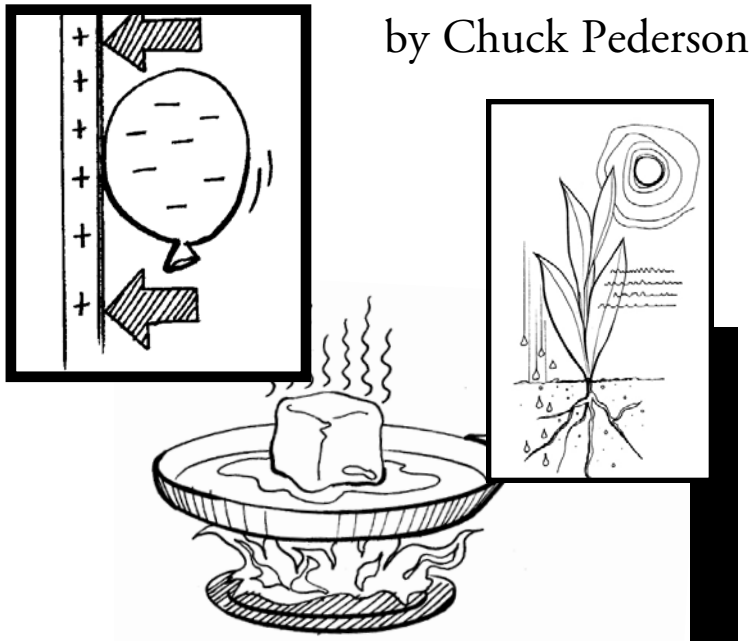
FOCUS ON SCIENCE

Earth Science

Water

# Physical Changes in Water

by Chuck Pederson



FOCUS ON SCIENCE

Earth Science

Water

# Physical Changes in Water

by Chuck Pederson



FOCUScurriculum

Curriculum materials for **your** content standards

## Table of Contents



*– Predict –*
*What do you think you will learn from reading this book?*

INTRODUCTION

# Things Change

Have you ever noticed that everything changes? Some changes are fun. For example, babies learn how to walk. A seed becomes a flower. Some changes are less fun. You fall and bruise your knee, or a severe storm develops after a sunny day.

Other changes happen, too. A carpenter saws a board to build a house. You put water in the freezer, and it becomes ice. A potter molds wet clay into a beautiful pitcher. You mix sugar and lemon juice to create thirst-quenching lemonade.

What do these changes have in common? They are **physical** changes.

**physical:** having to do with things that can be seen or measured



CHAPTER 1

# What Is Matter?

To understand physical change, you must understand matter. All substances are made of matter. It is the stuff around you. Matter includes paper, metal, glass, air, toenails, the farthest star, a waterfall, and your pet cat. In fact, almost everything in the universe is made of matter, whether you can see it or not. It is changing all the time.

People describe the physical **properties** of matter in many ways such as size, shape, color, texture, and **volume**. All matter takes up space. All matter has mass. Mass is the amount of matter in an object.

**properties:** qualities that something has
**volume:** the amount of space something occupies or takes up

People also describe materials by the matter from which they are made. For example, trees, sand, and iron are all matter that is used to make other materials. Paper is made from trees and other matter. Glass is made from melted sand, and steel is made from melted iron.

**Types of Materials**

| | |
|---|---|
| **Paper** | notebooks, cardboard boxes, newspaper, toilet paper, paper towels, photographs, books, bags |
| **Glass** | bottles, windows, sculptures, TV screens, pots, light bulbs |
| **Plastic** | keyboards, ski boots, CDs, brushes, soda bottles, bags, garbage cans |
| **Metal** | keys, doorknobs, belt buckles, wire, coat hangers, jewelry, knives, bolts |

The physical properties of matter can be observed and measured. For example, you can heat water and observe when the water begins to boil. You can then measure the temperature of the water to determine the boiling point of water.

*– Apply –*
*Describe other objects by the properties of the matter from which they are made.*



# States of Matter

Most matter on Earth, including water, exists in three states—solid, liquid, or gas. A fourth state of matter, plasma, exists in special situations such as lightning or in fluorescent light bulbs. Each state of matter has its own physical properties.

## Solids

A block of wood is a solid. So is your desk at home or at school. A computer is also a solid. Matter that is solid has a certain size and shape. It does not change its size or shape unless something causes it to change.

## Liquids

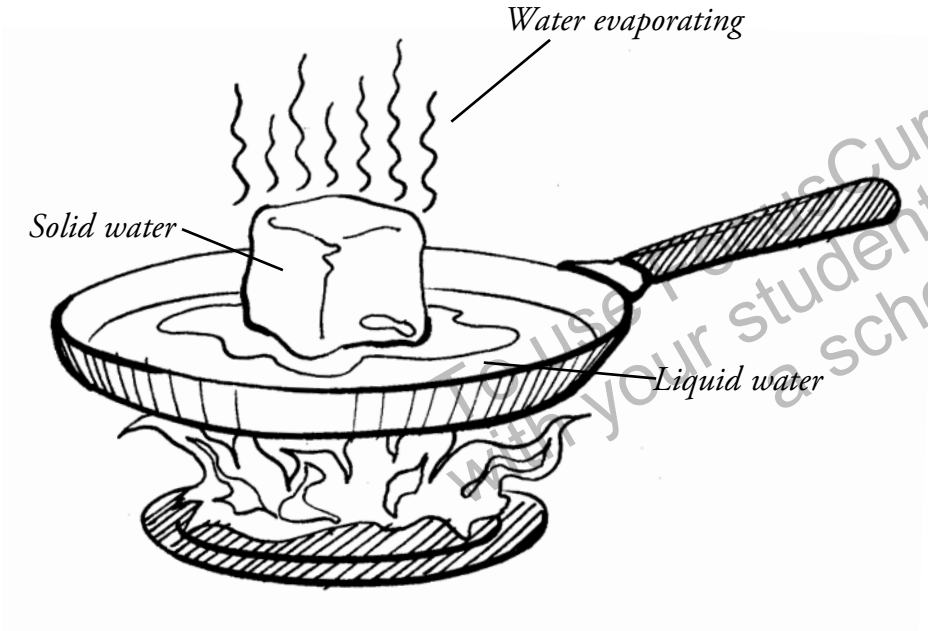
Milk is a liquid. It has size and volume. Milk does not have a particular shape, though. It takes the shape of its container. Liquids can flow, be poured, and be spilled. Solids cannot.

## Gases

Gases are matter that has no shape or size of its own. The air around you is a mixture of gases. You can't see air, but you can feel it.

*– Restate –*
*Explain the physical properties of different states of matter.*

Matter can change its state from solid to liquid to gas. Water provides a good example. Solid water is called ice. It has its own shape. Liquid water is the sloshy, wet stuff you can drink. It takes the shape of any container that holds it. When water **evaporates**, it can be seen as steam or water vapor. Water vapor has no definite shape or volume. Water as a gas is invisible in the air.




*When a solid is heated, it begins to melt. If heated enough, the melted liquid turns into vapor.*

**evaporate:** to change into a gas or vapor

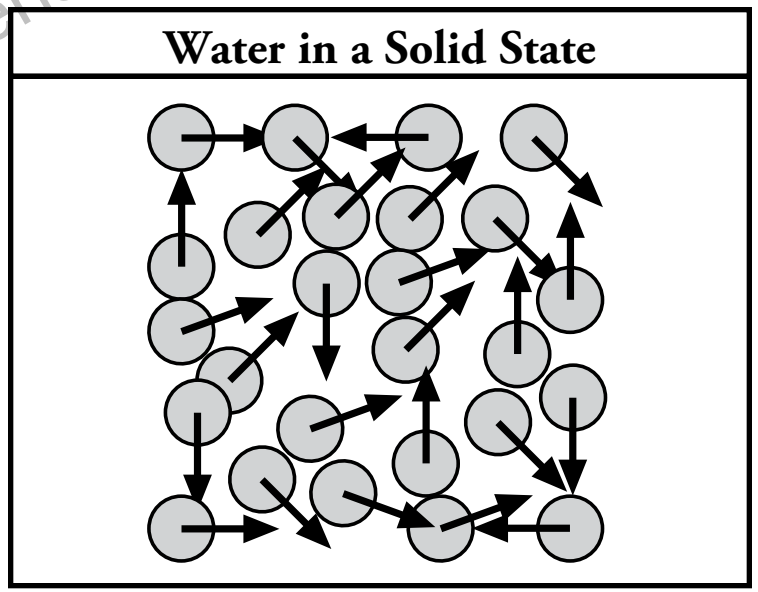


CHAPTER 2

# Particles in Matter

Matter is made of tiny particles. A million of these particles could fit in the size of the period at the end of this sentence. Particles join in groups to create matter.

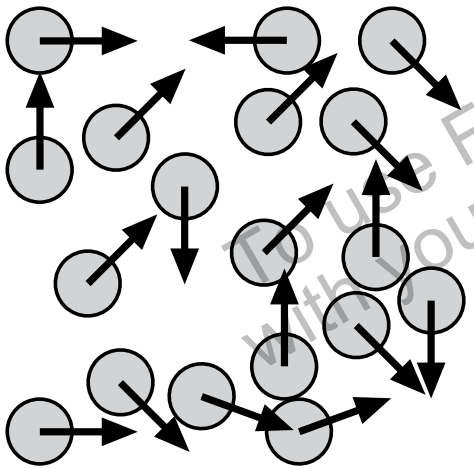
Particles move faster or slower depending on a substance's state. The particles in solid water, or ice, can move only a little. They are tightly packed in place, providing shape and hardness.




*The particles in solid water are packed together. They can move very little and make a substance hard.*

When water is heated, the particles begin to move faster. They start to break away from their places. At the temperature where water melts, it becomes a liquid. This temperature is called the melting point. Different kinds of solids have different melting points.

**Water in a Liquid State**

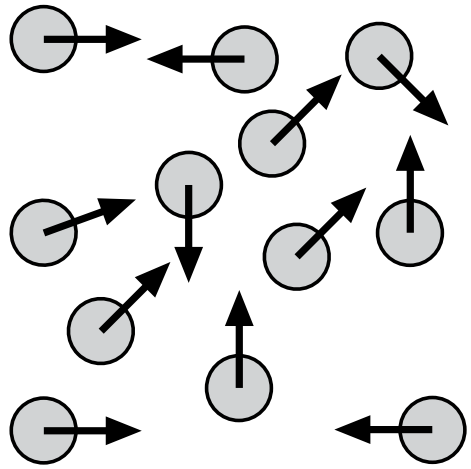


*The particles in liquid water are able to move more.*

If heating continues, some particles gain enough energy to break away from the liquid. They move into the surrounding space. This is called evaporation.

If enough heat, or thermal energy, is added, the liquid water begins to bubble and escape as a gas. This is called boiling. All liquids have different boiling points. Water's boiling point, for example, is 212 degrees Fahrenheit or 100 degrees Celsius (212° F or 100° C).

**Water in a Gas State**



*As a gas, the particles in water are furthest apart. They can move in all directions.*

Subtracting thermal energy, or cooling, will also change the state of matter. If a gas cools enough, it condenses. If you have ever had a cold drink on a hot day, you have seen condensation. It is what forms the little water drops on the outside of your glass. The water vapor in the air **condenses** on the cold surface of the glass.

Continue to subtract thermal energy, and the liquid becomes a solid. For water, this is the point at which it becomes ice. Water's freezing point is 32° F or 0° C.

*Water condenses on the outside of a cold glass.*

**condense:** to change from a gas to a liquid



CHAPTER 3

# What Is Physical Change?

Physical change occurs when objects or substances change their state of matter. Many properties of matter can change when this happens. Some examples of properties that might change include color, shape, size, temperature, and weight. Others include flexibility, the ability to float or sink, shininess, and magnetism.

For example, think about an iron nail. A solid nail can be melted and turned into a liquid. The liquid is still iron, even though its color, temperature, and shape have changed. You could melt several nails and put the liquid iron in a mold, cool it, and make a hammer head. The iron is still iron, even though its shape has changed.

When matter is heated, thermal energy is added. The thermal energy does the work of changing a solid to a liquid or a liquid to a gas. As the liquid iron becomes a solid hammer head, thermal energy is given off. That is, when an object cools it gives off thermal energy.

# Physical Versus Chemical Changes

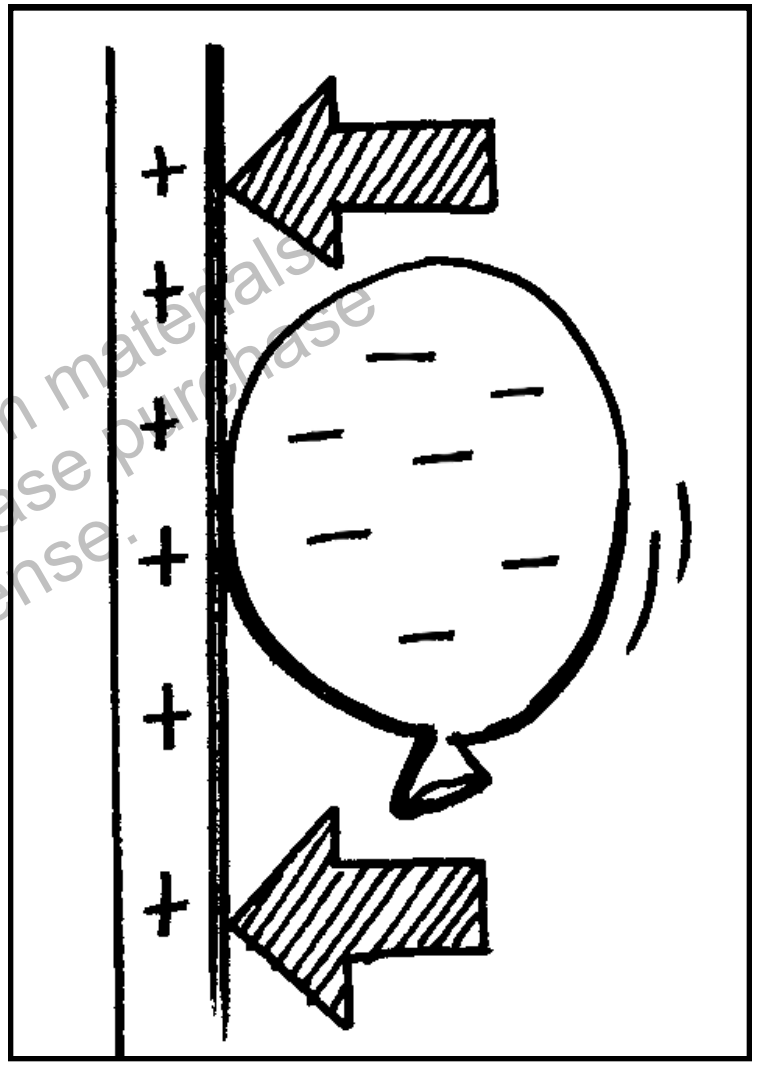
Chemical changes are usually **permanent**. They not only change the way matter looks, feels, smells, or tastes, but they also change the substance into something completely different. For example, when you melt sugar, it is no longer sugar but something else, called caramel.

So what is the difference between physical and chemical change? Sometimes, seeing the difference is easy. For example, a piece of paper may be folded to change its shape and size. This is a physical change. You can unfold the paper to its original shape and size. If you burn the paper, it changes to ash, smoke, and gases and cannot be changed back to paper. A chemical change has taken place.

Physical changes do not produce or create a new substance as chemical changes do.

**permanent:** unchanging





*Fog swirling around a bridge is condensed water vapor. When the air temperature is cool enough, fog forms near the ground. This is a physical change. The water changes state, but it is still water, not a different substance.*

## How Can You Tell the Difference?

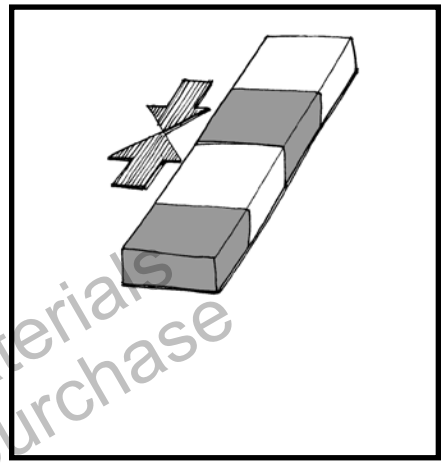
You've just read about some physical changes that are easy to see. Sometimes deciding whether a change is physical is harder. To help decide, ask yourself two questions. If you can answer yes to either question, then it is a physical change. If you answer no to both questions, it is a chemical change.

1. **Are the physical properties the same after the change?** For example, you bend a piece of wire. The shape has changed, but all of its other physical properties are the same. It is still wire. The answer is yes.

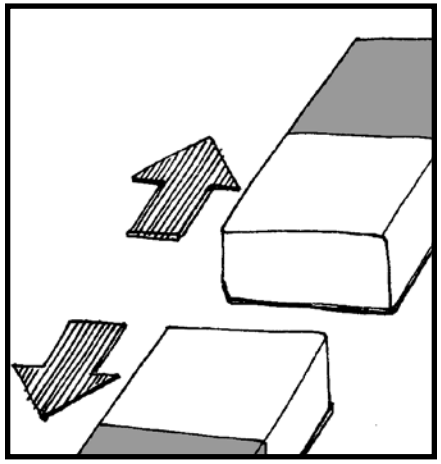
2. **Can the substance go back to the way it was?** For example, if sugar is dissolved in water, the sugar seems to disappear. However, you can still taste the sugar in the water. If the cup is left in the sun, the water will evaporate. The sugar will remain behind. The answer here also is yes.

*– Restate –*
*Explain the characteristics of a simple physical change.*





*Glass scatters when a window breaks.*
*Is this a physical change or chemical change?*



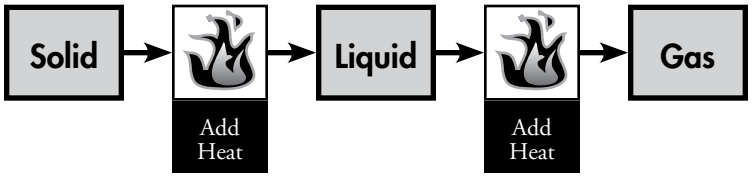
*Poor snowman! The sun is beginning to melt him.*
*Is this a physical change or chemical change?*

## Energy Flow

To change matter from one state to another, thermal energy is either added or subtracted. Heating causes a solid to melt or to evaporate. It can cause some substances to change from a solid directly to a gas without melting. This process is called sublimation. Dry ice shows sublimation. Dry ice is made from frozen carbon dioxide. You can see vapor rising directly from the dry ice, but it does not first melt into a liquid.

Subtracting energy causes gases to become liquids. They condense. Subtracting more thermal energy causes the liquid to become solid, or freeze.

Interestingly, thermal energy may be added to or subtracted from a substance. Yet the substance's temperature does not change until after the change is complete. This explains why the temperature of boiling water does not continue to rise.




*Heating adds thermal energy and causes matter to change states.*



CHAPTER 4

# Mixtures

One important physical change results in a mixture. In a mixture, two or more substances are physically combined. A physical force like shaking or stirring may combine them. For example, a tasty tossed salad often contains lettuce, other vegetables, and maybe some meat or cheese. It is a mixture. There are several types of mixtures.

## Diffusion

Diffusion occurs without shaking or stirring. The particles of a substance move throughout another substance until they are evenly distributed. This happens, for example, when a drop of dye is added to a glassful of water. Eventually, the dye is evenly spread through the water. You cannot distinguish the dye from the water.

**diffusion:** a mixture with an even distribution of particles in a substance without shaking or stirring

## Suspension

Suspensions are mixtures in which you can still see the different parts. Suspensions are stirred or shaken to mix their parts. When left alone, the parts will separate again. For example, a mixed salad is a suspension. So is the salad dressing of oil and vinegar. If you look closely, you can tell the oil from the vinegar.

*A salad is a type of mixture called a suspension. You can still see the individual parts of it.*

## Solution

Solutions consist of one substance completely dissolved in another. Iced tea mixed with sugar is an example. Usually, only a certain amount of a substance can be dissolved in another. If heated, more of the second substance can be dissolved.

**suspension:** a mixture whose different parts are clearly visible
**solution:** a mixture in which one substance is completely dissolved in another



## Physical Change Is All Around

Physical change causes the physical properties of a substance to become different. Physical change includes bending, cutting, chopping, folding, crushing, stretching, or melting anything.

Physical change can be useful. It allows us to create a bacon, lettuce, and tomato sandwich. Physical change can also be a problem. Global climate change seems to be causing some ice at the poles to melt. The melting ice could cause worldwide flooding.

Can you think of other physical changes that are useful or cause problems?

*– Summarize –*
*Write a paragraph that summarizes the main ideas in this book.*

# Glossary

**condense**—to change from a gas to a liquid

**diffusion**—a mixture with an even distribution of particles in a substance without shaking or stirring

**evaporate**—to change into a gas or vapor

**permanent**—unchanging

**physical**—having to do with things that can be seen or measured

**properties**—qualities that something has

**solution**—a mixture in which one substance is completely dissolved in another

**suspension**—a mixture whose different parts are clearly visible

**volume**—the amount of space something occupies or takes up





# To Find Out More . . .

Want to learn more about physical changes?

**Try these books**

Physical Changes by Darlene R. Stille. Compass Point, 2006.

*States of Matter* by Robert Snedden. Reed Educational and Professional Publishing, 2001.

*Solids, Liquids, and Gases* by Carol Ballard. Heinemann, 2004.

**Access these Web sites**

Chem4Kids.com
*http://www.chem4kids.com/files/matter_intro.html*

Change Is Cool
*http://www.usoe.k12.ut.us/curr/Science/sciber00/8th/matter/sciber/physchng.htm*

**Write for more information**

Museum of Science and Industry
57th Street and Lake Shore Drive
Chicago, IL 60637-2093

# Index



Published by FOCUScurriculum
866-315-7880
www.focuscurriculum.com


Order Number: ES-23AL

Created by Kent Publishing Services, Inc.
Designed by Signature Design Group, Inc.

Earth Science

Water

Advanced Level

# Assessments

## *Physical Changes in Water*



Print pages 20–22 of this PDF for the assessments.

Physical Changes in Water

# Check Understanding

**Shade the circle next to the correct answer or write your answer on the lines provided.**

**1**. A student is studying physical change in an unknown solid. Her teacher has asked her to plan an experiment to discover the melting point of the substance. What must the student do to change the substance into liquid?

Ⓐ Freeze the substance.

Ⓑ Dissolve the substance.

Ⓒ Add thermal energy to the substance.

Ⓓ Subtract thermal energy from the substance.

**2**. Which of the following statements is true of physical change?

Ⓐ The change is reversible.

Ⓑ The change is permanent.

Ⓒ A new substance is created.

Ⓓ The physical properties remain unchanged.

**3**. In a mixture, two or more substances are combined. Identify **one** type of mixture.

_____

Explain the mixture's characteristics.

_____

_____

_____

**4**. All substances are made of matter. Identify two states of matter.

1) _____

2) _____

Explain the movement of particles in each state.

_____

_____

_____

_____

# Check Understanding

**Shade the circle next to the correct answer or write your answer on the lines provided.**

**5**. Students in a fourth-grade class want to observe and record the change in temperature of a glass of water and ice every 5 minutes for a period of 20 minutes. Which table will best organize the data?

Ⓐ

| Time (Min.) | Temperature (°F) |
|---|---|
| 0 | |
| 2 | |
| 4 | |
| 6 | |
| 8 | |

Ⓑ

| Time (Min.) | Temperature (°F) |
|---|---|
| 0 | |
| 5 | |
| 10 | |
| 15 | |
| 20 | |

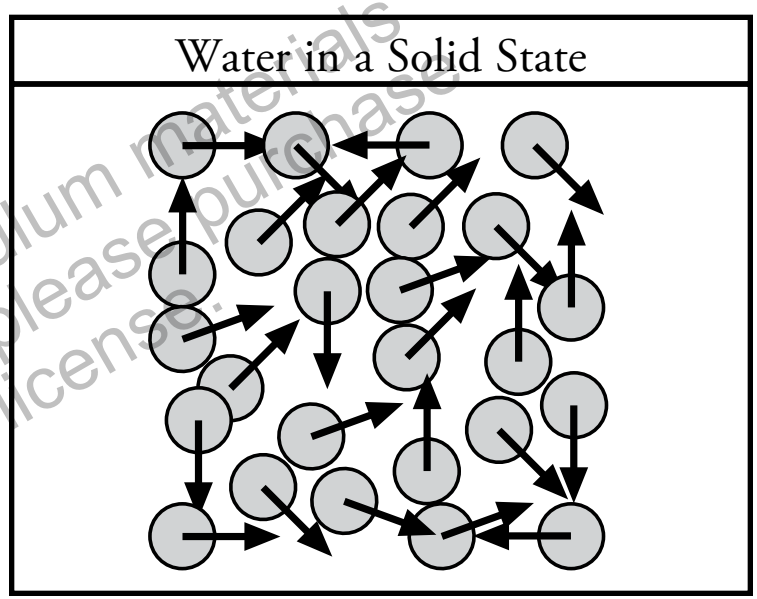
Ⓒ

| Time (Min.) | Temperature (°F) |
|---|---|
| 0 | |
| 10 | |
| 15 | |
| 20 | |
| 25 | |

Ⓓ

| Time (Min.) | Temperature (°F) |
|---|---|
| 0 | |
| 10 | |
| 20 | |
| 30 | |
| 40 | |

**6**. The following diagram shows particles of matter in a solid state.




Which description is true of water in a solid state?

Ⓐ It has no shape or size.

Ⓑ It has size but no shape.

Ⓒ It has shape but no size.

Ⓓ It has a certain size and shape.

Physical Changes in Water

# Assessment Scoring Guidelines

**1**. Answer C is correct.

**2**. Answer A is correct.

**3**. Diffusion
Particles move throughout another substance until they are evenly distributed.

Suspension
Parts of the mixture are clearly visible.

Solution
One substance is completely dissolved in another.

**4**. Solid
The particles are packed tightly together.

Liquid
The particles are able to move somewhat.

Gas
The particles can move in all directions.

**5**. Answer B is correct.

**6**. Answer D is correct.


Earth Science

Water

Advanced Level

# English Language Arts Activities

## *Physical Changes in Water*



**Print pages 24–28 of this PDF for the reading activities.**

# Summarize

**Summarizing means to retell the main points of what you have read. Summaries are shorter than the text you read. Read this paragraph. Then try to summarize it in a sentence.**

Matter can change its state from solid to liquid to gas. Water provides a good example. Solid water is called ice. It has its own shape. Liquid water is the sloshy, wet stuff you can drink. It takes the shape of any container that holds it. When water evaporates, it can be seen as steam or water vapor. Water vapor has no definite shape or volume. Water as a gas is invisible in the air.

**Is the following sentence a good summary?**

Water vapor has no definite shape or volume.

**No! The statement is too specific. It does not summarize the main idea. Is the following a good summary?**

Matter, including water, can be either a liquid, a solid, or a gas.

**Yes! It describes the main idea of the paragraph.**

TRY THE SKILL

**Read the paragraph. Shade the circle next to the best answer.**

Physical change occurs when objects or substances change their state of matter. Many properties of matter can change when this happens. Some examples of properties that might change include color, shape, size, temperature, and weight. Others include flexibility, the ability to float or sink, shininess, and magnetism.

1. Which sentence best summarizes this paragraph?

   Ⓐ Sometimes properties of matter change.

   Ⓑ Color, shape, size, and temperature are physical properties.

   Ⓒ Physical changes alter the physical properties of a substance.

# Compare and Contrast

**Comparing tells how things are alike. Contrasting tells how things are different. Read the following paragraphs and the T-chart that compares and contrasts.**

Diffusion occurs without shaking or stirring. The particles of a substance move throughout another substance until they are evenly distributed. This happens, for example, when a drop of dye is added to a glassful of water. Eventually, the dye is evenly spread through the water. You cannot distinguish the dye from the water.

Suspensions are mixtures in which you can still see the different parts. Suspensions are stirred or shaken to mix their parts. When left alone, the parts will separate again. For example, a mixed salad is a suspension. So is the salad dressing of oil and vinegar. If you look closely, you can tell the oil from the vinegar.

| Diffusions | Both | Suspensions |
|---|---|---|
| • No shaking or stirring is needed.<br>• The parts are evenly distributed.<br>• The parts are not visible.<br>• The parts will stay mixed. | • Both are mixtures.<br>• Two or more substances are put together. | • Mixed by shaking or stirring.<br>• The parts may not be evenly distributed.<br>• The parts are still visible.<br>• The parts will separate. |

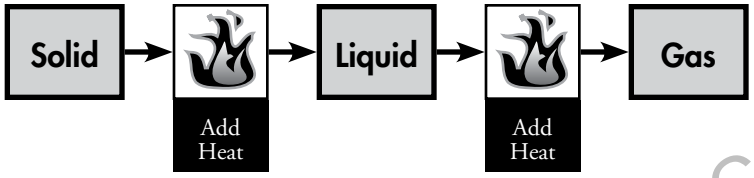
## TRY THE SKILL

**Read the following paragraph. Then create a T-chart to compare and contrast the information.**

Liquid water is the sloshy, wet stuff you can drink. It takes the shape of any container that holds it. When water evaporates, it can be seen as steam or water vapor. Water vapor has no definite shape or volume. Water as a gas is invisible in the air.

# Analyze Charts

**Charts and graphs are like pictures that give information. The chart below shows what happens when heat is added to a substance. You can see that the form of the substance changes. Look at the chart below.**




1. **What happens when heat is added to a solid?**

   It becomes a liquid.

2. **What happens when heat is added to a liquid?**

   It becomes a gas.

3. **Which of these would be the hottest: solid, liquid, or gas?**

   A gas would be the hottest.

4. **What do you think would happen if you removed heat energy from a liquid?**

   It would become a solid.

TRY THE SKILL

**Look at the chart below and then answer the questions.**

**Boiling Points of Different Substances**

| | |
|---|---|
| Water | 212° F |
| Iron | 4,982° F |
| Oxygen | -297.4° F |

1. List the boiling points in the chart from the lowest to the highest.

   _____

   _____

2. Which substance has the highest boiling point?

   _____

3. Which substance has a boiling point that is below 0° F?

   _____

4. Which substance needs the most energy to reach its boiling point?

   _____

# Antonyms

**Antonyms are words that have opposite meanings from each other. Some examples of antonyms are:**

*asleep* and *awake*
*dark* and *light*
*sink* and *float*
*freeze* and *liquefy*

**Read the following paragraph. Look for antonyms.**

To change matter from one state to another, heat energy is either added or subtracted. Adding heat causes a solid to melt or to evaporate. It can cause substances to move from solid directly to a gas without melting. This process is called sublimation.

Subtracting energy causes gases to become liquids. They condense. Subtracting more heat causes the liquid to become solid, or freeze.

**What antonyms did you find?**

Antonyms include *added* and *subtracted, solid* and *liquid,* and *freeze* and *melt.*

TRY THE SKILL

**Read the following paragraphs. Look for antonyms. Write them on the lines below.**

Subtracting thermal energy, or cooling, will also change the state of matter. If a gas cools enough, it condenses. If you have ever had a cold drink on a hot day, you have seen condensation. It is what forms the little water drops on the outside of your glass. The water vapor in the air condenses on the cold surface of the glass.

Continue to subtract thermal energy, and the liquid becomes a solid. For water, this is the point at which it becomes ice. Water's freezing point is 32° F or 0° C.

_____

_____

_____

# Answer Key

## Summarize

**1**. C

## Compare and Contrast

**Water as a Liquid:** Takes the shape of its container.
Is visible.
Both: Both are forms of water.
**Water as a Gas:** Called steam or water vapor.
Has no definite shape or volume. Is invisible.

## Analyze Charts

**1**. The boiling points in order of lowest to highest are -297.4° F, 212° F, and 4,982° F.
**2**. Iron has the highest boiling point.
**3**. Oxygen's boiling point is below zero.
**4**. Iron needs the most energy to reach its boiling point.

## Antonyms

cold/hot
liquid/solid