



ESSENTIAL QUESTION

How Does Matter Change?



Engage Your Brain

As you read the lesson, look for the answer to the following question and record it here.

A piece of iron can change in different ways. How is iron bending different from iron rusting?



ACTIVE READING

Lesson Vocabulary

List the terms. As you learn about each one, make notes in the Interactive Glossary.

Main Idea and Details

Detail sentences give information about a topic. The information may be examples, features, characteristics, or facts. Active readers stay focused on the topic when they ask, What fact or information does this sentence add to the topic?

Classifying Change



- ▲ Slicing apples and cracking eggs are physical changes.

Matter has properties, but matter also undergoes changes. How many different ways does matter change?

ACTIVE READING Each visual on these two pages has an empty bubble. Write a C if the visual shows a chemical change. Write a P if it shows a physical change.

Matter has physical properties that can be observed without changing the type of matter. Matter can also change in ways that do not affect the type of matter. These changes are called **physical changes**.

When you sharpen a pencil, the pencil goes through a physical change. The wood shavings and bits of graphite don't look like a pencil any more. But the wood is still wood, and the graphite is still graphite.



When an apple pie cooks, chemical changes occur. Cooked apples do not have the same properties as a raw apple.



- ▲ Slicing a pie is another physical change.



▲ The properties of the ash and gases that form when wood burns are different from the properties of wood.



▲ When iron rusts, it undergoes a chemical change.

Matter has other properties that cannot be observed without changing the identity of the matter. These properties are chemical properties. For example, you don't know if a type of matter will burn unless you burn it. When matter burns, it changes identity.

In the same way, **chemical changes** result in a change in the identity of matter. When a strawberry rots, it undergoes chemical change. The rotten strawberry's properties are quite different from those of a fresh strawberry. A chemical **reaction** is the process in which new substances are formed during a chemical change.

◀ When you eat apple pie, chemical changes in your body digest the food.



► Place a *P* by each physical change and a *C* by each chemical change.

Change	Type
Bacteria decompose leaves.	
A newspaper turns yellow in sunlight.	
Water evaporates.	
Gasoline burns in a car engine.	

Swelling and Shrinking

Why do you think many car owners use one tire pressure in summer and another one in winter? When temperature differs, volume often differs.

ACTIVE READING As you read this page, draw two lines under each main idea. Circle an example of matter expanding when it becomes warmer.

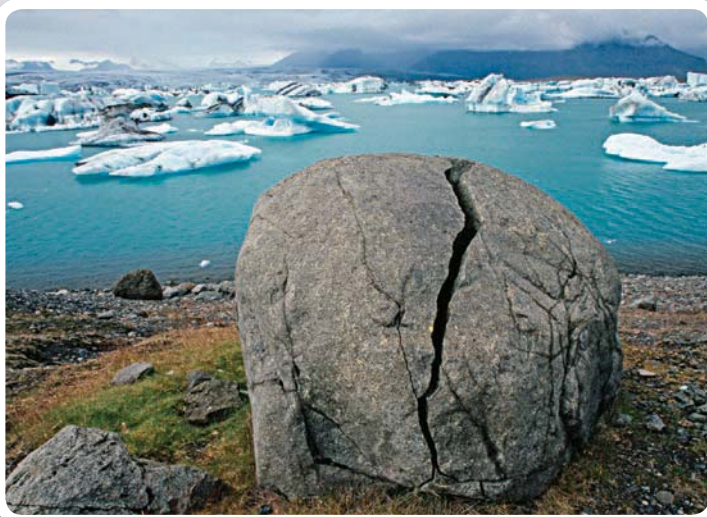
Most matter expands when the temperature goes up and contracts when the temperature goes down. Some kinds of matter expand and contract more than others. People may run hot water over the metal lid of a glass jar. This expands the lid so that it's easier to take off the jar.

One exception is water. It expands when it freezes. Because ice takes up more volume than the same amount of liquid water, ice is less dense than water. That's why ice floats in a glass of water. In winter, ice first forms at the surface of a lake.

One of water's unique properties is that it expands when it freezes.

Frozen Water
Volume = 1.09 L

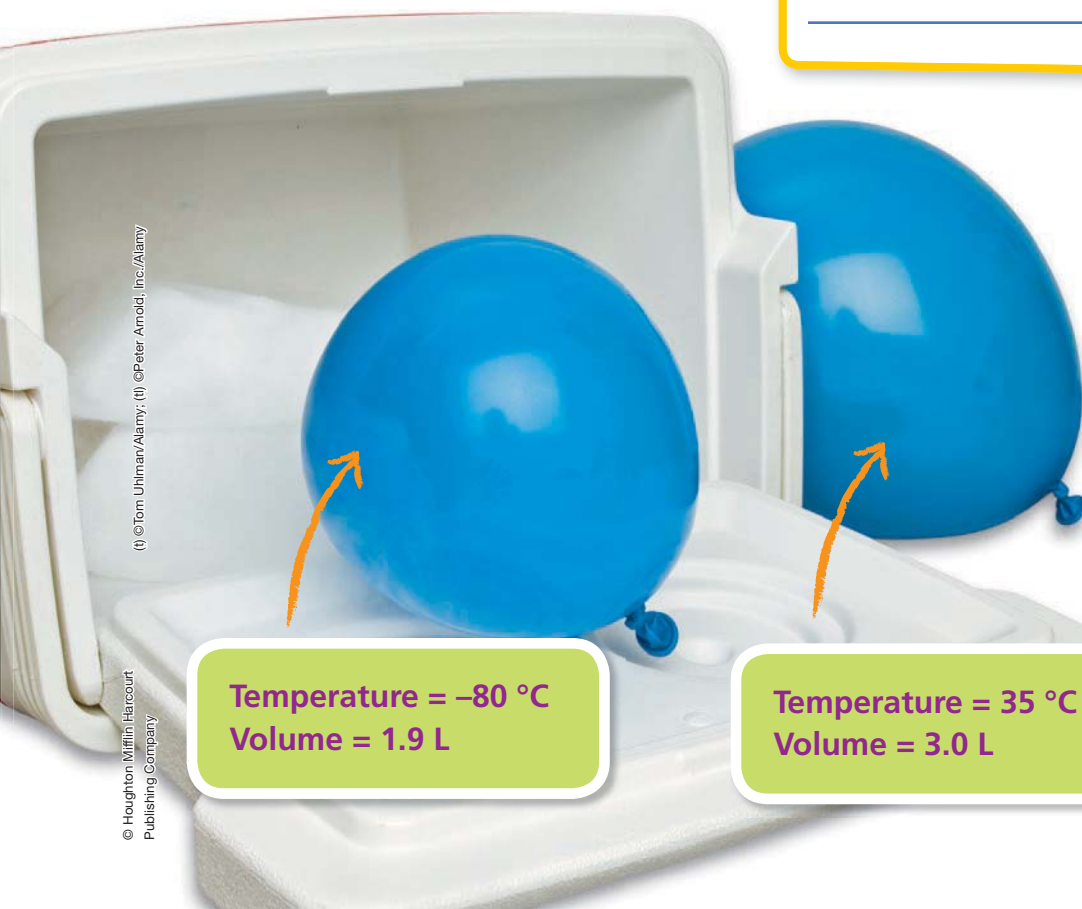
Liquid Water
Volume = 1.00 L



◀ Sometimes water flows into cracks in rocks and freezes. The expanding water makes the cracks in the rock larger and breaks large rocks into smaller pieces.

Expansion Joints

► Explain why bridges have expansion joints in them.



◀ This photo shows the same balloon at two different temperatures. The size of a sample of gas depends on its temperature. The gas in a balloon expands when it is warmed. The gas compresses when it is cooled.

Temperature = -80°C
Volume = 1.9 L

Temperature = 35°C
Volume = 3.0 L

Tampering with Temperature

When a burner on a stove is really hot, it glows red. A change in color is just one way temperature can affect matter.

ACTIVE READING As you read this page, underline examples of how temperature affects physical changes in matter.

Some physical changes, such as tearing a piece of paper, are not affected by temperature. Other physical changes happen faster or slower at different temperatures. How quickly a change occurs is called the rate of change.

For example, ice on a lake will melt if the air temperature is above 0°C . It will melt even faster if the air temperature is warmer. In the same way, water condenses more quickly on the outside of a very cold soft drink can than it does on a cool can.

Hot! Hot! Hot!
As iron is heated, it glows red or yellow.



WOW! This metal rod has been heated to more than 500°C (932°F).



OUCH! The filament of a light bulb is made of a metal called tungsten. It is glowing because it is heated to $2,500^{\circ}\text{C}$!



DO THE MATH

Graph Data

The data table shows how long it takes identical ice cubes to melt when placed in equal amounts of water at different temperatures. Make a line graph of these data.

Temperature of water (°C)	Melting time of ice (sec)
14	450
19	300
27	170
42	140
48	90
70	25



When grass and the air around it cool at night, water vapor in the air might condense, forming dew. As morning sunlight warms the air, the dew evaporates. In this photograph, the grass in the shade is wet but the grass in the sun has dried.

Adding it Up!

What happens to the mass of substances during physical or chemical changes?

ACTIVE READING As you read these pages, underline examples of conservation of mass.

During physical and chemical changes, matter may change its appearance or its identity. In either type of change, the total mass of the matter before and after the change remains the same. This is called **conservation of mass**. To *conserve* means “to save.”

For example, as water boils, it seems to disappear. However, the total mass of the particles of water vapor in the air equals the mass of the water that boiled away. Suppose you tear a 100-gram cardboard box into pieces. The total mass of all the pieces will also be 100 grams. The mass of the cardboard box stays the same. In this example, however, the volume of the cardboard box changes because tearing it into pieces causes it to lose its shape.

The total mass of the mixed salad is the sum of the masses of the vegetables in it.



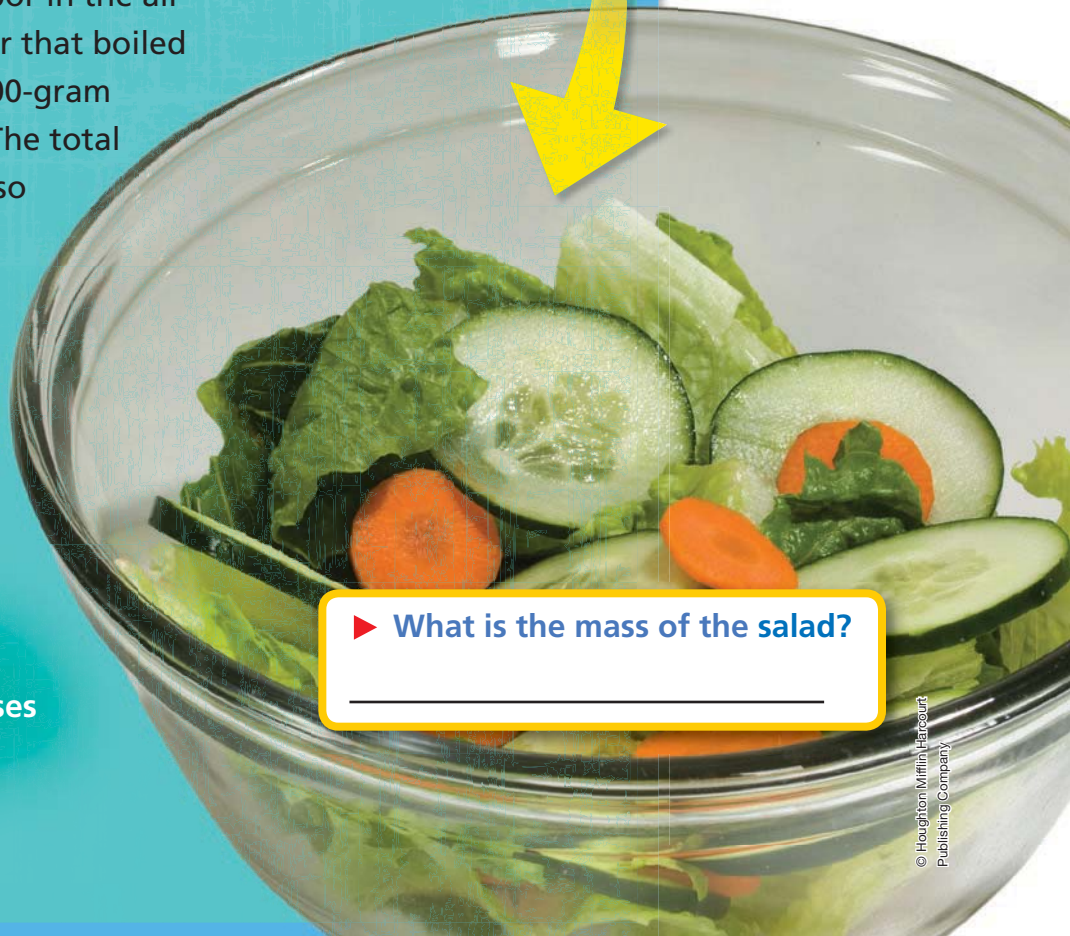
75 grams



110 grams



90 grams



► What is the mass of the salad?



During this chemical reaction, the flask is sealed. Nothing can enter or leave, so the final mass equals the starting mass.

A chemical change turns one kind of matter into another. However, the mass of the matter stays the same. It can be tricky to compare, though. First, you must collect and measure the mass of everything you begin with. Then, you must collect and measure the mass of everything you are left with.

When wood burns, it combines with oxygen from the air. Burning produces ashes, smoke, and other gases. The mass of the wood and oxygen equals the mass of the ashes, smoke, and gases that are produced.



DO THE MATH

Solve Problems

In a physical change, sugar is dissolved in water to form sugar water. In a chemical change, iron combines with oxygen to form rust. Fill in the missing values in the table.

Physical Change	Mass (grams)
sugar	125
water	
sugar water	198
Chemical Change	
iron	519
oxygen	23
rust	

Faster or Slower?

Temperature affects the rate at which chemical changes occur, too. Read to find out how.

ACTIVE READING As you read this page, circle two clue words or phrases that signal a detail such as an example or an added fact.

Increasing temperature often speeds up the rate of a chemical change. For example, increasing oven temperature speeds up the chemical changes that occur when a cake bakes or a potato cooks.

Decreasing temperature usually slows down the rate of chemical change. This is why food stays fresh longer when it is kept cool. Also, unused batteries stay charged longer when kept in the refrigerator.



The chemical changes that make food spoil are slowed down by keeping the food in the refrigerator.

cold water



warm water



An effervescent antacid tablet reacts more quickly with warm water than it does with cold water.



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Fevers

You feel awful. Your head hurts, and you have a fever. Why might having a fever be a good thing?

When you have a fever, your temperature rises above your normal body temperature (about 37°C). A low fever is between 38°C and 39°C . A high fever is greater than 40°C . Low fevers help the body fight disease. High fevers can cause severe problems.

Temperature can increase for many reasons. For example, certain bacteria have materials that your brain identifies as harmful. The brain sends out signals that cause an increase in the chemical changes that produce energy. Your temperature increases. Bacteria cannot survive at this higher temperature.



DO THE MATH

Use a Number Line

On the number line below, plot the following values in $^{\circ}\text{C}$.

- a. normal body temperature
- b. a slight fever
- c. a high fever

