

# Weathering

## ESSENTIAL QUESTION

**How does weathering change Earth's surface?**

By the end of this lesson, you should be able to analyze the effects of physical and chemical weathering on Earth's surface, including examples of each kind of weathering.

Wave Rock in Australia may look like an ocean wave, but it was actually formed when the rock in the middle of this formation weathered faster than the rock at the top.

## Lesson Labs

### Quick Labs

- Mechanical Weathering
- Weathering Chalk
- How Can Materials on Earth's Surface Change?

## Engage Your Brain

**1 Predict** Check T or F to show whether you think each statement is true or false.

- | T                        | F                        |   |
|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | Rocks can change shape and composition over time.           |
| <input type="checkbox"/> | <input type="checkbox"/> | Rocks cannot be weathered by wind and chemicals in the air. |
| <input type="checkbox"/> | <input type="checkbox"/> | A rusty car is an example of weathering.                    |
| <input type="checkbox"/> | <input type="checkbox"/> | Plants and animals can cause weathering of rocks.           |

**2 Describe** Your class has taken a field trip to a local stream. You notice that the rocks in the water are rounded and smooth. Write a brief description of how you think the rocks changed over time.

## Active Reading

**3 Synthesize** You can often find clues to the meaning of a word by examining the use of that word in a sentence. Read the following sentences and write your own definition for the word *abrasion*.

### Example sentences

Bobby fell on the sidewalk and scraped his knee. The abrasion on his knee was painful because of the loss of several layers of skin.

**abrasion:**

## Vocabulary Terms

- |                       |                       |
|-----------------------|-----------------------|
| • weathering          | • chemical weathering |
| • physical weathering | • oxidation           |
| • abrasion            | • acid precipitation  |

**4 Apply** As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.



# BreakItDown

## What is weathering?

Did you know that sand on a beach may have once been a part of a large boulder? Over millions of years, a boulder can break down into many smaller pieces. The breakdown of rock material by physical and chemical processes is called **weathering**. Two kinds of weathering are *physical weathering* and *chemical weathering*.

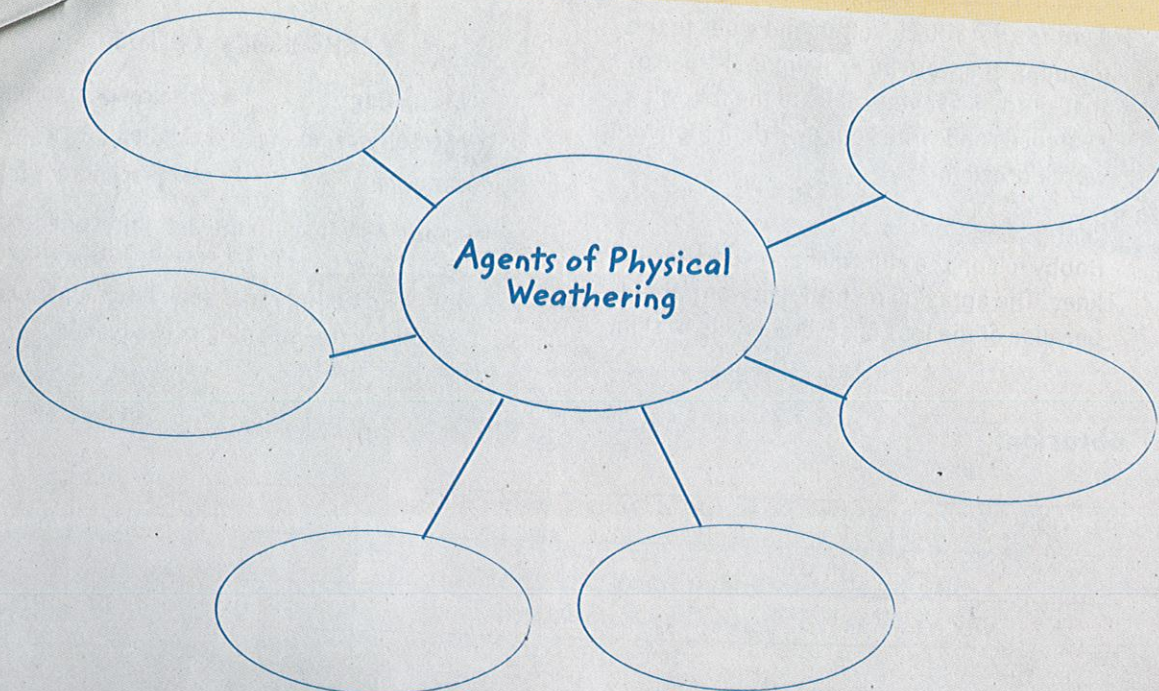
## What causes physical weathering?

Rocks can get smaller and smaller without a change in the composition of the rock. This is an example of a physical change. The process by which rock is broken down into smaller pieces by physical changes is **physical weathering**. Temperature changes, pressure changes, plant and animal actions, water, wind, and gravity are all agents of physical weathering.

As materials break apart, they can become even more exposed to physical changes. For instance, a large boulder can be broken apart by ice and water over time. Eventually, the boulder can split in two. Now there are two rocks exposed to the agents of physical weathering. In other words, the amount of surface area exposed to the agents of physical weathering increases. The large boulder can become thousands of tiny rocks over time as each new rock increases the amount of surface area able to be weathered.

### Active Reading

**5 Identify** As you read, place the names of some common agents of physical weathering in the graphic organizer below.



### Visualize It!

**6 Describe** Write a caption for each of the images to describe the process of ice wedging

Ice Wedging



Water



Ice



Water



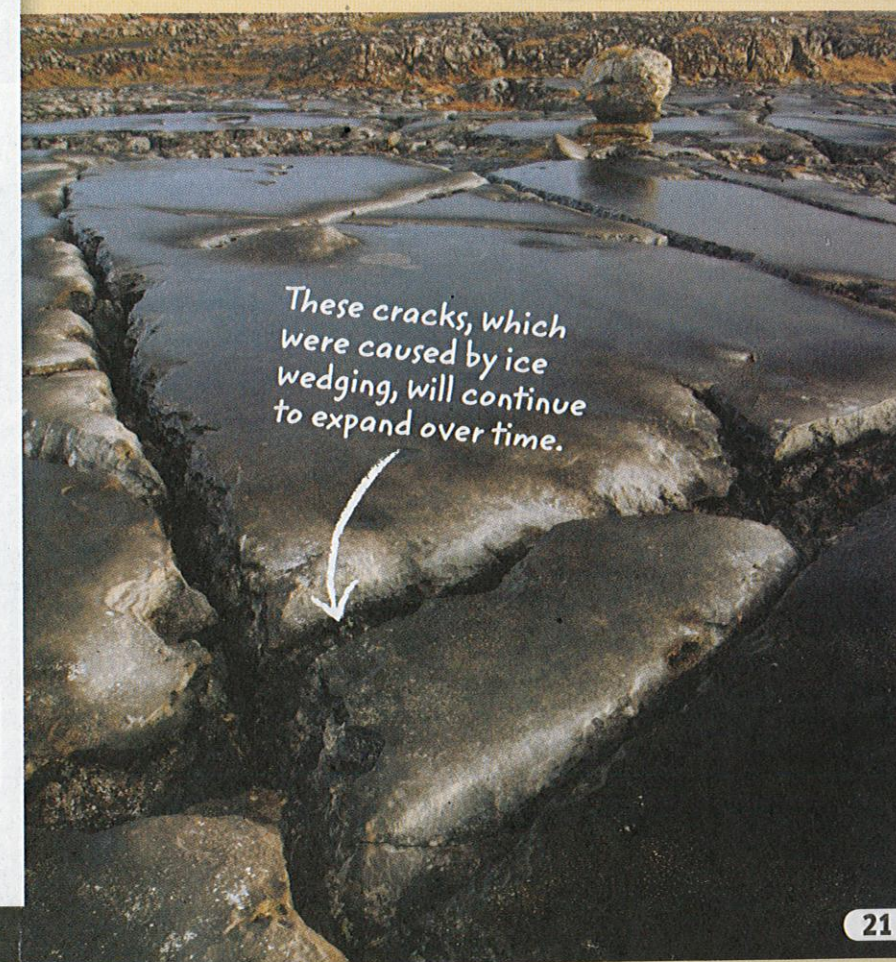
Ice

## Temperature Change

Changes in temperatures can cause a rock to break apart. A rise in temperature will cause a rock to expand. A decrease in temperature will cause a rock to contract. Repeated temperature changes can weaken the structure of a rock, causing the rock to crumble. Even changes in temperature between day and night can cause rocks to expand and contract. In desert regions differences in day and night temperatures can be significant. Rocks can weaken and crumble from the stress caused by these temperature changes.

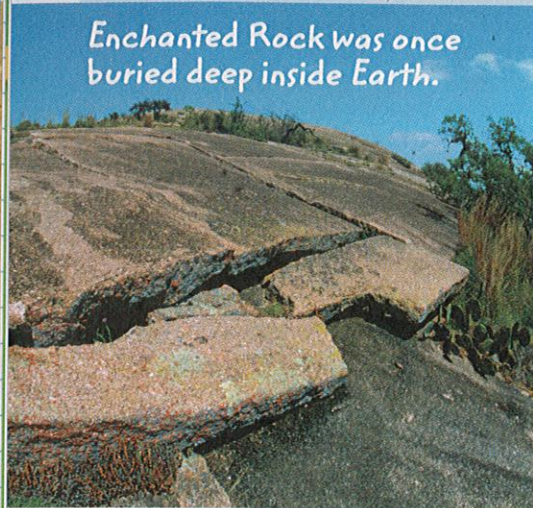
*Ice wedging*, sometimes known as *frost wedging*, can also cause rocks to physically break apart, as shown in the image below. Ice wedging causes cracks in rocks to expand as water seeps in and freezes. When water collects in cracks in rock and the temperature drops, the water may freeze. Water expands as it freezes to become ice. As the ice expands, the crack will widen. As more water enters the crack, it can expand to an even larger size. Eventually, a small crack in a rock can cause even the largest of rocks to split apart.

**7 Hypothesize** Where on Earth would physical weathering from temperature changes be most common? Least common? Explain.





Enchanted Rock was once buried deep inside Earth.



## Pressure Change

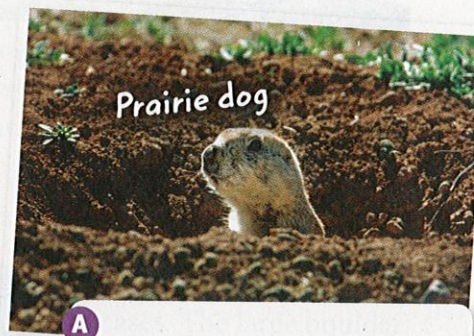
Physical weathering can be caused by pressure changes. Rocks formed under pressure deep within Earth can become exposed at the surface. As overlying materials are removed above the rock, the pressure decreases. As a result, the rock expands, causing the outermost layers of rock to separate from the underlying layers, as shown to the left. *Exfoliation* (ex•foh•lee•AY•shun) is the process by which the outer layers of rock slowly peel away due to pressure changes. Enchanted Rock in Texas is a 130 m–high dome of granite that is slowly losing the outermost layers of rock due to exfoliation and other processes.

## Animal Action

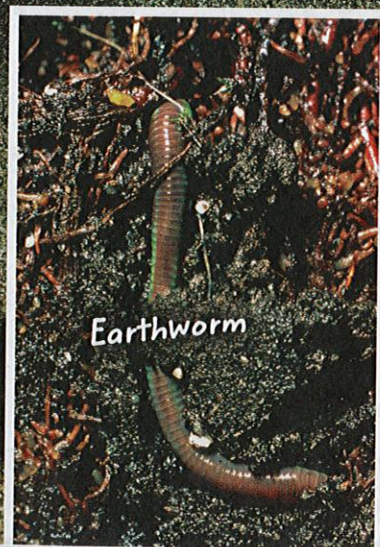
Animals can cause physical weathering. Many animals dig burrows into the ground, allowing more rock to be exposed. Common burrowing animals include ground squirrels, prairie dogs, ants, and earthworms. These animals move soils and allow new rocks, soils, and other materials to be exposed at the surface, as shown below. Materials can undergo weathering below the surface, but are more likely to be weathered once exposed at the surface.

### Visualize It!

**8 Describe** Write a caption for each animal describing how it might cause physical weathering.



A



B



Some pocket gophers can dig burrows up to 240 m in length.

C

## Wind, Water, and Gravity

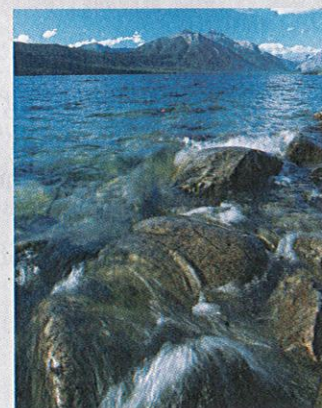
Rock can be broken down by the action of other rocks over time.

**Abrasion** (uh•BRAY•zhuhn) is the breaking down and wearing away of rock material by the mechanical action of other rock. Three agents of physical weathering that can cause abrasion are moving water, wind, and gravity. Also, rocks suspended in the ice of a glacier can cause abrasion of other rocks on Earth's surface.

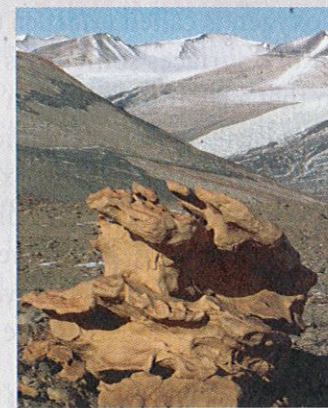
In moving water, rock can become rounded and smooth. Abrasion occurs as rocks are tumbled in water, hitting other rocks. Wind abrasion occurs when wind lifts and carries small particles in the air. The small particles can blast away at surfaces and slowly wear them away. During a landslide, large rocks can fall from higher up a slope and break more rocks below, causing abrasion.

### Active Reading

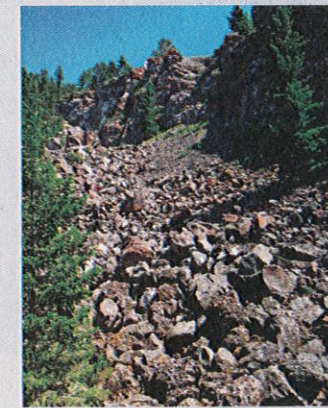
**9 Identify** As you read, underline the agents of weathering that cause abrasion.



Rocks are tumbled in water, causing abrasion.



Wind-blown sand can blast small particles away.



Rocks can be broken down in a landslide.

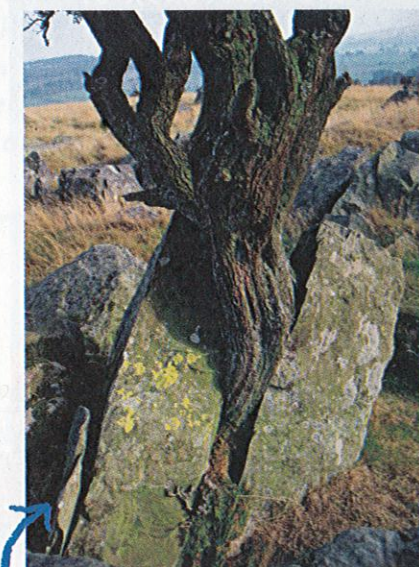
## Plant Growth

You have probably noticed that just one crack in a sidewalk can be the opening for a tiny bit of grass to grow. Over time, a neglected sidewalk can become crumbly from a combination of several agents of physical weathering, including plant growth. Why?

Roots of plants do not start out large. Roots start as tiny strands of plant matter that can grow inside small cracks in rocks. As the plant gets bigger, so do the roots. The larger a root grows, the more pressure it puts on rock. More pressure causes the rock to expand, as seen to the right. Eventually, the rock can break apart.

### Think Outside the Book Inquiry

**10 Summarize** Imagine you are a rock. Write a short biography of your life as a rock, describing the changes you have gone through over time.



This tree started as a tiny seedling and eventually grew to split the rock in half.



# Reaction

## What causes chemical weathering?

Chemical weathering changes both the composition and appearance of rocks. **Chemical weathering** is the breakdown of rocks by chemical reactions. Agents of chemical weathering include oxygen in the air and acids.

### Reactions with Oxygen

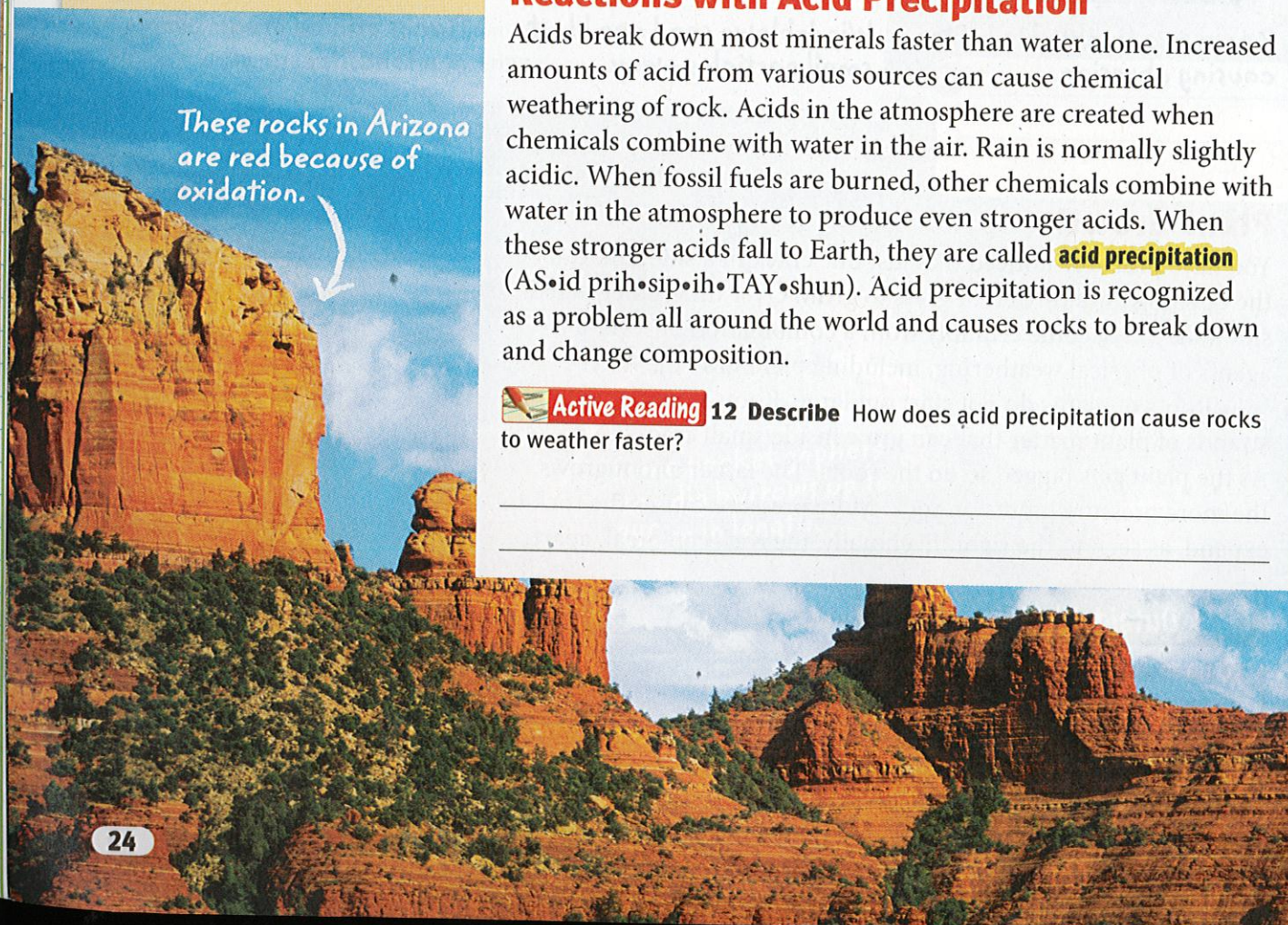
Oxygen in the air or in water can cause chemical weathering. Oxygen reacts with the compounds that make up rock, causing chemical reactions. The process by which other chemicals combine with oxygen is called **oxidation** (ahk•si•DAY•shun).

Rock surfaces sometimes change color. A color change can mean that a chemical reaction has taken place. Rocks containing iron can easily undergo chemical weathering. Iron in rocks and soils combines quickly with oxygen that is dissolved in water. The result is a rock that turns reddish orange. This is rust! The red color of much of the soil in the southeastern United States and of rock formations in the southwestern United States is due to the presence of rust, as seen in the image below.

### Reactions with Acid Precipitation

Acids break down most minerals faster than water alone. Increased amounts of acid from various sources can cause chemical weathering of rock. Acids in the atmosphere are created when chemicals combine with water in the air. Rain is normally slightly acidic. When fossil fuels are burned, other chemicals combine with water in the atmosphere to produce even stronger acids. When these stronger acids fall to Earth, they are called **acid precipitation** (AS•id prih•sip•ih•TAY•shun). Acid precipitation is recognized as a problem all around the world and causes rocks to break down and change composition.

**Active Reading** 12 **Describe** How does acid precipitation cause rocks to weather faster?

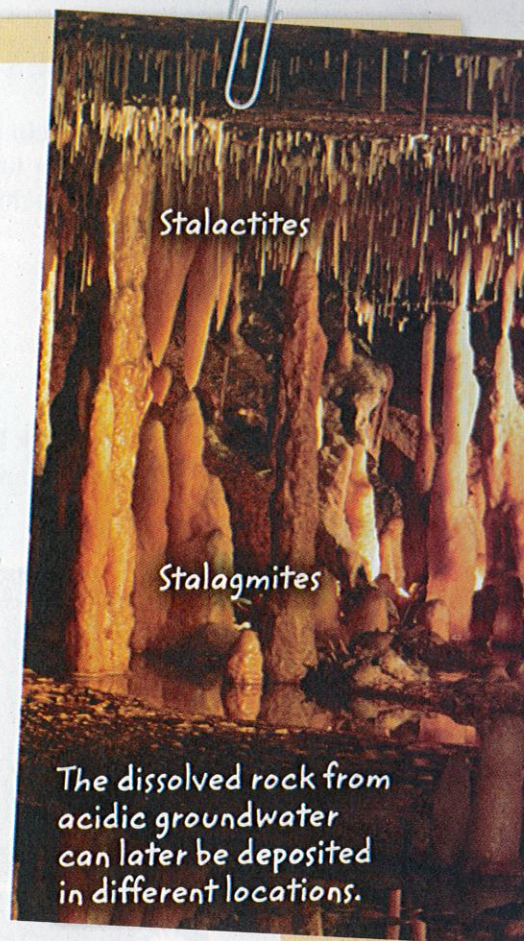


### Reactions with Acids in Groundwater

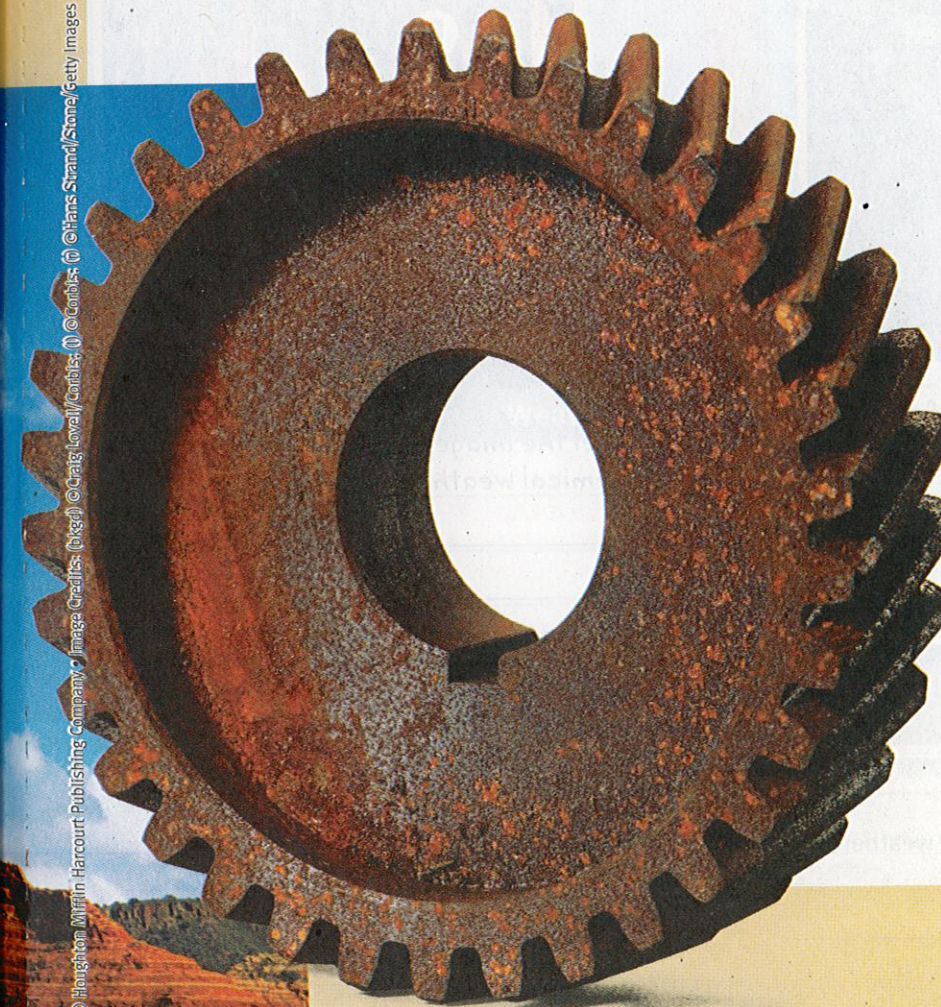
Water in the ground, or groundwater, can cause chemical weathering. As groundwater moves through spaces or cracks in rock, acids in the water can cause rocks to dissolve. A small crack in a rock can result in the formation of extensive cave systems that are carved out over time under Earth's surface, as shown to the right. The dissolved rock material is carried in water until it is later deposited. Stalactites (stuh•LAHK•tyt) and stalagmites (stuh•LAHG•myt) are common features in cave systems as dissolved chemicals are deposited by dripping water underground.

### Reactions with Acids in Living Things

Acids are produced naturally by certain living organisms. For instance, lichens (LY•kuhns) and mosses often grow on rocks and trees. As they grow on rocks, they produce weak acids that can weather the rock's surface. As the acids move through tiny spaces in the rocks, chemical reactions can occur. The acids will eventually break down the rocks. As the acids seep deeper into the rocks, cracks can form. The rock can eventually break apart when the cracks get too large.



The dissolved rock from acidic groundwater can later be deposited in different locations.



### Think Outside the Book

13 **Apply** Think of an item made by humans that could be broken down by the agents of physical and chemical weathering. Describe to your classmates all of the ways the item could change over time.

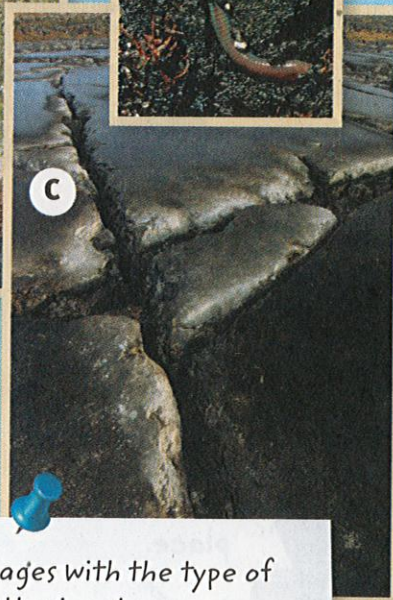
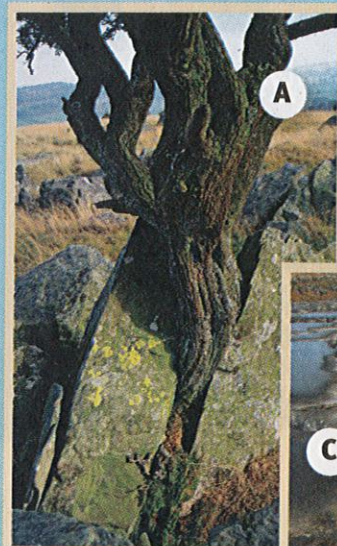


# Visual Summary

To complete this summary, fill in the blanks with the correct word or phrase. Then use the answer key to check your answers. You can use this page to review the main concepts of the lesson.

## Weathering

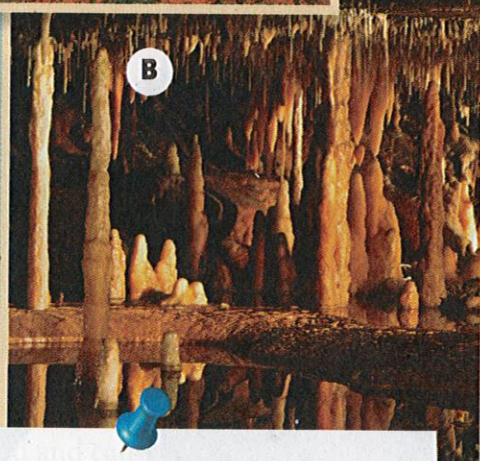
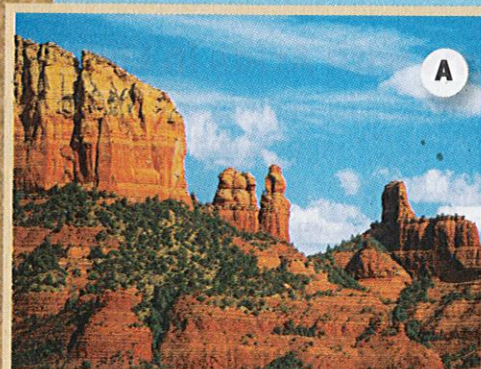
Physical weathering breaks rock into smaller pieces by physical means.



14 Label the images with the type of physical weathering shown.

- A \_\_\_\_\_  
B \_\_\_\_\_  
C \_\_\_\_\_

Chemical weathering breaks down rock by chemical reactions.



15 Label the images with the type of chemical weathering shown.

- A \_\_\_\_\_  
B \_\_\_\_\_

Answers: 14 A, plant growth; B, animal action; C, ice wedging; 15 A, oxidation; B, reactions with acids

16 Relate Why are some rocks more easily weathered than other rocks?

# Lesson Review

## Vocabulary

Fill in the blank with the term that best completes the following sentences.

- 1 Acid precipitation is an agent of \_\_\_\_\_ weathering.
- 2 The gradual wearing away or breaking down of rocks by abrasion is a type of \_\_\_\_\_ weathering.
- 3 The process of \_\_\_\_\_ causes rocks to change composition when reacting with oxygen.
- 4 The mechanical breakdown of rocks by the action of other rocks and sand particles is called \_\_\_\_\_.

## Key Concepts

5 Compare What are some similarities and differences between physical and chemical weathering?

6 List Provide examples of physical weathering and chemical weathering in the chart below.

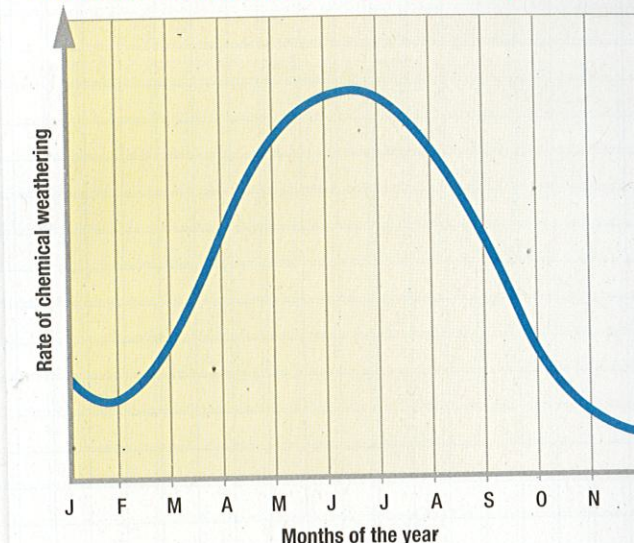
Physical Weathering	Chemical Weathering

7 Compare What are some similarities between ice wedging and plant root growth in a rock?

## Critical Thinking

Use the graph to answer the following questions.

The Effect of Temperature on Rates of Weathering



8 Analyze Which two months had the highest rates of chemical weathering?

9 Apply Why do you think those two months had the highest rates of chemical weathering?

10 Infer Coastal regions are often affected by abrasion. What processes would cause increased abrasion along a coastal region? Explain.