What Is Weathering?
How do large rocks turn into smaller rocks?
Weathering is the process in which rocks break down. There are two main kinds of weathering: mechanical weathering and chemical weathering.

What Is Mechanical Weathering?
Mechanical weathering happens when rocks are broken into pieces by physical means. There are many agents, or causes, of mechanical weathering.

ICE

Ice is one agent of mechanical weathering. Cycles of freezing and thawing can cause ice wedging, which can break rock into pieces.

The cycle of ice wedging starts when water seeps into cracks in a rock. When the water freezes, it expands. The ice pushes against the cracks. This causes the cracks to widen. When the ice melts, the water seeps further into the cracks. As the cycle repeats, the cracks get bigger. Finally, the rock breaks apart.

Critical Thinking

2. Infer Would ice wedging happen if water did not expand as it froze? Explain your answer.
WIND, WATER, AND GRAVITY

As you scrape a large block of chalk against a board, tiny pieces of the chalk rub off on the board. The large piece of chalk wears down and becomes smaller. The same process happens with rocks. Abrasion is a kind of mechanical weathering that happens when rocks are worn away by contact with other rocks. Abrasion happens whenever one rock hits another. Water, wind, and gravity can cause abrasion.

**Say It**
Discuss In a small group, talk about some different environments in which abrasion may happen.

**Take a Look**
3. Explain How does running water cause abrasion?

**Plant Growth**

Have you ever seen sidewalks and streets that are cracked because of tree roots? Plant roots may grow into cracks in rock. As the plants grow, their roots get larger. The growing roots can make the cracks in the rock wider. In time, an entire rock can split apart. Roots don’t grow fast, but they are very powerful!
ANIMALS
Did you know that earthworms cause a lot of weathering? They tunnel through the soil and move pieces of rock around. This motion breaks some of the rocks into smaller pieces. It also exposes more rock surfaces to other agents of weathering.

Any animal that burrows in the soil causes mechanical weathering. Ants, worms, mice, coyotes, and rabbits are just a few of the animals that can cause weathering. The mixing and digging that animals do can also cause chemical weathering, another kind of weathering.

What Is Chemical Weathering?
In addition to physical weathering, rocks can be broken down by chemical means. **Chemical weathering** happens when rocks break down because of chemical reactions.

Water, acids, and air are all agents of chemical weathering. They react with the chemicals in the rock. The reactions can break the bonds in the minerals that make up the rock. When the bonds in the minerals are broken, the rock can be worn away.

WATER
If you drop a sugar cube into a glass of water, the sugar cube will dissolve after a few minutes. In a similar way, water can dissolve some of the chemicals that make up rocks. Even very hard rocks, such as granite, can be broken down by water. However, this process may take thousands of years or more.

**Chemical Weathering in Granite**

Granite is made of many different minerals. Rain and air can contain chemicals that react with the minerals.

Eventually, many of the minerals in the granite will be broken down. The small pieces of minerals that are left are called sediment.

The chemicals in rain and air can break down the bonds in the minerals. Rain can dissolve some of the minerals in the rock and wash them away.

STANDARDS CHECK

**ES 1k** Living organisms have played many roles in the Earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.

**Word Help:** role
a part or function; purpose

**Word Help:** affect
to change; to act upon

4. Describe How can earthworms cause weathering?

READING CHECK

5. List What are three agents of chemical weathering?

TAKE A LOOK

6. Infer What do you think is the reason it takes a very long time for granite to break down?
ACID PRECIPITATION

Precipitation, such as rain and snow, always contains a little bit of acid. However, sometimes precipitation contains more acid than normal. Rain, sleet, or snow that contains more acid than normal is called **acid precipitation**.

Acid precipitation forms when small amounts of certain gases mix with water in the atmosphere. The gases come from natural sources, such as active volcanoes. They are also produced when people burn fossil fuels, such as coal and oil.

The acids in the atmosphere fall back to the ground in rain and snow. Acids can dissolve materials faster than plain water can. Therefore, acid precipitation can cause very rapid weathering of rock.

ACIDS IN GROUNDWATER

In some places, water flows through rock underground. This water, called *groundwater*, may contain weak acids. When the groundwater touches some kinds of rock, a chemical reaction happens. The chemical reaction dissolves the rock. Over a long period of time, huge caves can form where rock has been dissolved.

![This cave formed when acids in groundwater dissolved the rock.](image)
ACIDS FROM LIVING THINGS

All living things make weak acids in their bodies. When the living things touch rock, some of these acids are transferred to the surface of the rock.

The acids react with chemicals in the rock and weaken it. The different kinds of mechanical weathering can more easily remove rock in these weakened areas.

The rock may also crack in the weakened areas. Even the smallest crack can expose more of the rock to both mechanical weathering and chemical weathering.

AIR

Have you ever seen a rusted car or building? Rusty metal is an example of chemical weathering. Metal reacted with something to produce rust. What did the metal react with? In most cases, the answer is air.

The oxygen in the air can react with many metals. These reactions are a kind of chemical weathering called oxidation. Rust is a common example of oxidation. Rocks can rust if they have a lot of iron in them.

Many people think that rust forms only when metal gets wet. In fact, oxidation can happen even without any water around. However, when water is present, oxidation happens much more quickly.

Oxidation can cause rocks to weaken. Oxidation changes the metals in rocks into different chemicals. These chemicals can be broken down more easily than the metals that were there before.

<table>
<thead>
<tr>
<th>Factor</th>
<th>How does it cause chemical weathering?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Acid precipitation</td>
<td></td>
</tr>
<tr>
<td>Acids in groundwater</td>
<td></td>
</tr>
<tr>
<td>Acids from living things</td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
</tr>
</tbody>
</table>

9. **Explain** How can acids from living things cause weathering?

10. **Describe** Fill in the blank spaces in the table to describe how different factors cause chemical weathering.
1. List  What are three things that can cause abrasion?

2. Explain  Fill in the spaces to show the steps in the cycle of ice wedging.

   Water seeps into cracks in the rock.

   The cracks expand.

3. Identify  How can acids cause chemical weathering?

4. Compare  How is mechanical weathering caused by ice wedging similar to mechanical weathering caused by plant roots?
2. A large volume of gases and ash may be released during a volcanic eruption. These gases and ash can prevent sunlight from reaching the Earth. This can cause global temperatures to decrease.

3. cinder cones, composite volcanoes, shield volcanoes.

4. The lava that forms them is thin and runny and spreads out over a large area.

5. The material in them is loose and not cemented together.

6. lava plateaus

7. No, because it is thin and runny. Silica and water tend to produce thick, stiff lava and explosive eruptions.

SECTION 3 CAUSES OF VOLCANIC ERUPTIONS

1. It is under high pressure.
2. It will melt.
3. at tectonic plate boundaries
4. a decrease in pressure
5. Magma erupts from the mantle at divergent boundaries and hardens.
6. Oceanic crust is more dense.
7. Water released from the subducting plate mixes with the mantle and causes it to melt.
8. a place where volcanoes form far from plate boundaries
9. Dormant volcanoes may erupt again, but extinct volcanoes probably won’t.
10. Gas dissolved in the magma may bubble out and be emitted at the volcano.
11. Rising magma pushes it up.

Review

1. at divergent plate boundaries
2. Three points that are far from plate boundaries should be circled.
3. a decrease in pressure
4. As plates move apart, the pressure on the mantle below them decreases. This causes the hot rock in the mantle to melt and form magma.
5. increase in earthquakes, change in emitted gases, ground swelling, increase in surface temperatures

Chapter 10 Weathering and Soil Formation

SECTION 1 WEATHERING

1. breaking down rock by physical means
2. No, because it is the expansion of ice that causes ice wedging.
3. Running water moves rocks around. As the rocks are moved by the water, they bump into one another. This bumping causes abrasion.
4. Their tunneling breaks rocks into small pieces. It also exposes more surfaces to weathering.
5. water, air, and acid
6. The minerals in granite dissolve very slowly in water. It takes a long time for enough minerals to dissolve for the rock to break down.
7. active volcanoes and burning fossil fuel
8. the presence of acidic groundwater and rock that can be dissolved
9. Acids weaken the rock and make it crack. The rock in weakened areas is more likely to be removed by mechanical weathering.
10. | Factor          | How does it cause chemical weathering?          |
     | Water          | Water can dissolve mineral grains in rock and cause the rock to break down. |
     | Acid precipitation | Acids are more reactive than plain water. Acids in precipitation can quickly dissolve rocks. |
     | Acids in groundwater | Acids in groundwater can dissolve rock and carve huge caves underground. |
     | Acids from living things | Living things leave acids behind when they touch rock. The acids can weaken the rock and cause it to crack. |
     | Air            | Oxygen in the air can react with metals and other compounds to form new compounds. This can weaken rock. |

Review

1. water, wind, and gravity
2. (clockwise from the top)
   Water seeps into cracks in the rock.
   Water freezes.
   Ice pushes on the cracks.
   The cracks expand.
   The ice melts.
3. Acids can break the bonds between minerals in rocks. They can also dissolve rocks.
4. Both happen when non-rock material moves into cracks in a rock, expands, and causes the cracks to widen.

**SECTION 2 RATES OF WEATHERING**

1. Devils Tower would probably be much larger because the outer rock would not have worn away as much.

2. Chemical weathering happens when acid, water, or air react with rock. Only the outside of a rock is exposed to these agents, so only the outside experiences chemical weathering.

3. 96; 96; 192; 192

4. The edges and corners are where the most surface area is found.

5. Freezing and thawing are dependent on temperature.

6. Water on slopes has more energy to weather rock than water that isn’t moving.

**Review**

1. temperature, moisture, elevation, slope

2. Large rocks have less surface area for their volume than small rocks. Therefore, a smaller portion of the rock is exposed to weathering. It takes longer for the rock to wear away. The small rock has more surface area for its volume, so it weathers away faster.

3. The rock on the beach would be affected by waves and a lot of water. The rock on the side of the mountain would be affected by fast-moving water and possibly by high winds. It probably would also be exposed to colder temperatures than the rock on the beach.

4. The longer river probably carries the smallest sediment. The rocks in the longer river travel a longer distance before they drop. Therefore, they have more chance to weather. The particles will tend to be smaller than those in the shorter river.

**SECTION 3 FROM BEDROCK TO SOIL**

1. The rocks from which they form have different compositions.

2. (from left to right) residual soil, transported soil

3. the amounts of different-sized particles in a soil

4. about 25 times

5. organic material that comes from decayed organisms

6. O, A, and B

7. lemon juice

8. parent rock, acid precipitation, and fertilizers

9. Rainwater leaches nutrients from the soil.

10. Groundwater doesn’t evaporate as fast in cold climates.

**Review**

1. structure, texture, fertility

2. Neither arctic climates nor desert climates get a lot of rain.

3. Flowing water can leach nutrients out of soils. This makes the soils less fertile.

4. Most plants grow best in soil that is slightly acidic or neutral. If the pH is too low or too high, plants cannot grow.

5. the relative amounts of sand, silt, and clay in the soil

6. mineral fragments, organic material, water, air

**SECTION 4 SOIL CONSERVATION**

1. Animals get energy from plants, which need soil to grow. Some animals live in soil.

2. **What does soil provide?**

<table>
<thead>
<tr>
<th>Why is it important?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrients</td>
</tr>
<tr>
<td>Habitat</td>
</tr>
<tr>
<td>Water storage</td>
</tr>
</tbody>
</table>

3. Plant roots hold soil in place. They help to keep wind and water from carrying the soil away.

4. Slow-moving water carries away less soil.

5. Terraces can be difficult and expensive to build. They are only economical on very steep slopes where other methods don’t work.