

**Lesson Title: Acid Rain-Go Away!**

**Ohio Standards Connection:**

**Standard(s):** Earth Science

**Benchmark(s):** (grades 4-6) B. Summarize the processes that shape Earth's surface and describe evidence of those processes.

**Indicator(s):**

**Grade(4)** 8. Describe how wind, water and ice shape and reshape Earth's land surface by eroding rock and soil in some areas and depositing them in other areas producing characteristic landforms (e.g., dunes, deltas, glacial moraines).

10. Describe evidence of changes on Earth's surface in terms of slow processes (e.g., erosion, weathering, mountain building and deposition) and rapid processes (e.g. volcanic eruptions, earthquakes and landslides).

**Benchmark(s):** (grades 6-8) C. Describe the interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g. water cycle, weather and pollution).

**Indicator(s):**

**Grade(7)** 1. Explain the biogeochemical cycles which move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air).

**Lesson Summary:** Simulate the effects of acid rain on limestone

**Estimated Duration:** 60 minutes

**Background:** "Acid rain" is the term used to describe the result of a chain of complex chemical, atmospheric, and environmental processes that start with air pollutant emissions from utilities, industries, and motor vehicles, as well as natural sources (like volcanoes). When rain mixes with certain kinds of smoke and pollution in the air, acid forms. When these substances fall with rain, it is known as "acid rain." Acid rain can slowly do damage by killing plant life and water-dwelling creatures, and by damaging metal and stone, such as that in statues and buildings. The air pollutants that result in acid rain are sulfur oxides and nitrogen oxides. The major source of sulfur oxides are coal-burning power plants and industrial boilers. The major sources of nitrogen oxides are automobiles and coal-fired boilers at power plants and industries. The most cost-effective (and the only reliable) solution to the problem of acid rain is to control the offending pollutants at their source. The goal must be to emit fewer sulfur oxides and nitrogen oxides into the air so that fewer acids form in the atmosphere. Today power plants and industries emit a small fraction of what they did years ago. As pollution control technologies improve, and as society's commitment to environmental quality grows, we will emit even fewer acid-forming pollutants.

**Instructional Procedures:**

1. Gather the materials needed. Note that the chalk must be regular chalk, not “dustless.” Obtain marble chips wherever landscaping supplies are sold.
2. Make copies of the student sheet “Acid Rain, Go Away!”
3. Setting the Stage: Have the students imagine they are on a trip to some mountains far away. They want to visit a beautiful lake they once saw in a picture. Describe a trip from where you are located to such a place. Tell the students that when they arrive at the lake, it looks even more beautiful than in the picture. The lake is deep, clear, and very blue; it reflects the sky perfectly. Describe how quiet and serene it is there. Then introduce an ominous note by saying that it is “too quiet.” Describe how the students would start to notice that there were no fish jumping in the lake, no frogs “ribbet”-ing along the shore, and no dragonflies buzzing about the edge of the water. Because they have been good science students, they know that a lake should have all kinds of creatures and plants in and around it. As they start to examine the lake, they find no living things in the water—just some old shells, insect cases, and dead moss. This lake is dead!
4. Ask the students what they think happened. How could such a crime have been committed? Who is the murderer of the lake? Tell them they will learn to be better environmental detectives in this lesson.
5. Continue the story by telling the students that just as they are discussing what happened to the lake, they hear someone coming. (Could it be the criminal?) The students look for a place to hide, but before they can hide, Ranger Dave rides out of the forest on his faithful horse, Giddyup. He waves and smiles. The students are relieved. They crowd around as he climbs down from his mount, asking him about the dead lake. The ranger frowns, takes his hat, and says only two words...”Acid Rain.” What on earth does it mean? How could rain hurt the lake? How could the rain be acidic? Ranger Dave shook his head and drawled, “You folks best be getting back to class. The next lesson is about acid rain, and if you don’t hurry, you’re gonna miss it!”
6. Share with the students that sometimes moisture in the air mixes with certain kinds of smoke and other types of air pollution, producing acids in the rainwater; this is known as “acid rain.” When acid rain falls, it affects the land it falls on. The worse the problem, and the longer it goes on, the greater effect on the land.
7. Discuss the problem with the students. Acid rain may have recently been in the newspaper or magazines. Scientists cannot say exactly what the effects of acid rain on every place are, but they do know that there are places where acid rain has had serious effects. In Scandinavia and the Adirondack Mountains in the U.S., there are “dead” lakes like the one in our story. In many beautiful and historic old cities, famous buildings and statues seem to be “melting” because acid rain slowly dissolves the stone they are made out of.
8. Have the students explore the effects of acid rain on building materials. They will simulate this process.
9. Divide them into small teams. Give each student a copy of the student sheet “Acid Rain, Go Away!” (included), and have them complete this activity. They are to follow the directions on the student sheet. While they are waiting the 15 minutes, have them look up these terms in their dictionaries and write the definitions down.
  - Pollutant
  - Acid rain
  - Vegetation

- Acidic
  - Acid
10. Ask, “How did the vinegar affect the marble chips?” Explain that the vinegar does not affect the marble chips as noticeably, although they too contain calcium. Stress that the (sulfuric) acid in rain is different from the (acetic) acid in vinegar, so the effect is not exactly the same. This is a simulation—something like what really happens.
  11. Tell the students that acid rain affects water environments, too. Over a long period of time, a lake’s water can collect acid and other chemicals (e.g., metals that acidic rainfall leaches out of soil around the lake) that are harmful to the living things in the water. If the problem becomes severe enough, the smallest animals and plants will die first; then the larger animals will die. Finally, nothing will be alive in the lake.
  12. Have the students research local newspapers to find out if acid rain or snow is a problem in your area. What are the causes and possible solutions?

**Assessment:** Have the students imagine that they are fish living in a lake where there has been acid rain. Have them write a paragraph describing their experiences. Ask them to answer the question “What is life like for you in your lake?” What is happening to you, your neighbors, and your home?”

**Extensions**

- Have the students write their senators and representatives about the problem of acid rain.
- Contact the Environmental Protection Agency or your state’s environmental protection office for information about acid rain.

**Materials and Resources:**

- Vinegar
- Cups (4 per team)
- Marble chips
- Regular chalk (not “dustless”)
- Water
- Safety goggles
- Student sheet (included)

**Vocabulary:**

**acid:** a kind of chemical; acid in food is sour, sharp, or biting to the taste.

**acid rain (or acid precipitation):** rain with a pH of less than 5.6; results from atmospheric moisture mixing with sulphur and nitrogen oxides emitted from burning fossil fuels; may cause damage to buildings, car finishes, crops, forests, and aquatic life.

**acidic:** tending to form an acid.

**pollutant:** an impurity (contaminant) that causes an undesirable change in the physical, chemical, or biological characteristics of the air, water, or land that may be harmful to or affect the health, survival, or activities of humans or other living organisms.

**vegetation:** plant life.

**ACID RAIN, GO AWAY! Student Sheet**

1. Label four plastic cups A, B, C, & D.
2. In cup A, place a piece of chalk in water.
3. In cup B, place some marble chips in water.
4. In cup C, place some marble chips in vinegar.
5. In cup D, place a piece of chalk in vinegar.
6. Now stand back and wait. After 15 minutes, examine the materials in the cups.
7. What has happened in cup A?

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8. What has happened in cup B?

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9. What has happened in cup C?

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10. What has happened in cup D?

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Vinegar has acid in it, though not exactly like the acid in pollution. Notice what it does to the chalk in cup D. The acid in acid rain is not the same strength as that of vinegar, so the effect in nature will occur at a different speed than in your test, but in the end the effect is similar.

11. How might acid rain affect buildings and monuments?

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12. What might the acid do to trees and plants?

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13. Judging from the activity, would you say tap water has acid in it?

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14. Define acid rain.

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