

ACID RAIN (MODIFIED FOR ADEED)

INSTRUCTIONS



Overview:

In this lesson, students learn acid rain can cause chemical changes to rocks.

Objectives:

The student will:

- describe how acid rain affects rocks or other objects;
- infer how acid rain in the atmosphere affects other objects (i.e. statues, buildings, rocks or living organisms in the environment); and
- create a computer-generated presentation about the effects of acid rain.

GLEs Addressed:

Science

[11] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.

[11] SD1.2 The student demonstrates an understanding of geochemical cycles by integrating knowledge of the water cycle and biogeochemical cycling to explain changes in the Earth's surface.

Writing

[10] 4.2.2 The student writes for a variety of purposes and audiences by writing in a variety of nonfiction forms (e.g. letter, report, biography, and or/autobiography) to inform, describe or persuade.

Vocabulary:

acid rain - precipitation, as rain, snow or sleet, containing relatively high concentrations of acid-forming chemicals: formed from coal smoke, chemical manufacturing and smelting, that have been released into the atmosphere and combined with water vapor; harmful to the environment

atmosphere - the gaseous envelope surrounding the earth; the air

calcium carbonate - a white, crystalline, water-insoluble, tasteless powder, CaCO_3 ; occurring in nature in various forms as calcite, chalk and limestone; used chiefly in teeth whitening plant and polishes and in the manufacture of lime and cement

coal - a black or dark-brown combustible mineral substance consisting of carbonized vegetable matter, used as fuel

pH scale - used to express the acidity or alkalinity of a solution on a scale of 0 to 14, where less than 7 represents acidity, 7 neutrality, and more than 7, alkalinity; each unit change on the pH scale represents a 10-fold change in acidity

Materials:

- Clear plastic cups, one-cup size (two per group)
- Sidewalk chalk (two pieces per group)
- Vinegar ($\frac{1}{2}$ gallon)
- Lemon juice (one quart bottle)
- Lime juice (one quart bottle)
- Other liquids such as ginger ale, cola, tonic water (one - two cups of each)
- Plastic knives (one per student)
- Collection of four to eight different types/sizes of rocks; include at least one rock of limestone, marble or quartz
- pH paper/Litmus paper (scale 1-14)
- Plant leaves, (two to three fresh)
- Egg shells (two to three broken pieces)
- Science notebook (one per student)
- STUDENT INFORMATION SHEET: "Diagram of pH Scale"
- STUDENT INFORMATION SHEET: "The Formation of Acid Rain"

Activity Preparation:

1. The day prior to the activity, submerge leaves and egg shells in vinegar. Leave overnight.
2. The day of the activity set out four different types of rocks. Gather cups, sidewalk chalk and plastic knives; have vinegar, lemon juice, lime juice and other liquids available for student use.
3. Set out examples of organic substances, leaves and eggshells, which have been left in a cup, covered with vinegar overnight.
4. Prepare directions for explore activity on board, or provide a handout.

Activity Procedure:

Please refer to the assessment task and scoring rubric located at the end of these instructions. Discuss the assessment descriptors with the class before teaching this lesson.

Gear Up***Process Skills: observing, inferring, and communicating***

1. Start by asking students what they know about acid rain. Record and post all responses on the board.
2. Have students observe and listen carefully as you place a few drops of lemon juice on each of the four rock samples. Repeat the above procedure placing a few drops of vinegar on each of the four rocks but in a different place on the rock. Ask students the following questions:
 - a. What did you observe?
 - b. Why does the vinegar or lemon juice cause a reaction on some of the rocks and not on others?List and post all responses from students on the board.

Teacher Note: If students need more information, explain that lemon juice contains citric acid and vinegar contains acetic acid. Both are weak acids. Show students a pH scale and briefly explain how the pH scale works. Explain that these mild acids can dissolve rocks that contain calcium carbonate and the chalk is a soft white porous sedimentary rock made of limestone.

Explore***Process Skills: observing, predicting, investigating, measuring and communicating***

3. Introduce the topic of acid rain by handing out STUDENT INFORMATION SHEETS: "Diagram of pH scale" and "The Formation of Acid Rain." Point out to students the range of the pH of acid rain that is shown on the diagram. Briefly explain the illustration showing how acid rain is formed and be sure to mention that acid rain can be carried in the atmosphere hundreds of miles from where the source originated.
4. Divide students in pairs. Ask pairs to complete the following:
 - a. Collect two pieces of sidewalk chalk.
 - b. Carve a unique design on one piece of chalk, using a plastic knife. Make sure the design includes at least one deep line, and scrape away some of the surface of the chalk in one or more places.
 - c. Sketch a diagram of the design that is carved in chalk in your science notebook.
 - d. Add about 1/2 cup of vinegar to a clear cup. Measure the pH of the vinegar using litmus paper and record in science notebook.
 - e. Predict what will happen to the design on the piece of chalk if it is placed in vinegar. Record your prediction in your science notebook.
 - f. Place the chalk in the cup with vinegar, make sure it is enough to cover the chalk. Leave the chalk in the vinegar for 5-10 minutes.
 - g. Observe what happens to the chalk and record observations in your science notebook.
 - h. Sketch a diagram of the design after removing from vinegar and compare to original drawing. Write down any differences you noticed between the two drawings.
 - i. On the second piece of chalk carve another a design then choose one of the other liquids to use instead of vinegar and repeat the process.
 - j. Discuss with a partner any changes observed.

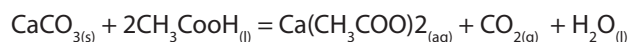
Generalize

Process Skills: *inferring, describing, making generalizations, and communicating*

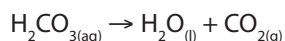
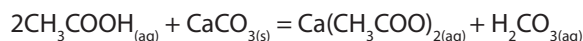
5. As a class, discuss the following:
 - a. Describe what happened to the design on the chalk.
 - b. Why do you think this happened?
 - c. Did you notice any other changes when you placed the chalk into the vinegar solution?
 - d. What would happen if you left the chalk in the vinegar for a longer period of time?
 - e. Did you notice any differences between the chalk left in vinegar and the chalk left in a different solution?
 - f. What would happen if the solution you used was more acidic?
 - g. What would happen if the solution you used was less acidic?
 - h. How does rain become acidic?
 - i. How does acid rain get onto statues, buildings or the land?

Teacher Note: If necessary discuss how acid rain is a term referring to a mixture of sulfur or nitric acids in the atmosphere; both are acidic (i.e. readily donate protons). Explain that acid rain formation results from both natural sources such as volcanoes and man-made sources such as burning coal for energy use.

Reaction of calcium carbonate with acid:



Which occurs in two steps:



This reaction is important in helping students to understand why their chalk loses mass – some enters the dissolved phase, but some is also lost as CO_2 gas.

6. Show students examples of organic objects (i.e. leaves from plants and eggshells) that have been left in vinegar overnight. Ask the following questions:
 - a. Does acid rain affect organic substance like plants or animals?
 - b. How could you test the effects of acid rain on organic substances?

Apply

Process Skills: *predicting and communicating*

7. Discuss with a partner what would happen to living organisms in streams that contain a significant increase in concentration of acid in the water. Record your inferences in your science notebook.

Resources:

Acid Rain, Natural Acid Rain, (n.d.). Retrieved June 15, 2009 from <http://www.elmhurst.edu/~chm/vchembook/190acidrain.html>

Effects of Acid Rain, (n.d.). Retrieved June 15, 2009 from http://faculty.plattsburgh.edu/thomas.wolosz/acid_rain.htm

The pH Scale, (n.d.). Retrieved June 15, 2009 from http://www.ec.gc.ca/WATER/en/info/pubs/FS/e_FSA3-1.htm

Acid Rain Revisited, (n.d.). Retrieved May 26, 2011 from <http://hubbardbrookfoundation.org/acid-rain/>

ACID RAIN

RUBRIC

Assessment Task:

Student will create a computer-generated presentation about the effects of acid rain on rocks or other objects. The presentation should include at least one illustration with labels that demonstrates the effects of acid rain on rocks or other objects. The presentation should also describe at least one effect acid rain causes to rocks or other objects and at least two inferences on the effect of acid rain on other objects in the environment.

Rubric:

Objective	GLE	Below Proficient	Proficient	Above Proficient
The student describes how acid rain affects rocks or other objects.	[1] SD1.1	The student does not describe how acid rain affects rocks or other objects.	The student describes one affect acid rain causes to rocks or other objects.	The student describes two affects acid rain causes to rocks or other objects.
The student infers how acid rain in the atmosphere affects objects, (i.e. statues, buildings or living organisms) in the environment.	[1] SA1.1	The student does not make an inference relating effects of acid rain to objects in the environment.	The student makes two inferences relating effects of acid rain to objects in the environment.	The student makes three or more inferences relating effects of acid rain to objects in the environment.
The student creates a computer-generated presentation that illustrates and informs about acid rain.	[9] W3.6.3	The student does not create a computer-generated presentation or lacks illustrations about acid rain.	The student creates a computer-generated presentation that includes one illustration with labels about acid rain.	The student creates a computer-generated presentation that includes two or more illustrations with labels about acid rain.



DIAGRAM OF pH SCALE

STUDENT INFORMATION SHEET

