

## Lesson Plan

### Summary

#### Subject(s)

ESS: Earth's Systems & Processes

#### Grade/Level

Grades 6-8

#### Activity Type

Constructing explanations & Designing solutions

#### MN Science Standard

6E.3.2.1.3

#### SEP / CCC

SEP: Constructing explanations and designing solutions

CCC: Cause & Effect

#### Est. Lesson Time

60 Minutes + 24 Hour Observation Period

**\*This curriculum is the property of the Friends of the Minnesota Valley River Watch program. No part of this curriculum may be reproduced without the written permission of Friends of the Minnesota Valley.**

### Implementation

#### Introductions

Solutions are a mix of two or more liquid chemicals, one of which is usually water.

In nature, nearly all the solutions are a mixture of water and some other chemical (nutrients from organic matter dissolved in lakes, rivers, and wetlands).

One way to measure the chemical properties of a solution is to find out its pH value, which measures the concentration of hydrogen ions in the solution. pH is measured on a scale between 1 and 14. 7 is the pH of water and is considered neutral. Acids have a pH between 1 and 6. An acid (acidic solution) is a solution with a low concentration of negatively charged hydronium ions. Acids act on other substances by pulling them apart into smaller pieces, corroding the substance. For example, it is important to brush your teeth after drinking lemon/orange juice because the acid in the juice can dissolve the enamel in your teeth, permanently eating away at their structure.

Acid Rain occurs when carbon gas emissions (car exhaust) mix with the water vapor in the clouds forming a weak acid. This acidic solution falls back to the Earth's surface as precipitation (rains, sleet, or snow). Acid rain, resulting from human pollution, can negatively impact both natural and constructed environments. In natural environments acid rain can cause plants to die, or create inhospitable living conditions for aquatic creatures. Acid rain typically has a pH between 3 and 5.

Bases have a pH between 8 and 14. A base (alkaline solution) is a solution with a high concentration of negatively charged hydronium ions. Bases act on other substances by latching onto or mixing with the substance, usually changing how the substance acts. For example, dish soap is used to clean bacon grease from a pan, because the soap mixes with the fat in the grease and loosens its grip on the pan, allowing it to be washed off.

Alkaline rain is mainly caused by the aeration of rock dust via mining, and ash created by industrial processes. The dust or ash mix with the water vapor in the clouds forming a weak base (weak alkaline solution). This basic solution falls back to the Earth's surface as precipitation. Like acid rain, alkaline (basic) rain can negatively impact creatures and plants on land and water by depositing pollutants. These interfere with an organism's biological processes like plants ability to drink water, or results in bioaccumulation of toxins in creatures. Alkaline rain typically has a pH between 8 - 10.5.

The following experiments will help us identify common acids and bases, and observe some ways they affect the environment, specifically plants.

## Key Terms

- **pH** - pH is the measure, on a scale of 1 to 14 that measures the concentration of hydronium ions in a liquid. In other words it measures how acidic (low pH) or basic (high pH) a liquid is. Water is neutral, and has a pH of 7, the halfway point in the scale.
- **Acid** - A liquid with a low pH is considered acidic. Acids interact with other substances by pulling them apart, breaking them into smaller pieces, and bonding with the acid. (Acids have a higher concentration of positively charged hydrogen (H<sup>+</sup>) ions than water [neutral, or a lower concentration of negatively charged hydronium ions]).
- **Base** - A liquid that has a high pH is considered basic. Bases interact with other substances by combining with them, and bonding with the substance. (Bases have a higher concentration of negatively charged hydroxide ions than water [neutral], and a low concentration of positively charged hydrogen ions).
- **Acid Rain** - The result of fossil fuel gasses released into the atmosphere mixing with water in the clouds.. The gasses and water mix to form an acidic solution (low pH), which falls to the Earth as precipitation.
- **Alkaline Rain** - The result of ash or dust (waste products) created by industrial processes rising into the atmosphere and mixing with the water in the clouds. The waste and water mix to form a basic (alkaline) solution, which falls to the Earth as precipitation.
- **Liquid Solution** - A homogenous mixture (all materials fully mixed in) of two or more liquids.

## Materials & Resources

- 5-6 Small Containers
- pH Test strips
- Lemon Juice
- Vinegar
- Soap
- Baking Soda
- Tap Water
- River/Pond Water (**Recommended**)
- Data Sheet
  
- 3 Large Clear Containers (1L or greater)
- 3 Small Containers (to hold flower upright within Larger Jar)
- Control Solution: 320 mL of Distilled Water
- Acid Rain Solution: 10 mL White Vinegar/ 310 mL of Water
- Alkaline Rain Solution: 7 g (1 2/5 tsp) of Baking Soda/320 mL of Water
- 3 Flowers with large petals (preferably white)
- Food Coloring
- Clear Plastic Wrap
- 3 Rubber Bands
- 3 Small Weights (Marble, Pennies)
- Sunny Window

## Objectives

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

## Essential Question

- What does pH measure?
- How do acids typically affect the materials they come in contact with?
- How do bases typically affect the materials they come in contact with?

- What causes acid rain? What causes alkaline rain?
- What effect does acid rain have on vegetation? What effect does the alkaline rain have on vegetation?
- What can be done/added to the soil to alter the pH levels?

## Procedure

### pH Activity

- Fill the six small containers with the same amount of the following fluids: Tap Water, Lemon Juice, Vinegar, Baking Soda (10 g) mixed with Distilled Water, Soap (10 mL) mixed with Distilled Water, and Natural Water. Make sure the substances mixed with water are mixed well.
- Hypothesize whether each solution will be acidic or basic.
- Per each solution:
  - Predict what color (pH) you expect the solution to turn the test strip
  - Dip the strip in the solution for 5 seconds.
  - Compare the color of a test strip to the color on the bottle's pH scale. Record the results.

### Acid/Alkaline Rain Activity

- Place the small container inside the large container, and fill the small container with water.
- Put the flower inside the small container so the flower stands upright within the larger container. You may need to trim the stem of the flower so it sits below the rim of the large container.
- Repeat this process 3 times, so you have one flower sitting in a smaller container that is inside each of the three larger containers.
- Prepare each of the large containers, making sure you do not get any of the vinegar or baking soda into the small container holding the flower.
  - Using test strips, determine the pH of your control, acid rain, and alkaline rain solutions.
  - Fill one large container with 320 mL of distilled water. Label "Control".
  - Fill a second large container with 10 mL of white vinegar & 310 mL of distilled water. Label "Acid Rain"
  - Mix 7 g (1  $\frac{2}{3}$  tsp) baking soda with 320 ml of distilled water. Pour into the third large container. Label "Alkaline Rain".
  - Add 6 drops of food coloring into each large container's water solution.
- Cover the tops of the three large containers with plastic wrap, and secure with a rubber band.
- Place a weight in the center of the plastic wrap just above the flower. Set in the sun.
- Hypothesize how you think the flowers will change when exposed to acid and alkaline rain.
- Allow time for the liquids to evaporate and then drip onto the flowers. Record changes in the flowers over a 24 hour period.

**Small Group Discussion (10 Minutes):** Pair off with another student and discuss the following questions:

- Name some common acids. What do they have in common?
- Name some common bases. What do they have in common?
- How do flowers in the test solutions differ from the control solution?
- Did the acid rain result in different changes to the flower than the alkaline rain? How do the changes differ? How are they the same?

**Large Group Discussion (15 Minutes):** As a whole class, have some pairs share their answers with the group. The discuss the following questions/topics:

- E. Based on your observations, what do you think happens to natural environments exposed to acid/alkaline rain?
- F. How do you think acid/alkaline rain affects organisms on land and in water?
- G. What conditions do you think could make acid/alkaline rain worse? What are some ways humans can reduce the acidity/alkalinity of rain?
- H. Based on what you know about acids and bases, how do you think they could affect constructed environments?

**Wrap-up (5 Minutes):** The Key Ideas from the lesson are:

- pH is the measure, on a scale of 1 to 14, of how acidic or basic (alkaline) a solution is. Water is neutral with a pH of 7.
- Acids and bases are common throughout our household, in our cooking and cleaning materials.
- In the natural environment, freshwater organisms can typically only tolerate mildly acidic conditions (pH 6) to mildly basic conditions (pH 8). When the pH is too high or low, it can harm aquatic creatures and the habitat.
- Acid and alkaline rain most commonly result from human-created pollution, and can negatively impact (interfere with) natural and constructed environments.

## Observations: pH

Liquid	Acid (pH 1-6)	Neutral (pH 7)	Base (pH 8-14)
Vinegar			
Baking Soda Water			
Lemon Juice			
Soap Water			
Tap Water			
Natural Water			

Fish need the pH in the water to be between 6.5 - 8.5.

Which of the liquids you tested could a fish survive in?

---

What might run into the river that is too acidic or too basic?

---

What can be done to alter the pH of runoff before it meets the river?