Teacher’s Guide: Buffering Acid Rain Investigation

BSC 307- Palmer

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1. **Purpose:**

The goal of this lesson is for students to participate in a pre-lab, post-lab, and laboratory experiment using the 5E model. Here, students will explore the relationship between acid rain and soil through inquiry-based learning. Students will be given a scenario and a set of materials and tools. Students will work with partners to determine an experimental method to test the effects of soil additives (peat moss, sand, and limestone) on rainwater pH before and after soil absorption. Throughout the investigation experience, students will have the opportunity to familiarize themselves with laboratory equipment, techniques, and safety.

1. **Major Concepts:**

* Pollutants like sulfur dioxides and nitrogen oxides combine with moisture in our atmosphere to create acid rain
* Some soils contain buffers that can neutralize the acidic precipitate
* Additives like limestone have buffers to help increase the pH
* Additives like peat moss and sand do not help to increase the pH
* **Objectives: TSWBAT…**
* Generate an alternative and null hypothesis given a scenario
* Design an experimental method given material and tools
* Calculate the change in pH of rainwater before and after soil contact
* Identify the optimal pH buffer soil with additive (peat moss, sand, or limestone); or identify the optimal amount of additive to buffer soil’s pH
* Organize data into a bar graph with appropriately labeled titles and axis
* Explain results and support/reject hypotheses
* Identify experimental error
* Identify solutions to experimental error

**Illinois Learning Standards:**

**12.C.5a** Analyze reactions (e.g., nuclear reactions, burning of fuel, decomposition of waste) in natural and man-made energy systems.

**13.B.4c** Analyze ways that resource manage­ment and technology can be used to accommo­date population trends.

**13.B.5c** Design and conduct an environmental impact study, analyze findings and justify recommendations.

**11.A.4b** Conduct controlled experiments or simulations to test hypotheses.

**11.A.4c** Collect, organize and analyze data accurately and precisely.

1. **Materials (per group/lab station):**

There will be a total of 3 groups (2 groups of 2; 1 group of 3)

* 3 plastic trays
* One 250 mL beaker of acid rainwater (pH= approximately 4.0)
* 1 *Spark’s* pH sensor
* Four 1 cup soil samples (soil obtained in Hoffman Estates Wetlands)
* 4 clear, large, plastic cups
* 4 clear, small, plastic cups
* Three ½ cups of peat moss, sand, limestone
* 1 Wash bottle with distilled water
* 1 Plastic spoon
* 1 Sharpie
* 5 rolls of colored tape (red, pink, green, yellow, blue)

**Prelab Preparation Guide:**

1. Create acidic rainwater
   1. Combined 5 teaspoons of vinegar with 1 liter of distilled water
   2. Fill four 250 mL beakers with acidic rainwater
   3. Place 1 beaker on each tray
2. Create soil cups
   1. Fill 12 large plastic cups with 1 cup of soil
   2. Label 3 large plastic cups with 1 inch of red tape
   3. Repeat process three times more using pink, yellow, and green tape
   4. Place 1 red, pink, yellow, and green soil cup on each tray
3. Create additive cups
   1. Fill 3 small plastic cups with ½ cup of peat moss
   2. Repeat process twice more using ½ cup of sand, limestone
   3. Place 1 peat moss, 1 sand, and 1 limestone cup on each tray
4. Gather tools for students
   1. Place ½ teaspoon measuring spoon per tray
   2. Place 1 black sharpie marker per tray
   3. Place 1 *Spark’s* pH sensor per
   4. Fill and place 1 distilled water wash bottle per tray
5. **Time/length of lab**

10 minutes: Pre-lab

* Reading objective
* Making hypothesis
* Determining experimental design with partner

25 minutes: Experimentation

* Conducting experiment
* Collecting results
* Cleanup

10 minutes: Post-lab

* Creating bar graph
* Answering questions
* Sharing results as a class

1. **Safety issues:**

* Do not eat food, drink beverages, or chew gum in the laboratory.  Do not use laboratory glassware as containers for food or beverages.
* Horseplay, practical jokes, and pranks are dangerous and prohibited.
* Work areas should be kept clean and tidy at all times.
* Goggles should be worn at all times to avoid debris in eyes
* Careful handling of beakers; if broken, glass should be disposed in appropriate glassware garbage using protective gloves and area swept with dustpan and brush.
* Keep hands away from face, eyes, mouth, and body while using chemicals or lab equipment.  Wash your hands with soap and water after performing all experiments.

1. **Prelab/postlab discussion guide**

Prelab Discussion guide:

* Read introduction: what is acid rain? How is it formed? What is the relationship between acid rain and soil?
* Give student’s their objective

Post lab discussion guide:

* Prompt students that we are going to share our findings
* Ask each group the following:
  + How did you set-up their experiment?
  + What were your original hypotheses?
  + What did your results indicate? Explain.
  + Did you support/reject your hypothesis?
* Remind students that post-lab questions are due the following day

1. **Any special notes**

* It is assumed that the previous day, students learned about the water cycle and acid rain
* It is assumed that this experiment takes place at the end of biology course
  + Students have been exposed to scientific method and designing experiments
* Modification: This experiment can be divided up into a multiple day lap depending on age group
  + One full day can dedicated to planning an experimental method with a partner
  + One full day can be dedicated to experimentation
  + Soil may need to sit for more than 2 minutes to fully neutralize acidic water; samples may need to absorb water overnight

**8. A diagram of the lab set up with instructions as to the distribution**

1. Trays will be placed on the perimeter of the classroom
2. Students will be prompted to get trays after given their objective

(only 1 student will get tray)