Activity: Investigating Acid Rain

FOR THE TEACHER

Summary
In this activity, students will investigate the chemistry of acid rain through web based research. Students will also have the opportunity to observe the reaction between a common acid and a material in a week long simulation and relate their findings to the effects of acid rain.

Grade Level
High school

Objectives
By the end of this activity, students should be able to
● Describe the components of acid rain as well as its effects on various environments.
● Interpret observations of chemical change in an acid reaction.

Chemistry Topics
This activity supports students’ understanding of
● Acids
● Acid Rain
● pH
● Chemical Reactions
● Chemical Change

Time
Teacher Preparation: 10 minutes
Lesson: 30 minutes for web assignment; 15 minutes/day, for 3-4 days for observations

Materials
(Per group)
● 25 ml vinegar
● One uncooked egg
● Glass container with lid
● pH paper with pH chart
● Graduated cylinder
● Small paint brush

Safety
● Always wear safety goggles when handling chemicals in the lab.
● Wash your hands thoroughly before leaving the lab.
● Follow the teacher’s instructions for cleanup of materials and disposal of chemicals.
● When working with acids, if any solution gets on your skin immediately rinse the area with water.
Teacher Notes

- On the first day students should complete the webquest portion of this activity in the beginning of the class period, followed by the set-up of the acid rain simulation with the egg and vinegar.
- Materials listed are per student group. I would suggest placing students in groups of 2-3 for the simulation portion of the activity.
- The vinegar used in the simulation can be any type of vinegar (apple cider, white, etc.)
- It is possible that an egg may break at some point, so it is helpful to have multiple jars within a class so students can observe the entire process even if their egg doesn’t last through the entire week.
- Observation check-ins can be adjusted as needed with your class schedule. I would suggest having 3-4 observations after the start of the simulation.
- Students should be familiar with molecular names, formulas and reactions at this point. If students haven’t been exposed to this content yet, adjust the analysis questions as needed.

Cross-Disciplinary Extensions

Connect to Reading
Read articles linking the declining bird population with acid rain.
http://www.news.cornell.edu/stories/2002/08/songbird-population-declines-linked-acid-rain
http://www.scientificamerican.com/article/acid-rain-linked-to-bird/
http://faculty.plattsburgh.edu/thomas.wolosz/acid_rain.htm

Connect to Writing
Write a summary essay explaining the types of acid rain and the effects on the bird population.

Connect to Social Studies
Track the governmental regulations that have been enacted since the early 1960’s to the present for diminishing the emissions of sulfur oxides and nitrogen oxides.

FOR THE STUDENT

Lesson

Acid Rain Webquest

Visit the following website to thoroughly answer the next five questions using your own words. http://www.epa.gov/acidrain/education/site_students/whatisacid.html

First watch the “Acid Rain Simulation” to get an overview. Then answer the following questions based on what you learned. You may also navigate through the website to help answer each of the questions.

1. What is acid rain?
2. What are causes of some acid rain?
3. Why is acid rain harmful?
4. What is being done to reduce acid rain?

5. What can you do to help reduce acid rain?

Visit the following website to thoroughly answer the next five questions using your own words.  
http://www.softschools.com/facts/weather/acid_rain_facts/575/

6. When was acid rain first recognized?

7. When did people begin to note the crisis and looked for solutions?

8. What is the general pH range of acid rain?

9. What emissions do power plants produce that contribute to acid rain?

10. What emissions do vehicles produce that contribute to acid rain?

11. What consumer products have similar pH values as acid rain?

Visit the following website to thoroughly answer the next five questions using your own words.  
https://ypte.org.uk/factsheets/acidrain/theyeffectsofacid-rain#section

12. How does acid rain spread?

13. Why is nitrogen a problem?

14. How can the damage be restored?

15. What can be done to help reduce acid rain?

16. Describe how mass transit would play a role in diminishing acid rain.

Part 2: Acid Rain Simulation

Background
Acid rain and vinegar have similar pH values. Over the next week you will observe and record the effect that vinegar has on an egg shell.

Materials
- 25 ml vinegar
- One uncooked egg
- Glass container with lid
- pH paper with pH chart
- Graduated cylinder
- Small paint brush
Safety
- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- Follow the teacher’s instructions for cleanup of materials and disposal of chemicals.
- When working with acids, if any solution gets on your skin immediately rinse the area with water.

Procedure
1. Carefully place a single egg inside one of the glass containers.
2. Record your qualitative observations about the egg shell in the data table (color, hardness, etc.)
4. Pour all the vinegar onto the egg in the jar. Using the paint brush, apply the vinegar to the shell of the egg, so that the entire surface has been saturated with vinegar.
5. Touch the paint brush to a strip of pH paper. Compare the color change with the pH color chart. Record the pH value in the data table.
6. Seal the jar with the lid, and place the jar in a safe place.
7. After 24 hours return to the jar.
8. Remove the lid, and dip your paint brush in the jar and touch it to a new piece of pH paper. Record this value in your data table.
9. Again record your qualitative observations about the egg shell in the data table, specify color, hardness, etc. Wear gloves if you remove the egg from the jar.
10. Seal the jar with a lid, and place the jar in a safe place.
11. Repeat steps 7-9 several times during a week (complete 3-4 observations after the first day).
12. After a week, wearing gloves remove the egg from the jar and gently rinse the egg with water. Record your final observations.

Observations

<table>
<thead>
<tr>
<th>Observation</th>
<th>pH value</th>
<th>Qualitative Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial (Day 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second (Day __)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third (Day __)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth (Day __)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Final (Day 7)

Analysis

1. How does the pH of vinegar compare with the average pH of acid rain? Refer to your webquest if needed.

2. What indicators of chemical change did you observe on the egg shell during the week trial?

3. Research to find out what the main chemical component of an egg shell is. Record its chemical name and chemical formula.

4. Research to find out what the acid in vinegar is called. Record its chemical name and chemical formula.

5. What kind of reaction took place between the egg shell and the vinegar?

Conclusion
What other materials contain the same chemical as the one found in egg shells? Reflect on the egg and vinegar reaction, why was this done, and how was it helpful as you learned about acid rain?