Science/Math and Technology Applications and Research

(STAR)

an Illinois Math/Science Partnership Grant

Originally developed as part of the ***(COIILS)***

Illinois Scientific Literacy Staff Development Grant through the St. Clair County Regional Office of Education

Acid Rain - The Effect of Air Pollution

Developed by Carol Mahan mahan@frg70.stclair.k12.il.us
Edited by: Mike Schneider, Bob Williams and Marylin Lisowski
Soon to be Field Tested by: STAR teachers

Description: This investigation involves having students collect and measure the pH of rainwater in their area. Then students will determine the distance from the nearest coal-fired power plant and prevailing winds. When this data is entered into the provided form, students can compare their results with those of students from different parts of the country and world.

Grade Levels: 4-12(Note: This experiment can be simplified or made more challenging depending on the developmental levels of your students. See Teacher Information.)

Approximate Time Involved: Daily monitoring of rain gauge for one month. One or two 30-minute classroom planning sessions, 20 minutes to set out rain gauges and wind vanes (additional time may be required if you choose to make your own gauges and vanes, 20 minutes to identify and map closest coal-fired power plants, 20 minutes to enter data online, one or two 30-minute classroom sessions to examine results, state conclusions, draw inferences, and make recommendations.

National Science Standards Addressed:

Content Standard A: As a result of activities in grades K-12, all students should develop

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard C: As a result of activities, all students should develop understanding of:

- (K-4) Organisms and environments

Program Standard D: The K-12 science program must give students access to appropriate and sufficient resources, including quality teachers, time, materials, and equipment, adequate and safe space, and the community.

- Good science programs require access to the world beyond the classroom.

Illinois Applications for Learning:

- Through applications of learning, students demonstrate and deepen their understanding of basic knowledge and skills.
- Recognize and investigate problems; formulate and propose solutions supported by reason and evidence.
- Express and interpret information and ideas.
- Use appropriate instruments, electronic equipment, computers and networks to access information, process ideas and communicate results.

- Learn and contribute productively as individuals and as members of a group.
- Recognize and apply connections of important information and ideas within and among learning areas

Illinois Science Goal 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments, and solve problems.

- Standard A. Know and apply the concepts, principles, and processes of scientific inquiry.

Illinois Science Goal 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

- Standard D. Know and apply concepts that describe force and motion and the principles that explain them.
- Standard E. Know and apply concepts that describe the features and processes of the Earth and its resources.

Illinois Science Goal 13: Understand the relationships among science, technology, and society in historical and contemporary contexts.

- Standard A. Know and apply accepted practices of science.
- Standard B. Know and apply concpets that describe the interaction between science, technology and society.

Illinois Math Goal 6: Demonstrate and apply a knowledge and sense of numbers, including numeration and operations (addition, subtraction, multiplication, division), patterns, ratios and proportions.

- Standard A. Demonstrate knowledge and use of numbers and their representations in a broad range of theoretical and practical settings
- Standard B. Investigate, represent and solve problems using number facts, operations (addition, subtraction, multiplication, division) and their properties, algorithms, and relationships.
- Standard D. Solve problems using comparison of quantities, ratios, proportions, and percent.

Illinois Language Arts Goal 1: Read with understanding and fluency.

- Standard C. Comprehend a broad range of reading materials.

Illinois Language Arts Goal 3: Write to communicate for a variety of purposes.

- Standard A. Use correct grammar, spelling, punctuation, capitalization, and structure.
- Standard B. Compose well-organized and coherent writing for specific purposes and audiences.
- Standard C. Communicate ideas in writing to accomplish a variety of purposes.

Illinois Language Arts Goal 5: Read with understanding and fluency.

- Standard A. Locate, organize and use information from various sources to answer questions, solve problems and communicate ideas.
- Standard B. Analyze and evaluate information acquired from various sources.
- Standard C. Apply acquired information, concepts and ideas to communicate in a variety of formats.

Teacher Information:

Page Top

Acid rain is rain that is more acidic than normal and is caused by air pollution, particularly pollution from coal-fired power plants. The pollution from the power plant is released into the air and travels with the prevailing winds, sometimes for hundreds of miles. When it rains, the pollutants (especially sulfur dioxide and nitrogen oxides) fall back to the surface of the earth damaging soil, plants, and animals.

This should become a team exercise where your student groups might each develop and write a hypothesis, list the materials they would use, and a procedure. An excellent way to assess this activity is to have the teams repeat each other's experiment to see if they achieve the same results. This will also replicate the real world challenges facing a research scientist.

Challenging Your Students to Be Problem Solvers:

To make this experiment more challenging to your students, you might just want to pose a question such as: What types of rain gauges will produce the most accurate measure of precipitation? What location in the schoolyard will

allow you to collect the most rainfall? Design and conduct an experiment to compare the pH of rainfall to pond water, well water, or another water source.

 Student Instructions Available to download as a PDF file.

Needed Materials: pH paper and color chart (range pH 2-7), rain gauge (can be milk carton or coffee can securely placed in the outdoor classroom, distilled water, wind vane (wind direction can be determined from observing a flag or other object. This information could also be obtained from the local weather report on the Internet), data collection form and pencil, water samples from other sources such as local wells, lakes, ponds, streams, wetlands, and water puddles.

Safety Rule: Be sure to NOT drink the collected water samples and be sure to wash your hands after tests are completed.

Procedure:

Student Information: The following information will provide you with the steps for setting up your acid rain experiment. It is important to hold all of the variables constant except for those that are being manipulated. Constant (or controlled variables) could be such things as: the amount of time the experiment is conducted, the frequency with which the rain gauge is emptied, the location of the rain gauge or the other water sources, the amount of water sampled, etc. Manipulated (or independent) variables would be those things that we can change to see if the response will be different, such as: type of gauge, location of the gauge or other water sources, season of collection, etc. The responding (or dependent) variable for this experiment will be the pH of the rainfall in each of your gauges and the pH of the other water sources. NOTE: Amount of rainfall is one variable that will be difficult to control or intentionally manipulate in this experiment. However, from your experiments, you may be able to infer as to whether amount of rainfall has any impact on pH of the water collected. The reporting form for this experiment is set up so that you can determine how many gauges you want to put out and where you want to place them. NOTE: Remember that a good scientific experiment is repeated a minimum of three times. Therefore, your data will be more accurate if you set up several gauges that are exactly the same and then compile an average of your data before submitting it. With the other water sources, be sure to test each sample at least three times to more accurately determine the pH.

Procedural Steps for Conducting the Investigation

Rain Gauge Procedure:

- 1. Click on the “View Data” link at the Acid Rain Investigation web page. Click on “View” in the blank sample listed on the chart. What comes up is the data collection sheet that will be used in this investigation. Print it and place it on your clipboard.
- 2. Choose a location for your rain gauges. Look for places in open, protected areas that will not get a lot of human interference.
- 3. Monitor the gauges daily for a period of at least one month. One month in the fall and another in the spring may be the most appropriate in the mid-west. It is important to choose months of the year that will provide the most rainfall for testing.
- 4. If rain is present, record the wind direction, amount of rain, and collect the water from the rain gauge. If there is no rain, record the amount as 0. If the carton is wet but cannot be measured, record as 0. Measurable rain should be recorded in millimeters (mm).
- 5. If rainfall was collected, the carton should be rinsed with distilled water after being emptied.
- 6. Measure the pH of the collected rainfall with pH test strips. Dip the strip in the collected rain, then hold the strip near the pH color chart. Record the pH number of the matching color. Also, measure the pH of distilled water and record that for your control.
- 7. When you are finished, remove the gauges from the outdoor area.

Other Water Sources Procedure:

- 8. Using new pH paper strips each time, test each of your other water source samples at least three times each to verify your results. NOTE: If you must limit your pH paper use, compare your results to that of two other groups testing the same water sample.
- 9. Be sure to enter all of your collected data onto your printed data collection sheet.
- 10. After group and classroom discussions have occurred, login to enter your data. online at the correct location. NOTE: Only numbers must be inserted into the spaces provided in order for your Excel spreadsheet to work properly.
- 11. Once all classroom data is submitted you can download **all** submitted Schoolyard Litter data and develop charts and graphs in Excel by following the general directions provided at "Downloading and Analyzing Collected Data Using an Excel Spreadsheet"

Below is a list of questions that can be used to stimulate student discussions. If your students are at a developmental level where you are able to challenge their higher level thinking skills, then only present them with the first set of questions from each group below. Use the second list of questions as a way to stimulate thinking when you students seem unable to expand their knowledge on their own.

Examining Local Results

Discussion Questions that Require More Critical Thinking Skills:

- What were your conclusions for this experiment?
- What could your infer based on your conclusions?
- How would you design this experiment differently the next time?

Discussion Questions that Require Less Critical Thinking Skills

- What was the pH of your collected rainfall?
- Did the wind direction have any impact on the pH of the rainfall?
- Would you expect to find the same results all year round? How could you test your predictions experimentally?

Examining Local and Online Results

Discussion Questions That Will Require Critical Thinking Skills to Compare Local Data to the Online Data of Others

- How did your results compare with the results of others?
- What conclusions can you make when you compare your results with the results of others?
- What inferences can you draw from your additional conclusions?
- What changes would you now make in this experiment based on the information you now have?

General Discussion Questions that May Occur as a Result of Comparing Local Data to the Online Data of Others

- Where is the geographic location of the schools who have provided online data?
- How did the pH of the rainwater you collected compare with that collected by others?
- What external factors may have contributed to different pH of rainwater?

- What similarities existed among those schools that collected the same pH of rainwater?
- What could be the reason for differences in pH among those schools?

Performance and Multiple Choice Assessment Options

Acid Rain Links

EPA Acid Rain Program/Experiments This site has nine experiments dealing with measuring pH of water and soil, and observing the influence of acid rain on plants.

EPA Acid Rain Program/What is Acid Rain? This is a good source for background information on acid rain. You can also search the EPA website for other information concerning acid rain.

The Water Cycle This site is maintained by the United States Environmental Protection Agency.

U.S. Geological Survey This home page contains links to information about rain, the water cycle, and activities for students.

U.S. Geological Survey/Education This is a link from the USGS page that lists educational opportunities concerning water.

Earthday 2000 Group of European schools monitor acid rain in an effort to increase students' awareness of its harmful impacts. Read facts about acid rain. You can also see about joining the project.

Acid Rain FAQ Helpful sight to look at for facts about acid rain such as how it affects aquatic ecosystems, plant life, and human health.

How to Measure Acid Rain Provides information about how to properly collect rain water and measure its pH.

More links to Schoolyard Habitat Information

Schoolyard Habitat Links Learn more about developing and maintaining schoolyard and backyard habitats by visiting these links.


Back to COIILS Main Page


To SPLASHD Web Page

Back To List

Schoolyard Acid Rain Investigation - View

ID	1
School Name	Data Entry Example
Grade Level	7
Team Name/Number	Team #2
School Latitude	50.2N
School Longitude	76.3W
Date(s)	5/5/01
Distance to power plant (miles)	9
Season	Spring
Wind Direction	Northwest
Air Temp Low (Celsius)	28C
Air Temp High (Celsius)	30C
Amount of rain (cm)	4
pH	5.5
Amt of Pond Water (cm)	
pH	
Amt of Well Water (cm)	
pH	
Amt of Stream Water (cm)	
pH	
Amt of Other (cm) (Describe in Comments)	
pH	
Contact's Email Address	mschneid@stclair.k12.il.us

Comments	

Back | Reset | Refresh

Schoolyard Acid Rain Investigation

School Name	Grade Level	School Latitude	School Longitude	Amount of rain (cm)	pH	
Data Entry Example	7	50.2N	76.3W	4	5.5	View
Blank Data Page						View
Jefferson Grade School	4th	N 39.29.832	W 088.10.433	.3	6.5	View
Jefferson Grade School	4th	N 39.29.832	W 088.10.433	.4	7	View
Jefferson Grade School	4th	N 39.29.832	W 088.10.433	.2	7.3	View
Jefferson Grade School	4th	N 39.29.832	W 088.10.433			View
Buncombe Grade School	7					View
Buncombe Grade School	7					View
Buncombe Grade School	7					View
Buncombe Grade School	7					View
Buncombe Grade School	7					View

Records 1 to 11 of 11

Search For: Search Now

Acid Rain – The Effect of Air Pollution Needed Materials: pH paper and color chart (range pH 2-7), rain gauge (can be milk carton or coffee can securely placed in the outdoor classroom, distilled water, wind vane (wind direction can be determined from observing a flag or other object. This information could also be obtained from the local weather report on the Internet), data collection form and pencil, water samples from other sources such as local wells, lakes, ponds, streams, wetlands, and water puddles. Safety Rule: Be sure to NOT drink the collected water samples and be sure to wash your hands after tests are completed. Procedure: Student Information: The following information will provide you with the steps for setting up your acid rain experiment. It is important to hold all of the variables constant except for those that are being manipulated. Constant (or controlled variables) could be such things as: the amount of time the experiment is conducted, the frequency with which the rain gauge is emptied, the location of the rain

gauge or the other water sources, the amount of water sampled, etc. Manipulated (or independent) variables would be those things that we can change to see if the response will be different, such as: type of gauge, location of the gauge or other water sources, season of collection, etc. The responding (or dependent) variable for this experiment will be the pH of the rainfall in each of your gauges and the pH of the other water sources. NOTE: Amount of rainfall is one variable that will be difficult to control or intentionally manipulate in this experiment. However, from your experiments, you may be able to infer as to whether amount of rainfall has any impact on pH of the water collected. The reporting form for this experiment is set up so that you can determine how many gauges you want to put out and where you want to place them. NOTE: Remember that a good scientific experiment is repeated a minimum of three times. Therefore, your data will be more accurate if you set up several gauges that are exactly the same and then compile an average of your data before submitting it. With the other water sources, be sure to test each sample at least three times to more accurately determine the pH. Procedural Steps for Conducting the Investigation Rain Gauge Procedure: • 1. Click on the “View Data” link at the Acid Rain Investigation web page. Click on “View” in the blank sample listed on the chart. What comes up is the data collection sheet that will be used in this investigation. Print it and place it on your clipboard. • 2. Choose a location for your rain gauges. Look for places in open, protected areas that will not get a lot of human interference. • 3. Monitor the gauges daily for a period of at least one month. One month in the fall and another in the spring may be the most appropriate in the mid-west. It is important to choose months of the year that will provide the most rainfall for testing. • 4. If rain is present, record the wind direction, amount of rain, and collect the water from the rain gauge. If there is no rain, record the amount as 0. If the carton is wet but cannot be measured, record as 0. Measurable rain should be recorded in millimeters (mm). • 5. If rainfall was collected, the carton should be rinsed with distilled water after being emptied. • 6. Measure the pH of the collected rainfall with pH test strips. Dip the strip in the collected rain, then hold the strip near the pH color chart. Record the pH number of the matching color. Also, measure the pH of distilled water and record that for your control. • 7. When you are finished, remove the gauges from the outdoor area. Other Water Sources Procedure: • 8. Using new pH paper strips each time, test each of your other water source samples at least three times each to verify your results. NOTE: If you must limit your pH paper use, compare your results to that of two other groups testing the same water sample. • 9. Be sure to enter all of your collected data onto your printed data collection sheet. • 10. After group and classroom discussions have occurred, login to enter your data.online at the correct location. NOTE: Only numbers must be inserted into the spaces provided in order for your Excel spreadsheet to work properly. • 11. Once all classroom data is submitted you can download allsubmitted Schoolyard Litter data and develop charts and graphs in Excel by following the general directions provided at "Downloading and Analyzing Collected Data Using an Excel Spreadsheet"