



Author Name: Julie Grimes	Content Areas: Earth Science, Life Science and Ecology
Lesson Plan Title: Pollutant effects of Acid Rain	State: GA
Lesson Time Frame: 1 st class – 45 minutes Day 3, 5, 7, 9 – 15 minutes Day 11 – 30 minutes	Expedition Title: Mexican Mangroves and Wildlife
Student Level: Middle School	

Academic Standards Addressed: Georgia Quality Core Curriculum

1 Topic: Scientific Inquiry Process

Standard: Uses process skills of observing, classifying, communicating, measuring, predicting, inferring, identifying, and manipulating variables. Also uses skills of recording, analyzing and operationally defining, formulating models, experimenting, constructing hypotheses, and drawing conclusions.

2 Topic: Safety Skills

Standard: Understands and applies laboratory safety rules and practices.

3 Topic: Standard International (SI) Measurements (Metric System)

Standard: Defines and identifies standards of measurement.

3.1 Names the prefixes used in the SI system.

3.2 Identifies SI units and symbols for length, volume, mass, density, time, and temperature.

3.3 Converts measurements among related SI units.

3.4 Uses appropriate tools for determining mass volume, temperature, density, and length.

4 Topic: Reference Skills

Standard: Selects and uses multiple types of print and nonprint sources for information on science concepts.

5 Topic: Human Interactions with the Environment

Standard: Recognizes the effects human beings have on pollution and the environment.

5.1 Identifies ways human beings cause and can correct pollution of water bodies, the atmosphere (acid rain, ozone layer, and greenhouse effect) and the land (soil pollution, and chemical/nuclear waste).

5.2 Examines the effects pollution from cities have on weather and the effect of burning fuels on the atmosphere, melting of polar ice caps, and predicting earthquakes.

Abstract:

This laboratory experiment was designed as an extending and refining lesson to our unit on pollution. Students will use simulated acid rain when watering plants in order to determine its effects on vegetation. Students will also make inferences on how sulfur dioxide and acid rain may affect the environment.

Goals: (overall essential questions)

How do humans contribute to the formation of acid rain?

How does acid rain affect the environment?

What can be done to control the effects of acid rain on the environment?

Performance Indicators:

Students will be able to identify the characteristics and most likely causes of acid rain.

Students will be able to recognize sources of sulfur dioxide pollution and relate the formation of air pollution to the creation of acid rain.

Students will be able to identify methods to correct or reduce atmospheric sulfur dioxide in an effort to reduce acid rain.

Background information:

This laboratory experiment is designed as an extending and refining lesson for use after completion of acquisition lessons on this topic. Acquisition lessons may vary in design; however, they must answer the essential questions prior to conducting the lab. Important background information concerning sulfur dioxide and acid rain accompanies the laboratory handouts and serves as reinforcement to previously discussed material. Please see the attached lab for this material.

Materials:

- Water solutions prepared to a pH of 5.5, 4.5, 3.5 (Tap water can be adjusted to the correct pH by adding small additions of sulfuric acid. These solutions can also be purchased using school science suppliers.)
- Inexpensive landscaping annuals/perennials (Those contained in small round cups work best.)
- Drain trays
- Graduated cylinder
- PH meter or pH test papers/strips
- Camera (optional)

Technology:

Students may use the computer to type their lab report.

Instructional Procedure:

Introduction: Students will read and participate in class discussion concerning the information obtained from reading the background information section of their laboratory handouts. Use of county and state statistics from the Environmental Defense website www.scorecard.org can be used to relate pollution to local communities.

Activities: See lab handouts outlining laboratory procedures.

Closure: Students will complete critical thinking questions found in the lab handout. Students will conclude by summarizing their thoughts and opinions while writing the lab report.

Assessment:

Please see attached lab report rubric

Connection to other content areas:

Georgia History Students can research other areas in Georgia where substantial amounts of sulfur dioxide are produced by industry using the website www.scorecard.org.

Language Arts The process of writing lab reports focuses on many performance standards within the language arts curriculum.

Extensions:

An in-depth study of other forms of pollution can be conducted. This will allow for a more comprehensive understanding of issues facing the global community. Examples could include: ozone pollution, toxic wastes, pesticides & herbicides, and indoor air pollution.

Acknowledgements:

Kubasek, N., & Silverman, G. (2005). *Environmental law*. Upper Saddle River, NJ: Pearson Prentice Hall.

Environmental Defense. (2004). *Pollution in your community*. Retrieved August 7, 2005, from <http://www.scorecard.org/>



Background Information:

Pollutant Effects of Acid Rain

Most people think of congested highways with vehicles spewing exhaust or a large city with an endless horizon of industrial smokestacks; however, this is far from being the only picture of air pollution. The clean air act of 1970 and 1990 were designed to enforce regulations to control sources of air pollution. These two laws have significantly improved air quality, but air pollution is still one of the most serious environmental problems in the United States. As of 2002, the Environmental Protection Agency (EPA) estimated that more than 126 million Americans lived in areas where pollution levels exceeded Federal air-quality standards. When compared with air-quality standards of 1999, it is an increased risk for 25 million additional people.

Today's main air pollutants are commonly referred to as "criteria pollutants" and include carbon monoxide (CO), lead, ozone (O₃), nitrogen oxides (NO_x), and sulfur dioxide (SO₂).

In Bartow County, the largest source of air pollution is Plant Bowen, a coal-fired power plant. It is presently the third largest power plant in the United States. Our school, Woodland Middle School, is located within two miles of this facility. The most current data indicates that our county (Bartow County) is number one in the state of Georgia and twenty-second in the nation for total environmental releases to the environment. It is because of the large amount of power generated by Plant Bowen, that the large amount of pollution is released within our county.

When power plants burn fossil fuels containing sulfur, sulfur dioxide (SO₂), a highly corrosive gas is formed. Since the United States relies on fossil fuels for 90% of its energy needs, it is quite evident why our county's atmosphere is affected.

When sulfur dioxide is released from tall smoke stacks high in the atmosphere, it is known as a transboundary pollutant. Because

of winds and weather patterns, much of the pollution does not settle in our immediate area. Instead, it is carried downwind where it becomes a hazard for areas that did not create the pollution.

Primary health concern associated with sulfur dioxide (SO_2) is damage to the lungs and respiratory tract; yet an even greater danger exists. When sulfur dioxide (SO_2) and nitrogen dioxides (NO_x) chemically react with sunlight and water vapor in the atmosphere, they form sulfuric (H_2SO_4) and nitric (HNO_3) acids. When these acids fall with precipitation, they form acid rain that damages trees, buildings, vegetation, and aquatic life. In areas with little rainfall, these acids may cling to other particles and fall in a dry form known as dry deposition.

Although water typically has a pH of close to 7, “pure” rainwater uncontaminated by pollution has a slightly acidic pH of 5.6. Acid precipitation, known as acid rain, begins to be a problem when pH levels begin to fall below 5. Rainfall with levels as low as 4.3 have been measured in parts of the Eastern U.S. and Canada. In addition, eighty percent of Norway’s lakes are considered “dead” and over 300 lakes in Ontario have pH levels below 5.

If the contamination of water sources due to water run-off and the loss of aquatic species is not enough, acidic bodies of water have the ability to dissolve mercury and other toxic heavy metals from lake soils. These metals are also very toxic and can lead to a more complicated pollution picture.

Many things can be done in order to decrease sulfur dioxide production, thus limiting the amount of acid rain that enters our environment. Staying abreast of current legislation in regards to the Clean Air Act is one of the best methods. Write elected representatives from your area and make sure they are aware of your desire to protect the environment. Other things you can do to minimize the impact of burning fossil-fuels is to limit the amount of electricity you use unnecessarily. Turn off lights, and appliances when leaving the room. Depending on the season, set thermostats so that heating and air conditioning units run minimally when gone during the day. Any method used to reduce the amount of electricity used will decrease the demand for electricity. With this decrease

comes a decrease in sulfur dioxide and acid rain. Conservation is the key to a cleaner, greener Earth.

Acknowledgements:

Kubasek, N., & Silverman, G. (2005). *Environmental law*. Upper Saddle River, NJ: Pearson Prentice Hall.

Environmental Defense. (2004). *Pollution in your community*. Retrieved August 7, 2005, from <http://www.scorecard.org/>

Earth Science Lab Report Rubric

Basic information:

Due Date:

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- Black / blue ink only (no pencil) and legible
 - Use front side of paper only
 - No wrinkles, tears, or stray marks
 - Each section is clearly labeled and in correct order
 - No folders or report covers
 - Staple report at the top left hand corner
-
- 10 pts. All of the above criteria were met
 - 7 pts. 1-2 of the above criteria were not met
 - 5 pts. 3-4 of the above criteria were not met

Heading:

- Full Name
 - Class Period
 - Date
 - Assignment title (Title of lab)
 - Located center front page
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- 10 pts. All of the above criteria were met
 - 7 pts. 1 of the above criteria were not met
 - 5 pts. 2-3 of the above criteria were not met

Purpose / Hypothesis:

- The problem or purpose to be studied in the lab is clearly stated and explained.
 - A personal hypothesis is stated and explained.
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- 10 pts. Well written, fully stated in clear terms with a good explanation
 - 7 pts. Acceptable, explanation not fully discussed
 - 5 pts. Weak or unclear or no explanation given

Background information:

- Provide a background discussion about the problem studied in the lab.
- Key vocabulary words should be defined and source of information noted.

- 10 pts. Principles and/or vocabulary words are explained; source(s) noted
- 7pts. Principles and/or vocabulary words are present but no source is listed
- 5pts. Principles and/or vocabulary words are incomplete

Materials:

- List all laboratory equipment and other materials needed to perform the experiment.
 - 10 pts. All materials are listed
 - 7 pts. 1-2 materials are missing
 - 5 pts. 3 or more materials are missing

Procedure:

- Describe each step of the experiment so that someone else could perform the experiment following your directions.
- This section should **not** be written in paragraph form.
- Each step should be numbered.
 - 10 pts. All steps are present and clearly stated.
 - 7 pts. Clearly stated, but 1-2 steps are missing
 - 5 pts. More than 3 steps are missing or unclear on meaning

Data / Observations:

- Include all data, tables, and/or graphs obtained in the experiment.
- Always record data and observations in an organized manner.
- Be sure to title and label all graphs or tables and answer any questions present in the lab handout.
 - 20 pts. All data, tables, and/or graphs are present, titled, and labeled correctly
 - 15 pts. 1-2 errors are present, but all work is included and complete
 - 10 pts. Work is mostly complete or contains 3 or more errors

Conclusion:

- This is the most important part of your report. It involves your thought and analysis.
- Explain why you thought certain events occurred as they did. Also, state if problems were encountered. Mistakes can affect the results and suggest ways that you could improve them.
- State whether your hypothesis was correct or not.
- The conclusion should be written in paragraph form.
- The more of an explanation, usually the better. Small thoughts are important too!

- 20 pts. Logical and well-stated with a good comparison of the results to the original hypothesis
- 15 pts. Fairly well-stated with an acceptable comparison between the results and the original hypothesis
- 10 pts. Present and fairly stated, but not explained well and/or no comparison of results with hypothesis

Lab reports may be typed. If a lab report is illegible, it will not be graded. A letter grade will be deducted for each day late.

Name: _____

Parent Signature:
