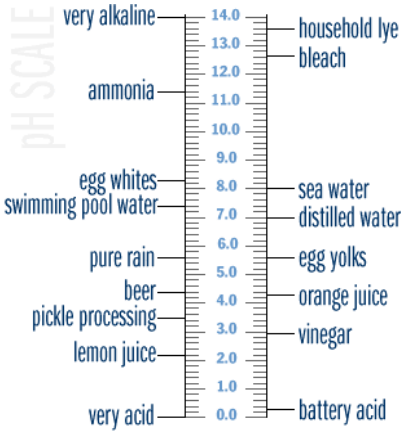
Visualizing Differences in pH Levels

Pre-lab

1. Sources of Nitrogen oxides (NOx):
2. Sources of Sulfur oxides (SOx):



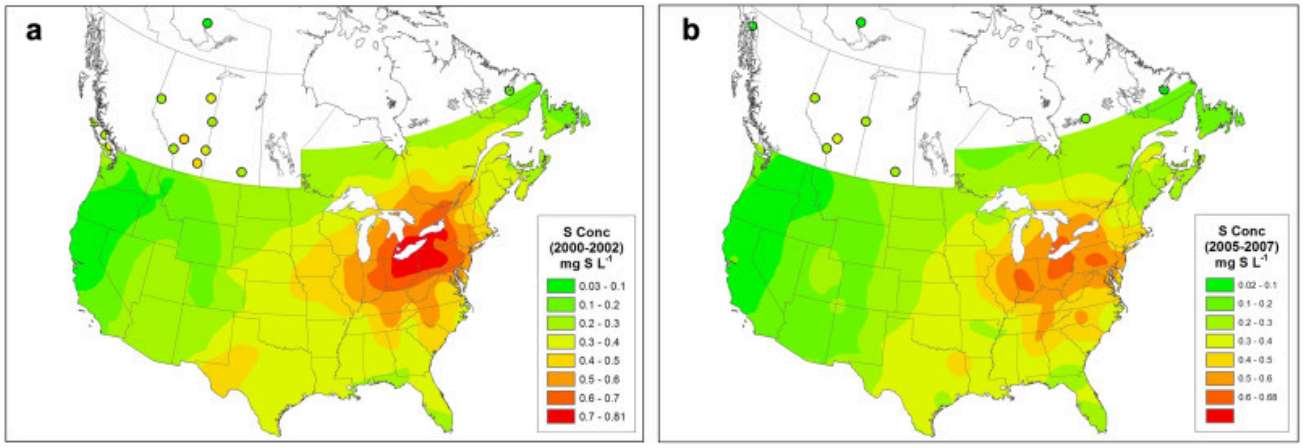
The terms nitrogen oxides, oxides of nitrogen, and NOx all refer to the air pollutants nitric oxide (NO) and nitrogen dioxide (NO2). The source of most NOx is the combustion of fossil fuels, during which the nitrogen and oxygen in air combine to form NOx . Because nitric oxide reacts quickly with the oxygen in air to form NO2, most of the NOx that pollutes our air is in that form.
The terms sulfur oxides, oxides of sulfur, and SOx all refer to the air pollutants sulfur dioxide (SO2) and sulfur trioxide (SO3). The source of most SOx is the combustion of fossil fuels, especially coal. Fossil fuels were formed from organic material that naturally contained trace amounts of sulfur which, when burned, oxidizes to form SOx . The primary form of SOx that pollutes our air is SO2.

Areas affected by acid deposition (biotic/abiotic)	Effects

hint: acidification does not burn plants

Acid Precipitation in the United States

This data is taken from measurements made in 2002, and in 2007. The darker areas indicate lower recorded rainfall pH levels.



1. What region of the country seems to have the biggest problem with acid precipitation? Why?

Lab 1: Visually Comparing Rainwater pH Levels

This lab will have you analyze several simulated acid rain samples and observe how much of each is required to completely neutralize a given base (or bring a pH 12 to 7).

Materials:

- Test tube
- Eight simulated acidic rain samples (pH 5.6-4.2)
- 0.01M Sodium hydroxide-NaOH (pH = 12)
- Dropper bottle of phenolphthalein
- Safety goggles
- Graduated cylinder

Procedure

1. Label eight of the test tubes with the pH of the different rain samples. There should be eight samples ranging from a pH of 5.6 to 4.2.
2. Put 5mL of NaOH into the unlabeled test tube.
3. Add 1 drop of the phenolphthalein solution to the test tube. The solution should change color.
4. Add one drop of the pH 5.6 rainwater sample to the test tube. Stir the test tube by lightly tapping it with your finger.
5. *Continue to add drops of the rainwater sample to the test tube until the color disappears. Record the total drops of acid added to the solution in your data table.*
6. Pour out the neutralized (pH = 7) solution down the sink and rinse with water.
7. Repeat steps #2-6 for the other acidic rainwater samples.

Drops of Rainwater Sample Needed to Neutralize NaOH (Class Data)

Normal Rain pH = 5.6	Acid Rain pH = 5.4	Acid Rain pH = 5.2	Acid Rain pH = 5.0	Acid Rain pH = 4.8	Acid Rain pH = 4.6	Acid Rain pH = 4.4	Acid Rain pH = 4.2
133	117	97	80	63	47	26	9

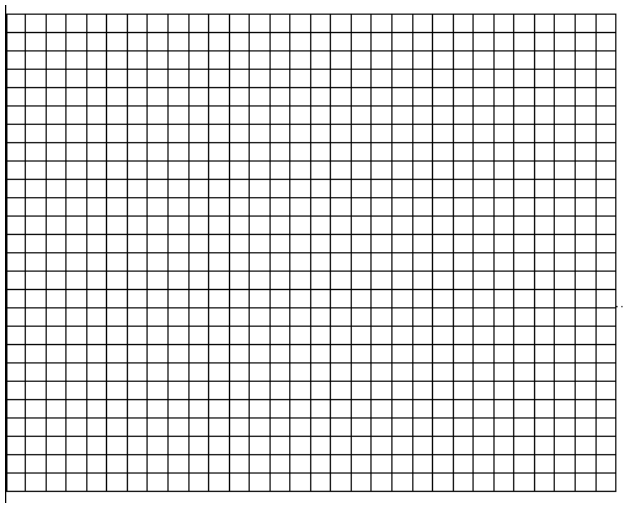
Lab 1 Conclusion

1. In this data set, what is the **independent variable** that you are controlling?

2. In this data set, what is the **dependent variable** that you are measuring?

3. Analyze results of the lab, labeling both the IV and DV in your answer.

4. Create a **graph** based on the collected data. Remember, the independent variable should be on the **x-axis** and the dependent variable should be on the **y-axis**.



Lab 2: Investigating effects of Sulfur and Nitrogen Oxides on Plants

Daily video 7.7 1 and 2

Lab summary: *each group had three petri dishes (atmospheric chambers) with 25 seeds each that were exposed to SO2, NO2, or acted as the control for three days until seeds germinated.*

Lab 2 Conclusion

Choose one of the following student hypotheses:

a. *Seeds exposed to SO2 and NO2 will have less successful germination than control seeds.*

b. *SO2 and NO2 will inhibit radish seed germination.*

c. *SO2 and NO2 will have no effect on radish seed germination (statistical null hypothesis).*

1. Explain if the hypothes is supported or refuted using the below results of the lab experiment.

	Length of Seedling (mm)		
	Control	SO_2	NO_2
1	39	58	2
2	32	58	2
3	50	33	3
23	46	49	3
24	27	20	2
25	40	40	2
Average	39	43	23

	Observations
Control	Bright green with long roots
SO_2	The seedlings that grew in the SO_2 were yellow and much thinner than those in the control group.
NO_2	The seeds in the NO_2 did not germinate at all, or if they did, only the tip of a root was visible.

Group Name	Number of Seeds Germinated			pH		
	Control	SO_2	NO_2	Control	SO_2	NO_2
Our Group	25	23	2	6.5	3.5	1.0
Other Group 1	24	21	0	6.5	3.0	1.5
Other Group 2	25	22	3	6.5	3.5	1.0
Other Group 3	25	20	0	6.5	3.5	1.0
Average	25	22	1	6.5	3.4	1.1

2. Choose a Group #, state that #, and calculate the germination rate of each (control, SO_2, NO_2).

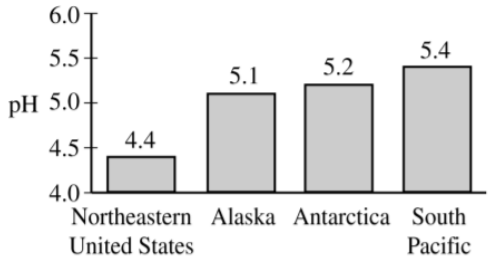
3. Describe the differences in how each gas affected the growth or germination of radish seeds and how they varied from the control.

4. A buffer is a chemical that keeps the pH of a system constant. Limestone bedrock is a natural buffer in some aquatic ecosystems. Explain how the results of this experiment might have been altered if a buffer had been added to each atmospheric chamber.

Conclusion conclusion

1.

The graph below shows the average pH of precipitation from several regions of the world.



Approximately how many more times acidic, in terms of H+ concentration, is precipitation in the northeastern United States as compared to precipitation in the South Pacific?

a. 0.1
b. 2
c. 10
d. 20

2. Which of the following would be the most likely effect of acid deposition on a northern forest?
   a. Decreased ability of trees to withstand cold weather
   b. Decreased concentration of H+ ions in the soil
   c. Decreased levels of light on the forest floor
   d. Increased buffering capacity of the soil

3. Which of the following would most likely neutralize the effect of acid rain on bodies of water, based on the composition of soils and bedrock in the region?
   a. An area downwind of a coal-burning electrical plant
   b. A valley that is frequently shrouded in fog
   c. A forest underlain by limestone
   d. An open plain underlain by granite

4. Acid deposition would most likely result in which of the following?
   a. The release of aluminum ions from soil
   b. An increase in populations of mollusks
   c. The death of species tolerant of low pH levels
   d. An increase in buffering of lake water by sulfates

5. Which of the following best describes how ocean acidification affects coral formation?
   a. The increase in hydrogen ions dissolved in the ocean water erodes the skeleton of corals, making them weak and vulnerable to damage or death.
   b. The increase in calcium carbonate ions dissolved in the ocean water leads to an increase in the formation of coral reefs and increases the number of algae species that inhabit the reef systems.
   c. The increase in carbonic acid dissolved in the ocean water leads to increased deposition of calcium carbonate by coral species, leading to a bleaching of coral.
   d. The increase in hydrogen ions dissolved in the ocean water sequesters available carbonate ions, preventing the use of calcium carbonate for coral skeleton formation.

6. Which of the following solutions can best reduce an anthropogenic cause of ocean acidification?
   a. Rotate crops planted in agricultural fields each year
   b. Use biomass for heating homes and for cooking

c. Switch from coal-burning power plants to nuclear power plants for electricity generation
d. Install catalytic converters on cars and trucks

7. Which of the following best describes a potential unintended negative consequence of implementing measures to control acid deposition?

a. A reduction in environmental lead, leading to decreased negative health effects in humans and wildlife.
b. A reduction in sulfur for crops as a result of less acidic rainfall, leading to an increased need for sulfur supplements.
c. A reduction in mortality rates in freshwater aquatic organisms from an increase in pH of the water.
d. A reduction in acid mine drainage, resulting from a reduced need for nuclear fuel and uranium mining

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2019 lab

4. A common source of acid rain is air pollution that contains sulfur. This creates sulfuric acid when it mixes with water vapor in the air. Sulfur air pollution is easy to identify because it has a rotten-egg odor. What are some sources of sulfur air pollution?

5. Go to the National Acid Deposition Program website and look at the current animated maps of sulfate and nitrate ion soil concentration in soil. How has the map changed since the 1980s for both pollutants? How does one account for this change in both pollutants? How have the pollutants been mitigated?

SO4 (sulfate) concentration animated map:
https://www3.epa.gov/airmarkets/progress/reports/acid_deposition_figures.html#figure1
nadp.sws.uiuc.edu/data/amaps/so4/amaps.html

Changes:

Reasons:

NO3 (nitrate) concentration animated map:
https://www3.epa.gov/airmarkets/progress/reports/acid_deposition_figures.html#figure2
nadp.sws.uiuc.edu/data/amaps/no3/amaps.html

Changes:

Reasons:

6. How can a *citizen* ***mitigate*** acid deposition in the first place? https://www.youtube.com/watch?v=VILCk2CpUCw

7. What is an indicator species? How can it assess acid deposition within an ecosystem?