APES: Acid Rain Lab

Name_________________________**Blk**_____

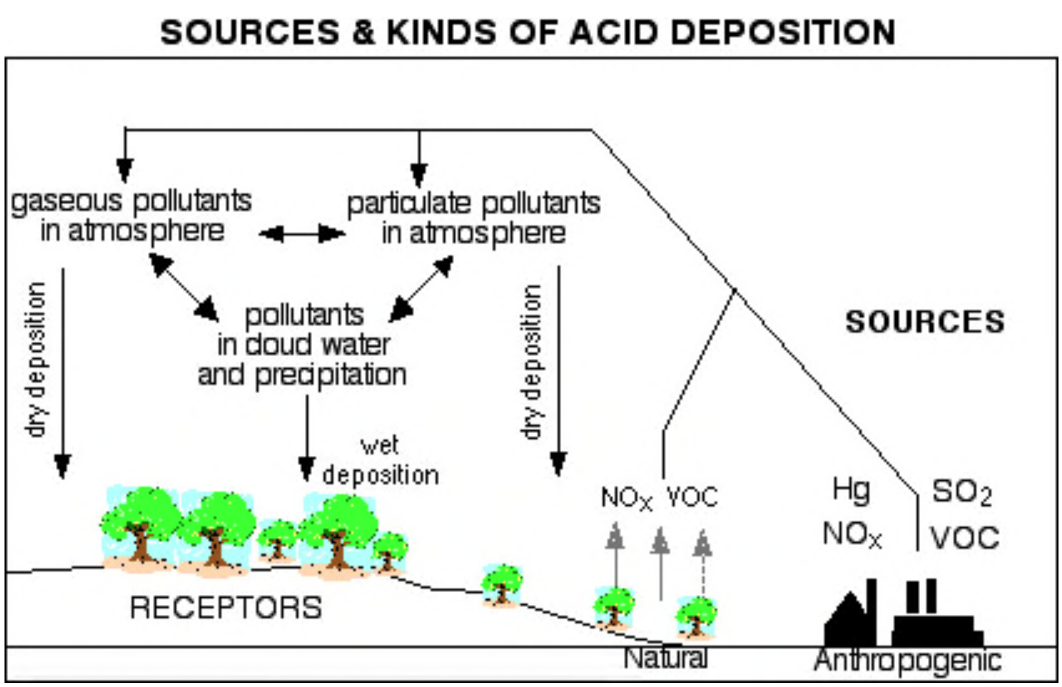
Obj.47 - Acid Deposition.

Lab Background: The Effects of Acid Rain

Acid rain is a general term that describes how acids fall out of the atmosphere. A better term would be acid deposition, which occurs in two ways: wet and dry. Acid rain, fog, and snow are known as **wet deposition**. **Dry deposition** is made up of acid gases and particles, and these constitute about 50% of all acidic fallout from the atmosphere. When coal, oil, or gasoline is burned, nitrogen oxide & sulfur oxide gases are released. These particles get blown by wind onto cars, buildings, bridges, forests, etc. When it rains, these particles dissolve in the water, and the runoff can become more acidic than the rainfall itself. In areas with limestone ($CaCO_3$) bedrock, surface waters have high concentrations of carbonate and bicarbonate and therefore are able to resist change in pH. The pH of a well-buffered lake does not change dramatically following a storm or snowmelt period because the acidity becomes neutralized by these ions.

When you hear or read in the media about the effects of acid rain, you are usually told about the lakes, fish, and trees in New England and Canada. However, we are becoming aware of an additional concern: many of our historic buildings and monuments are located in the areas of highest acidity. In Europe, where buildings are much older and pollution levels have been ten times greater than in the United States, there is a growing awareness that pollution and acid rain are accelerating the deterioration of buildings and monuments.

Stone weathers (deteriorates) as part of the normal geologic cycle through natural chemical, physical, and biological processes when it is exposed to the environment. This weathering process, over hundreds of millions of years, turned the Appalachian Mountains from towering peaks as high as the Rockies to the rounded knobs we see today. Our concern is that air pollution, particularly in urban areas, may be accelerating the normal, natural rate of stone deterioration, so that we may prematurely lose buildings and sculptures of historic or cultural value.



Carbonic acid occurs when carbon dioxide gas dissolves in rain droplets of unpolluted air:

(1) $CO_{2(g)} + H_2O_{(l)} \rightarrow H_2CO_{3(aq)}$

Nitrous acid and nitric acid result from a common air pollutant, nitrogen dioxide (NO_2). Most nitrogen dioxide in our atmosphere is produced from automobile exhaust. Nitrogen dioxide gas dissolves rain drops and forms nitrous and nitric acid:

(2) $2NO_{2(g)} + H_2O_{(l)} \rightarrow HNO_{2(aq)} + HNO_{3(aq)}$

Sulfurous acid is produced from another air pollutant, sulfur dioxide (SO_2). Most sulfur dioxide gas in the atmosphere results from the burning of coal containing sulfur impurities. Sulfur Dioxide dissolves in rain drops and forms sulfurous acid:

(3) $SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{3(aq)}$

Lab Purpose: In this lab, you will observe the formation of various acids that contribute to acid rain.

- Carbonic acid, H_2CO_3
- Nitrous acid, HNO_2
- Nitric acid, HNO_3
- Sulfurous acid, H_2SO_3

In the procedure outlined below, three gases will first be produced. These gases will then be bubbled though the water, producing the acids found in acid rain. Using a universal indicator, which reveals the pH of the water, the acidity of the water will be monitored.

Acid rain is one of the major factors in karst formation. The acidic water flows through existing fractures in the surface and dissolves away limestone, dolomite, and gypsum enlarging the fractures. This action increases the amount of water that enters the karst drainage system.

Lab Materials:

Distilled water
micro-chem plate
universal indicator
100 ml beaker
tap water for cleanup
safety goggles

3 Beral pipets with large opening for
- solid $NaHCO_3$ (pink)
- solid $NaNO_2$ (or KNO_2) (green)
- solid $NaHSO_3$ (orange)

3 Beral pipets with small opening for gas collection
- $NaHCO_3$ ------> $CO_{2\,(g)}$
- $NaNO_2$ (or KNO_2) ------> $NO_{2(g)}$
- $NaHSO_3$ ------> $SO_{2(g)}$

1 Beral pipet with 1.0 M HCl

Lab Procedure:

1. Obtain and wear safety goggles.

2. Obtain your lab set up of one micro-chem plate containing 3 of each type of Beral pipets. Check and make sure the large opening ones are named for each solid; $NaNO_2$, $NaHCO_3$ and $NaHSO_3$. Check and make sure the small opening ones are labeled for the gases; CO_2, NO_2 and SO_2. Always set the Beral pipets with the open-end upright in your beaker.

3. Take your large opening pipets to the front lab table and obtain the solid substances. Squeeze the bulb of the pipet to expel all of the air, suck some of the solid into your pipet. Do this several times (4-5) for each solid until you have enough solid to fill the curved end of the bulb. It may be necessary to scoop some of the solid into the pipet. It should be about 1/3 full. ***Caution, avoid inhaling dust from the solids.***

4. Fill three wells of your micro-chem plate with 10 drops of distilled water. Measure the pH of the water by adding **one drop of indicator solution**. Record this as the initial pH of your experiment.

5. Obtain a small opening Beral pipet with 1.0 M HCl from the teacher. **Caution: HCl is a strong acid. Gently hold the pipet with the stem pointing up, so that the HCl drops do not escape.**

6. **TEST ONLY ONE SOLID AT A TIME**. **PAY ATTENTION TO COLOR!** Insert the narrow stem of the HCl pipet into the larger opening of the pipet containing the solid. Gently squeeze the HCl pipet to release about 20 drops of HCl into the solid. When finished, remove the HCl pipet and gently swirl the pipet containing the solid to mix them together. Be careful as it may overflow. **Leave the pipets open end up in your beaker.** (The gases you have produced are denser than the air in the classroom and will remain in the bulb of the pipet.)

7. Collect the gas from the pipets by inserting the small opening pipets while holding the bulb squished between your fingers. Slowly release the pressure so that the gas is sucked into the gas pipet. Be careful to use the correct pipets for the correct gas and also be careful to only collect the gas. Place the gas pipet open end up into your beaker with the solid.

8. Take your first gas sample and insert the tip of the pipet into one of the wells filled with water. Slowly bubble the gas through the water. Take a pH reading after ten bubbles. Take a pH reading after ten more bubbles. Record this information.

9. Repeat for the other two gas samples.

COPY OR TAPE THE DATA TABLE INTO YOUR LAB NOTEBOOK.

Acid Rain Data Table

Gas Produced	Initial pH of Water	pH after First 10 Bubbles	pH after Second 10 Bubbles	Final pH	ΔpH
CO_2					
NO_2					
SO_2					

Analysis Questions

1. For each of the three gases, calculate the change in pH (ΔpH), by subtracting the final pH from the initial pH. Record these values in the Acid Data Table.

2. In the experiment, which gas caused the smallest drop in pH? Why do you think this is?

3. Which gas (or gases) caused the largest drop of pH? Why do you think this is?

4. Coal from western states such as Montana and Wyoming is known to have a lower percentage of sulfur impurities than coal found in the eastern United States. How would burning low sulfur coal lower the level of acidity in rainfall? Use specific information about gases and acids to answer the question.

5. High temperatures in the automobile engine cause nitrogen and oxygen gases from the air to combine to form nitrogen oxides. What two acids in acid rain result from the nitrogen oxides in automobile exhaust?

6. Which gas would produce acid rain from air that is unpolluted?

7. Why is acid rain more of a problem in the northern U.S. and Canada then in central Texas?

8. Why might a conifer tree have the potential to suffer more from acid rain than a deciduous tree?

9. Write out the three chemical reactions for the formation of acid rain. For each reaction explain how the gases made create acid rain.

10. How does acid rain affect historical monuments, buildings or tombstones?

11. Read the information on karst cave formation. Describe the formation of a karst cave.

12. What is the primary source of sulfur dioxide emissions? Describe three ways sulfur dioxide emissions can be lowered.

13. Why are the highest values in the Midwest in southeast Ohio?

14. Why are the values so low west of the Rocky Mountains?

15. What is the primary source of NOx emissions?

16. Where are the highest concentrations on this map, and why?

17. Why are the values so low in rural central and northern California but higher east of the urban San Francisco Bay area?

18. Why are the lowest pH (most acidic) values generally in the Northeast?