

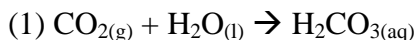
Acid Rain

Lab Purpose: To observe how four different acids can cause acid rain:

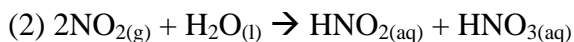
- Carbonic acid, H_2CO_3
- Nitrous acid, HNO_2
- Nitric acid, HNO_3
- Sulfurous acid, H_2SO_3

Lab Background:

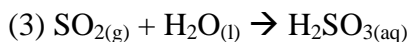
Carbonic acid occurs when carbon dioxide gas dissolves in rain droplets of unpolluted air:



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:



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:



In the procedure outlined below, you will first produce these three gases. You will then bubble the gases through the water, producing the acids found in acid rain. Using a universal indicator, which reveals the pH of the water, will monitor the acidity of the water.

Lab Materials:

Distilled water	solid NaNO_2 (or KNO_2)
100 ml beaker	solid NaHCO_3
micro-chem plate	solid NaHSO_3
universal indicator	tap water for cleanup
3 Beral pipets with small opening	safety goggles
3 Beral pipets with large opening	
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 chem.-plate.
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, hold in the solid and release the bulb. Some of the solid will be sucked into your pipet. Do this several times for each solid until you have enough solid to fill the curved end of the bulb. (Shown in figure 1) **Caution, avoid inhaling dust from the solids.**
4. 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.** One at a time, insert the narrow stem of the HCl pipet into the larger opening of the pipet containing the solids. 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. **Leave the pipets open end up in your micro-chem plate.** (The gases you have produced are denser than the air in the classroom and will remain in the bulb of the pipet.)
5. 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 micro-chem plate.
6. Fill three wells of your micro-chem plate half way with distilled water. Measure the pH of the water by adding ten drops of indicator solution. Record this as the initial pH of your experiment.
7. 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 every ten bubbles. Record this information.
8. Repeat for the other two gas samples.

Acid Data Table

Gas	Initial pH	After 10 bubbles	After 10 more bubbles	Final pH	ΔpH
CO_2					
NO_2					
SO_2					

Processing the Data

- 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.
- 2) In the experiment, which gas caused the smallest drop in pH?
- 3) Which gas (or gases) caused the largest drop of pH?
- 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 than in central Texas?