Acid Rain* Lab (Easy)

Theory:

Water is able to absorb a large variety of chemicals, leading us to call it the "universal solvent". In this lab we will be looking at how water absorbs CO_2 gas. We will be observing the pH level of the water sample as CO_2 is added, forming carbonic acid and lowering the overall pH level. This lab will point the way to other gases being absorbed and similarly being converted to acidic compounds.

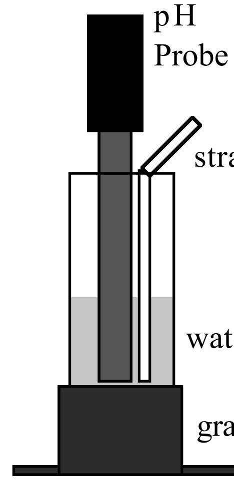
Purpose:

Study the absorption of CO_2 by water.

Equipment:

pH Sensor, TI Graphing Calculator**, 50-ml Graduated Cylinder, water, straw, LabPro or CBL2 or Easy Link interface

Procedure:



1. Put 10-15 ml of distilled water at room temperature in the graduated cylinder. Put a similar amount of water in a test tube and place it in an ice water bath for later use. Prepare a third sample but place it in a hot water bath.

2. Rinse the pH Sensor with pure water and insert in the graduated cylinder. Also insert the straw.

3. Plug the pH Sensor into your Vernier interface. Launch the ***Easy Data*** program under [APPS]. When the software is launched successfully, it should find the pH probe and set up a sample data collection. Modify this setup for a 4-minute collection time. Follow these steps:

   - Press the button under [Setup].
   - Choose Time Graph. The settings will be shown.
   - Press the button under [Edit] to change the settings.
   - Enter 1 to set a 1-second sampling rate. Then press the button under [Next].
   - Enter 240 for 240 samples, which gives a total time of 4 minutes. Press the button under [Next].
   - If the settings are okay, press the button under [OK] to get back to the main menu.

4. Begin collecting pH readings. Press the button under [Start]. After about 30 seconds, begin blowing <u>very gently</u> through the straw, bubbling the water. Note any changes in the pH readings. Keep blowing gently for two minutes. Then let things settle out for the last minute of data collection.

5. Once data collection is completed, the graph will be redrawn and autoscaled to fill the whole screen. Answer questions 1 to 3 in the Analysis section.

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6. Press [ENTER] to go back to the main menu. Put the water sample that was in the ice water bath in the graduated cylinder. Rinse the pH bulb with pure water, then insert the pH probe and straw into the cold water. Repeat step (4).

7. Once data collection is completed, the graph will be redrawn and autoscaled to fill the whole screen. Answer question 4 in the Analysis section.

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8. Press [ENTER] to go back to the main menu. Put the water sample that was in the hot water bath in the graduated cylinder. Rinse the pH bulb with pure water, then insert the pH probe and straw into the hot water. Repeat step (4).

9. Once data collection is completed, the graph will be redrawn and autoscaled to fill the whole screen. Answer questions 5 and 6 in the Analysis section.

Analysis:

1. What was the pH reading of your distilled water at the beginning of your run? (To see this pH, note there is a blinking cursor at the start of your graph. What is the value given for the y-value (at the top of the graph)? Does this reading indicate the water is acidic, basic or neutral?

2. Describe the graph generated as you blew air through the water. Note that the CO_2 in your breath was combining with water molecules to form carbonic acid, H_2CO_3. Does the direction of the graph indicate that an acid is being formed?

3. What is the lowest pH your water went to during the 4-minute data run? (To see this pH, use the right-arrow on the keyboard and move the cursor to the lowest point in the graph. The value is given at the top of the screen.) What was the overall change in pH?

4. Repeat steps (1) to (3) above, but for the cold-water sample. How does the pH change of the cold water compare to the pH change for the room temperature water? If it was a larger change, what does that indicate about the amount of CO_2 that was absorbed? Or if it was a smaller change, what does this indicate?

5. Repeat steps (1) to (3) above, but for the hot-water sample. How does the pH change of the hot water compare to the pH change for the room temperature water? What does this indicate about the amount of CO_2 that was absorbed?

6. Can hot water or cold water contain more dissolved CO_2 based on your experimental results? Would we expect to find more CO_2 in warm equatorial waters or in the cold northern or southern waters? What might this say about the amount of food that can be supported in warm vs. cold waters?

Extension:

Compare the rate at which the pH changes if you have been resting recently and if you have been exercising. For example, run in place, run around the building or do some jumping jacks immediately before blowing into the straw. What does this say about the amount of CO_2 that you have in your breath?

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* This isn't really an Acid Rain Lab. The process of absorbing CO_2 by water and forming carbonic acid means that airborne water is slightly acidic. In a similar manner, SOx and NOx are both absorbed forming acidic compounds that contribute to the problem we call acid rain. The more SOx and NOx in the air as a result of burning fuels, the more acid rain we generate.

The lab manual Chemistry with Vernier contains a more sophisticated technique for generating CO_2, SO_x and NO_x. This is recommended for a more thorough investigation of the phenomenon of Acid Rain.

** This lab can be used for TI-83+ and TI-84+ graphing calculators. The calculator should have the latest operating system and must have EasyData loaded into Apps. For TI-83+, a CBL2 or LabPro interface is needed. TI-84+ can use EasyLink.

For "pure water", we have often use bottled water although tap water can also be used very successfully. Clearest results ensue if the initial water is very slightly basic.

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