

pH OF STREAMS

Lab PH-1

From *Water Quality with Calculators*, Vernier Software & Technology, 2000

MATERIALS CHECKLIST

- | | |
|--|--|
| <input type="checkbox"/> LabPro or CBL 2 interface | <input type="checkbox"/> 250-mL beaker |
| <input type="checkbox"/> TI Graphing Calculator | <input type="checkbox"/> small plastic or paper cup (optional) |
| <input type="checkbox"/> DataMate program | <input type="checkbox"/> pH 7 buffer solution |
| <input type="checkbox"/> Vernier pH Sensor | <input type="checkbox"/> pH 10 buffer solution |
| <input type="checkbox"/> tissues or paper towels | <input type="checkbox"/> distilled water |

Collection and Storage of Samples

1. This test can be conducted on site or in the lab. A 100-mL water sample is required.
2. It is important to obtain the water sample from below the surface of the water and as far away from shore as is safe. If suitable areas of the stream appear to be unreachable, samplers consisting of a rod and container can be constructed for collection.
3. If the testing cannot be conducted within a few hours, store samples in an ice chest or refrigerator.

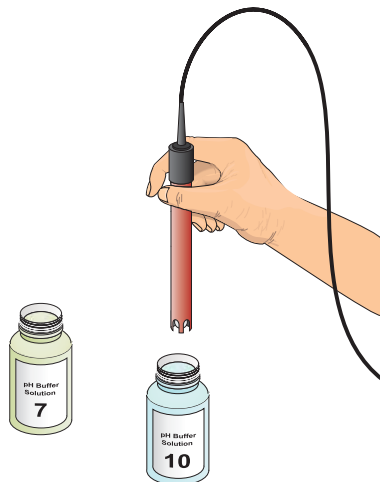
Testing Procedure

1. Plug the pH Sensor into Channel 1 of the LabPro or CBL 2 interface. Use the link cable to connect the TI Graphing Calculator to the interface. Firmly press in the cable ends.
2. Turn on the calculator and start the DATAMATE program. Press to reset the program.
3. Set up the calculator and interface for the pH Sensor.
 - a. Select SETUP from the main screen.
 - b. If the calculator displays PH in CH 1, proceed directly to Step 4. If it does not, continue with this step to set up your sensor manually.
 - c. Press to select CH 1.
 - d. Select PH from the SELECT SENSOR menu.
4. Set up the calibration for the pH Sensor.
 - If your instructor directs you to use the stored calibration, proceed directly to Step 5.
 - If your instructor directs you to manually enter the calibration values, select CALIBRATE, then MANUAL ENTRY . Enter the slope and intercept values for the pH calibration, select OK, then proceed to Step 5.
 - If your instructor directs you to perform a new calibration for the pH Sensor, follow the procedure below:

First Calibration Point

- a. Select CALIBRATE, then CALIBRATE NOW.

- b. Remove the sensor from the bottle by loosening the lid, then rinse the sensor with distilled water.



- c. Place the sensor tip into pH-7 buffer. Wait for the voltage to stabilize, then press .
- d. Enter "7" (the pH value of the buffer) on the calculator.

Second Calibration Point

- e. Rinse the pH Sensor with distilled water and place it in the pH-10 buffer solution.
- f. Wait for the voltage to stabilize, then press .
- g. Enter "10" (the pH value of the buffer) on the calculator.
- h. Select OK to return to the setup screen.
5. Set up the data-collection mode.
- a. To select MODE, press once and press .
- b. Select SINGLE POINT from the SELECT MODE menu.
- c. Select OK to return to the main screen.
6. Collect pH data.
- a. Remove the pH Sensor from the storage bottle. Rinse the tip of the sensor thoroughly with the stream water.
- b. Place the tip of the sensor into the stream at Site 1, or into a cup with sample water from the stream. Submerge the sensor tip in the stream or in a cup to a depth of 3-4 cm.
- c. When the readings stabilize, select START to begin sampling. **Important:** Leave the probe tip submerged while data is being collected for 10 seconds.
- d. After 10 seconds, the pH value will appear on the calculator screen. Record this value on the Data & Calculations sheet.
- e. Press to return to the main screen.
- f. Select START to repeat the measurement. Record this value on the Data & Calculations sheet (round to the nearest 0.01 pH units).
- g. Press to return to the main screen.
- h. Rinse the sensor with distilled water and return it to the storage bottle when you have finished collecting your data.

DATA & CALCULATIONS

pH of Streams

Stream or lake: _____

Time of day: _____

Site name: _____

Student name: _____

Site number: _____

Student name: _____

Date: _____

Student name: _____

Column	A
Reading	pH (pH units)
1	
2	
Average	

Column Procedure:

- A. Record the pH value from the calculator.

Field Observations (e.g., weather, geography, vegetation along stream) _____

Test Completed: _____ Date: _____

TEACHER INFORMATION

pH of Streams

- Step 4 of the student procedure provides three alternatives for loading or performing a pH calibration:
 - The easiest option is to use the pH calibration stored in the DataMate program. This is done automatically when the pH Sensor is chosen from the setup screen. Using this stored calibration will generally yield accuracy to within ± 0.2 pH units.
 - A second option is to perform a two-point calibration in the lab, using the PERFORM NOW option in the CALIBRATION menu (described in Step 4 of the student procedure, using buffers of pH 7 and pH 10). After this calibration is completed, record the calibration *slope* and *intercept* values that are displayed on the calculator screen. We recommend that you record these two values on a piece of label tape attached to the pH Sensor. When students get to the field at a later time, they can use the MANUAL ENTRY option of the CALIBRATION menu to manually enter the slope and intercept values for their pH Sensor. Since there is very little change in pH Sensor performance over short periods of time, we think this is a good way for students to handle pH calibrations. With careful calibration, this method can provide accuracy within ± 0.05 pH unit.
 - The third option has students perform a two-point calibration *in the field*, using the PERFORM NOW option in the CALIBRATION menu (using buffers of pH 7 and pH 10). Carrying buffer solutions to the field and performing a two-point calibration in uncertain conditions may not gain enough accuracy over the second option to justify the extra effort.
- If you choose to calibrate the pH Sensor, it is important to have adequate supplies of pH buffer solutions available. Vernier sells a pH buffer package for preparing buffer solutions with pH values of 4, 6, 7, and 10. You simply add the capsule contents to 100 mL of distilled water. The order code is PHB, and the price is \$10.00.

You can also prepare pH buffers using the following recipes:

- pH 4.00: Add 2.0 mL of 0.1 M HCl to 1000 mL of 0.1 M potassium hydrogen phthalate.
 - pH 7.00: Add 582 mL of 0.1 M NaOH to 1000 mL of 0.1 M potassium dihydrogen phosphate.
 - pH 10.00: Add 214 mL of 0.1 M NaOH to 1000 mL of 0.05 M sodium bicarbonate.
- The pH Sensor can be stored short term (up to 24 hours) in pH-4 or pH-7 buffer solution. For long-term storage (more than 24 hours) the pH Sensor should be stored in a buffer pH-4/KCl storage solution in the storage bottle. The pH Sensor is shipped in this solution. You can prepare additional storage solution by adding 10 g of solid potassium chloride, KCl, to 100 mL of buffer pH-4 solution.
 - Your Vernier pH Sensor is not temperature compensated. Commercial pH electrodes are not usually temperature compensated, because most measurements or calibration will be done at room temperature—any errors related to temperature variation are most likely negligible. If you are taking pH measurements in a stream that is significantly warmer or cooler than room temperature, the error may still be very small or negligible. This is because the pH Sensor has an *isopotential* value of pH 7.0. The isopotential point is that pH value where the response of the electrode does not vary with temperature. If you are making pH measurements in water with a value near pH 7, then almost no pH error results with changing temperature. Even if you were measuring a sample with a pH of 8.0 at a temperature that is 15°C lower than the temperature at which your calibration was performed, the error that results from neglecting the temperature factor is only 0.05 pH units. Another option, of course, would be to take the sample back to the lab, and let it return to room temperature just before taking its pH reading. Since the sample is at the same temperature at which the calibration is performed, no error results.

5. The SINGLE POINT data-collection mode was designed to make measurements easier and more accurate. When SINGLE POINT mode is used, the interface takes readings for 10 seconds. These readings are averaged and this average value is displayed on the calculator. This method has several advantages over other data-collection modes: (1) It eliminates the need for students to choose one value over another if that value is fluctuating; (2) If the readings are fluctuating a little, an average of the values is desirable; (3) It requires the students to hold the sensor in the water longer that they might tend to otherwise.

How the pH Sensor Works

The Vernier pH Sensor is a general-purpose pH measurement system. The electrode has a gel-filled half cell that is sealed—it never needs to be refilled. The glass bulb at the tip of the electrode measures the H^+ concentration. The voltage produced varies linearly with the log of the H^+ concentration; therefore, because $pH = -\log[H^+]$, the voltage varies linearly with pH.

