Vernier Drop Counter

The Vernier Drop Counter is used to perform accurate, automatic titrations. This digital sensor is used in conjunction with a pH Sensor (or other sensor) to accurately record drops of titrant added (or mL of titrant, with calibration of drop size) during a titration. Using Logger Pro or Drop Counter software on a Windows® or Macintosh® computer, you can collect data, and view plots of pH *vs.* volume, first derivative *vs.* volume, or second derivative *vs.* volume.

The Vernier Drop Counter has an optical-path slot that is 5.7 cm (2.25 in.) in length. When the infrared beam between the source and detector is blocked by a drop of titrant, a digital signal is sent to the LabPro, and the data collection program records a drop. The drops are then converted to volume units (e.g., milliliters), using a calibration feature in the software.

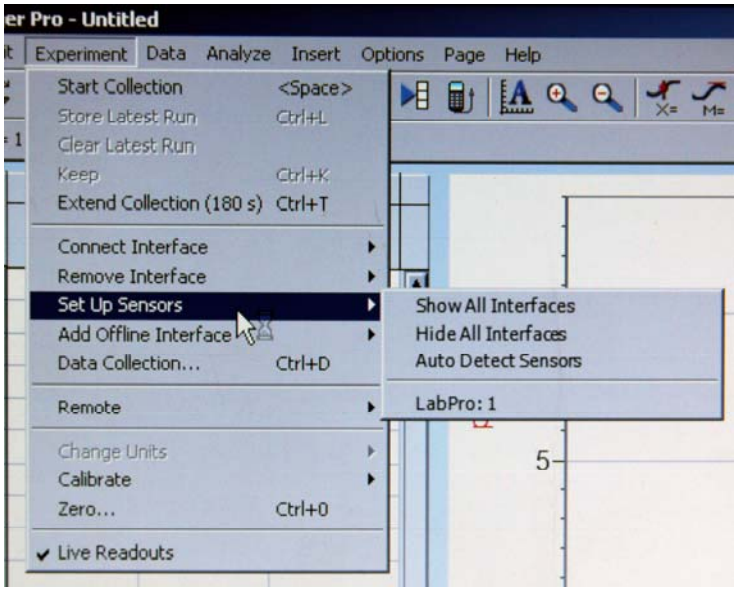
Directions

1. **Calibration of Drop Volume (in mL)**

   To calibrate drops so that the volume of titrant is recorded in units of milliliters, choose **Calibrate Drops** in your program. This menu choice helps you to measure the volume of an individual drop by counting the number of drops that pass through the Vernier Drop Counter and dividing by the total volume of the drops.

   Procedure

   a. Connect the pH Sensor to CH 1 of the LabPro or CBL 2 interface, and connect the cable of the Vernier Drop Counter to the Dig/Sonic 1 channel. Attach the LabPro to a computer.
   b. On the Logger Pro program, click on Experiment and then Set Up Sensors on the menu. Select Auto Detect Sensors.



c. Assemble the apparatus according to Figure 1. But do not put the pH sensor in the drop counter.

d. Connect the spout and two 2-way valves to the plastic reagent reservoir. Note: There are *two* 2-way valves below the reagent reservoir. The bottom valve is used as an on-off valve (either completely open or completely shut). The top valve is used as an adjustment valve, to deliver drops at a slow, consistent rate.

e. Make sure that both 2-way valves are in the closed position (horizontal), then add about 30 mL of titrant to the plastic reagent reservoir. The titrant to start with is a 0.1 M NaOH solution.

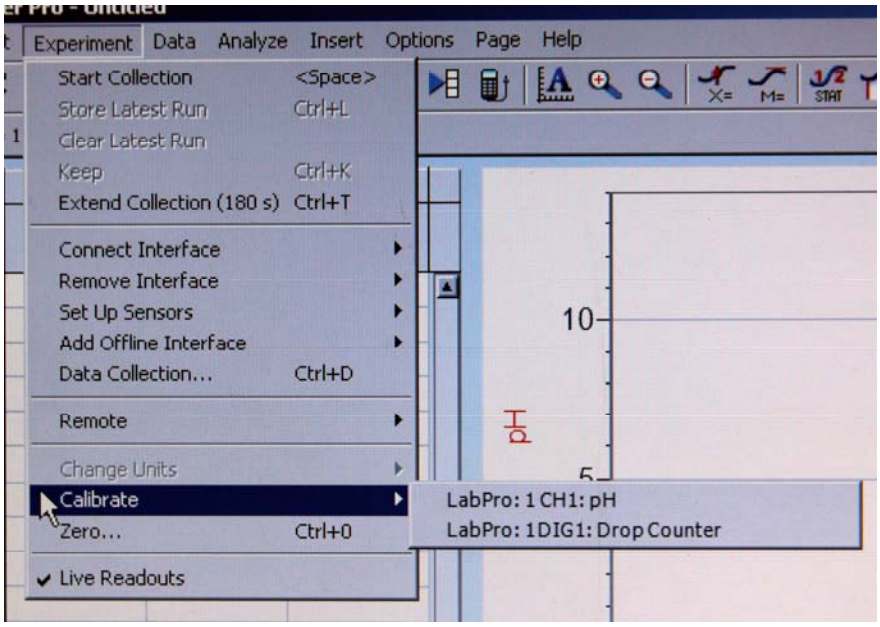
f. Place a small beaker under the reagent reservoir. Adjust the flow rate of the two valves of the reagent reservoir by, first, completely opening the bottom 2-way valve; then slowly open the top valve until a very slow drip rate is achieved -a rate of approximately **one drop every two seconds**. Close the bottom valve.

Figure 1. Drop counter setup

g. Remove the beaker and pour the solution into the proper waste container.

h. Place a clean, dry 10 mL graduated cylinder below the slot of the Drop Counter.

i. Start the calibration routine in your program.

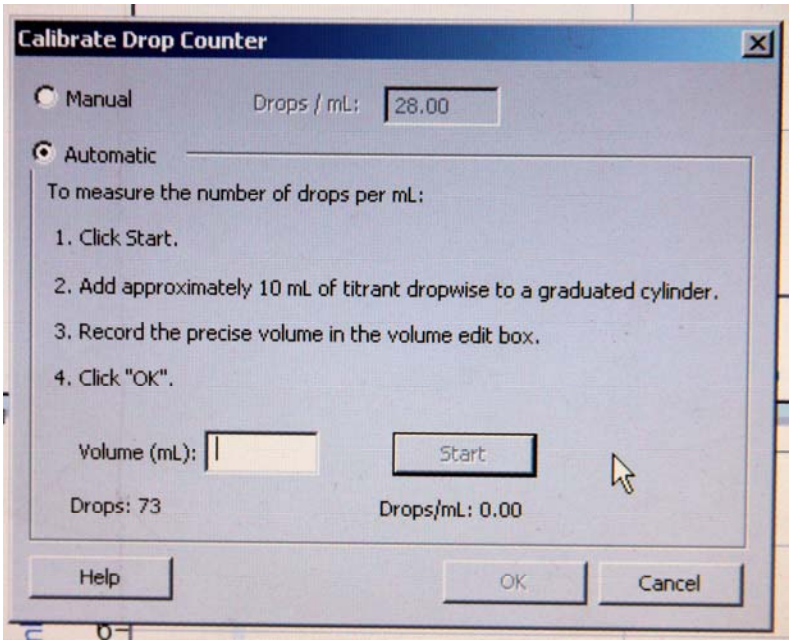


j. Open the bottom 2-way (on-off) valve to begin releasing drops from the vessel through the Drop Counter (Do NOT adjust the top valve.).

k. Continue to release drops until there are between 9 and 10 mL of liquid in the graduated cylinder.

l. Close the bottom valve on the vessel to stop the drops.

m. Type the precise volume of liquid in the graduated cylinder in the Volume (mL) box of the Calibrate drops dialog box.



n. The number of drops/mL will be displayed. It may be helpful to record the value for that particular reagent reservoir for future titrations.

o. Click on OK

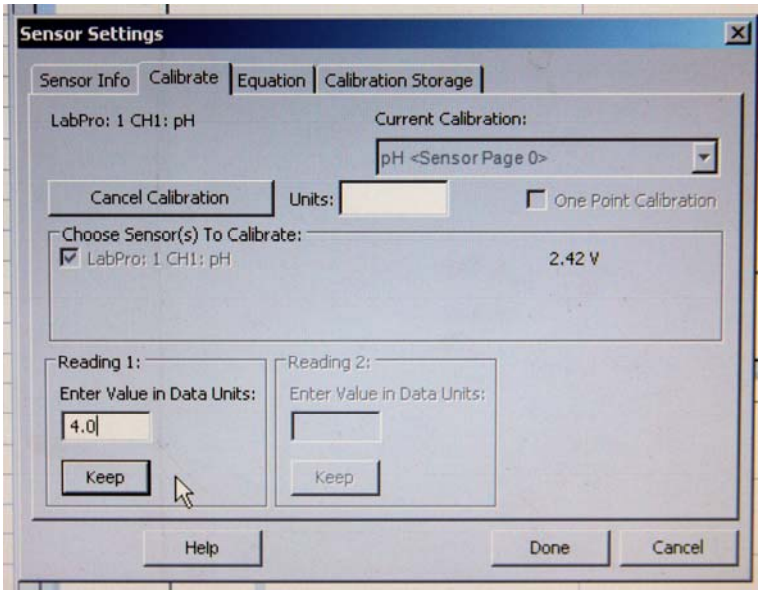
2. Calibrate the pH Sensor

First Calibration Point

a. In your program, choose to do a new calibration.

b. Rinse the pH Sensor with distilled water and place it into a buffer of pH 4.0.

c. Type "4" in the edit box as the pH value. Swirl the beaker containing the buffer solution gently, wait until the voltage stabilizes, then choose to **Keep** the calibration point.



Second Calibration Point

a. Rinse the pH Sensor with distilled water, and place it into a buffer of pH 7.0.

b. Type "7" in the edit box as the pH value for the second calibration point. Swirl the beaker containing the buffer gently and wait until the voltage stabilizes. Click **Keep**, then click OK. This completes the calibration.

Begin your titrations

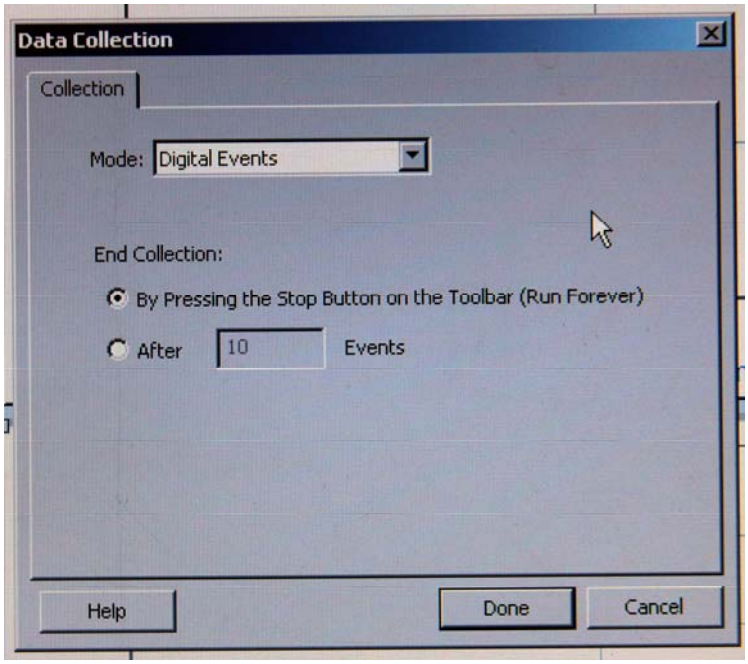
a. Place a magnetic stirrer on or at the base of the ring stand. Place a 100 mL beaker on the center of the stirrer. (See Figure 1)

b. Insert the pH Sensor body through the larger round hole on the Vernier Drop Counter.

c. Place a magnetic stir bar in the beaker (this is the preferred method for stirring) or slip the Microstirrer (see Figure 2) onto the bottom of the pH Sensor. Slide the Vernier Drop Counter down the ring stand to a level such that the Microstirrer is very close to the bottom of the beaker. Tighten the turn screw of the Drop Counter to hold it firmly in place.

d. Add the solution to be titrated to the 100 mL beaker. For this run, use 5.0 mL of 0.1 M HCl solution. Add enough distilled water so the solution level covers the bulb of the pH Sensor (about 30-35 mL). Optional: Add one drop of phenolphthalein indicator. Turn on the magnetic stirrer.

e. Set the Data Collection on the computer to Digital Events. Click on Done



f. The computer screen should display data collection for pH and Volume in mL. . Start data collection by clicking on Collect, or choosing Start. Important: No data will be collected until the first drop falls through the Drop Counter's slot. Completely open the lower 2-way valve (the upper valve should still be set to a slow drop rate). You will now see pH *vs.* volume data being plotted on a graph.

g. When you are satisfied that the titration has proceeded past the equivalence point stop the data collection, and shut off the lower 2-way valve of the reagent reservoir. A plot of pH *vs.* volume will be displayed for your data collection.

h. This is your titration data for Experiment 1 a strong acid with a strong base.

The remaining experiments will be conducted as follows:

	Titration	**Solution 1** In the 100 mL beaker	**Solution 2** In the reagent reservoir
Experiment 1	Strong acid with strong base	0.1 M HCl	0.1 M NaOH
Experiment 2	Weak acid with strong base	0.1 M CH_3CO_2H	0.1 M NaOH
Experiment 3	Strong base with strong acid	0.1 M NaOH	0.1 M HCl
Experiment 4	Weak base with Strong acid	0.1 M NH_3	0.1 M HCl
Experiment 5	Identification of an unknown weak acid	0.1 g of solid weak acid	0.1 M NaOH

Repeat the procedure with other combinations of strong and weak acids as outlined above.

Run the procedure for Experiment 2 similar to the procedure above, using 5.0 ml of weak acid in the clean 100 mL beaker.

Run the procedure for Experiment 5 similar to the procedure above, using 0.1 g of unknown weak acid in the clean 100 mL beaker.

For experiments 3 and 4, drain the reagent reservoir, rinse it twice with distilled water, but do not change the setting of the upper 2-way valve. Rinse the reagent reservoir twice with a few mL of 0.1 M HCl before filling it with 20 mL of 0.1 M HCl. NOTE: The drop size of the HCl drops will be slightly different than those of 0.1 M NaOH, however, the difference is small enough that a new drop calibration does not have to be run.

Run the procedure for Experiments 3 and 4 similar to the procedure above, using 5.0 ml of strong base or weak base, as called for, in the clean 100 mL beaker.

Complete the Data Analysis according to the procedure for Experiment 22. The Titration of Strong and Weak Acids and Bases, page 95, in the General Chemistry in Action Laboratory Manual.

All the data for this experiment is quantitative.