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# Vernier Drop Counter

## (Order Code VDC-BTD)



The Vernier Drop Counter is used to perform accurate, automatic titrations. This digital sensor can be used in conjunction with a pH Sensor (or other sensor) to accurately record drops of titrant added (or mL of titrant) during a titration. Using the Vernier Drop Counter, you can perform the following kinds of experiments:

- Collect pH vs. volume data in a typical acid-base titration.
- Collect conductivity vs. volume data using a Vernier Conductivity Probe (conductimetric titration).
- Collect mV vs. volume data using a Vernier ORP Sensor (potentiometric titration).
- Collect ISE mV vs. volume data using a Vernier ISE Sensor.
- Collect mV vs. volume data using a third-party ORP or ISE with the Vernier Electrode Amplifier.
- Collect temperature vs. volume data using a Stainless Steel Temperature Probe (or monitor temperature simultaneously with pH).

### What is included with the Vernier Drop Counter?

- Vernier Drop Counter
- A cable that connects the Vernier Drop Counter to a digital channel of the Vernier LabPro<sup>®</sup>, Vernier LabQuest<sup>®</sup> 2, the original LabQuest<sup>®</sup>, LabQuest<sup>®</sup> Mini, SensorDAQ<sup>®</sup>, CBL 2<sup>™</sup>, or TI-Nspire<sup>™</sup> Lab Cradle interface.
- Plastic reagent reservoir
- Plastic valve with a double stopcock fitting (screws onto the base of the reagent reservoir, with a gentle half turn)
- Vernier Microstirrer (a stirrer that fits onto the tip of your pH Sensor, and is used along with a magnetic stirrer)

**NOTE:** Vernier products are designed for educational use. Our products are not designed nor recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

## Collecting Data with the Drop Counter

The Drop Counter can be used with the following interfaces to collect data.

- Vernier LabQuest 2 or original LabQuest as a standalone device or with a computer
- Vernier LabQuest Mini with a computer
- Vernier LabPro with a computer or TI graphing calculator
- Vernier SensorDAQ
- CBL 2™
- TI-Nspire™ Lab Cradle

## Data-Collection Software

This sensor can be used with an interface and the following data-collection software.

- **Logger Pro** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, and LabPro. **Note:** Use Logger *Pro* version 3.5 or newer. The most recent version of Logger *Pro* is available at [www.vernier.com/downloads](http://www.vernier.com/downloads)
- **LabQuest App** This program is used when LabQuest 2 or LabQuest is used as a standalone device.
- **EasyData App** This calculator application for the TI-83 Plus and TI-84 Plus can be used with CBL 2™ and LabPro. We recommend version 2.0 or newer, which can be downloaded from the Vernier web site, [www.vernier.com/easy/easydata.html](http://www.vernier.com/easy/easydata.html), and then transferred to the calculator. See the Vernier web site, [www.vernier.com/calc/software/index.html](http://www.vernier.com/calc/software/index.html) for more information on the App and Program Transfer Guidebook.
- **DataQuest™ Software for TI-Nspire™** This calculator application for the TI-Nspire can be used with the TI-Nspire Lab Cradle.
- **LabVIEW** National Instruments LabVIEW™ software is a graphical programming language sold by National Instruments. It is used with SensorDAQ and can be used with a number of other Vernier interfaces. See [www.vernier.com/labview](http://www.vernier.com/labview) for more information.
- **DataDrop** This calculator application supports the Drop Counter with CBL 2™ and LabPro. The program can be downloaded from [www.vernier.com/til/2673](http://www.vernier.com/til/2673)

## How the Vernier Drop Counter Works

The Vernier Drop Counter has an optical-path slot that is 5.7 cm (2.25 in.) in length. When the infrared beam (centered at 890 nm) between the source and detector is blocked by a drop of titrant, a digital signal is sent to the data-collection interface, and the data-collection program records a drop. The drops are then converted to volume units (e.g., milliliters), in the data-collection program.

This sensor is equipped with circuitry that supports auto-ID. When used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, SensorDAQ, TI-Nspire™ Lab Cradle, or CBL 2™, the data-collection software identifies the sensor and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor.

## Using the Drop Counter

1. Assemble your equipment as shown here.
  - a. Note that the Vernier Stir Station, 100 mL beaker, and utility clamp are not included with the Vernier Drop Counter. As an alternative to using the Stir Station, students can use a ring stand and a magnetic stirrer.
  - b. Place a 100 mL beaker on the center of the Stir Station.
  - c. Remove the pH storage bottle from the pH Sensor. Insert the pH Sensor body through the larger round hole on the Vernier Drop Counter.
  - d. Slip the Microstirrer (shown at right) 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.
  - e. Connect the pH Sensor to CH 1 of the interface, and connect the cable of the Vernier Drop Counter to the digital channel 1.
  - f. Connect the spout and two 2-way valves to the plastic reagent reservoir.  
**Note:** There are *two* 2-way valves below the reagent reservoir. In these directions, we will use the *bottom valve* as an on-off valve (either completely open or completely shut). We will use the *top valve* as an adjustment valve, to deliver drops at a slow, consistent rate.
2. Make sure that both 2-way valves are in the closed position (horizontal). Add about 20 mL of titrant to the plastic reagent reservoir. For this example, we will use 0.1 M NaOH solution.
3. Before collecting data or calibrating the drops, adjust the flow rate of the two valves of the reagent reservoir. Temporarily, place another beaker below the spout of the reagent reservoir. First, completely open the bottom 2-way valve; then slowly open the top valve until a very slow drip rate is achieved—a rate of one drop every two seconds, or slower. Close the bottom valve.
4. Add the solution to be titrated to the 100 mL beaker. For this example, we will use about 5 mL of 0.1 M HCl solution. Add enough distilled water so the solution level covers the bulb of the pH Sensor (about 35–40 mL). If you are going to use a small magnetic stirring bar, less distilled water will be required (about 1–20 mL). Optional: Add two drops of phenolphthalein indicator. Turn on the magnetic stirrer. **Important:** Minimizing volumes of solution titrated, and maximizing stirring efficiency will significantly improve your titration results!
5. Start the data-collection program. If you have older sensors that do not auto-ID, manually set up your sensors. See “Using Other Sensors with Drop Counter” below for additional information about manually setting up sensors.



6. There are three different ways to handle the reporting of volume.
  - **Use the stored calibration** In this case, you can skip to Step 7, and begin collecting data.
  - **Manually enter a drops/mL ratio value** If you have done a previous calibration with a particular apparatus, you can enter the drops/mL ratio.
  - **Perform an Automatic drops/mL calibration** You can use a 10 mL graduated cylinder and perform this calibration (see “Calibrate Drop Volume” below for specific directions).
7. Start data collection. **Important:** No data will be collected until the first drop falls through the Drop Counter’s slot. Carefully center the spout of the reagent reservoir over the slot in the Drop Counter. 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. 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.
8. After collecting data, the program will allow you to view graphs of the first or second derivative vs. volume. Data from LabQuest or calculators can be imported into Logger *Pro* 3 for further analysis or enhanced display or printing capability.

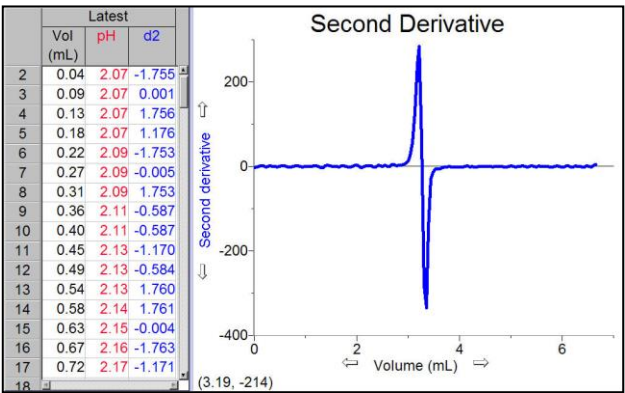
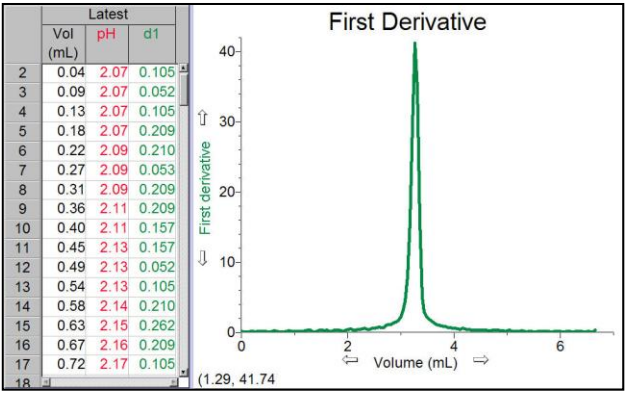
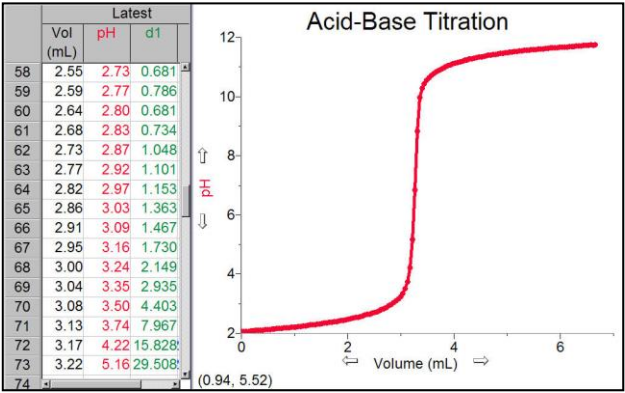
## Optional Calibration Information

To perform your own drop to volume calibration, choose Calibrate Drops in the data-collection program. The Automatic 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. To calibrate drops

- a. Place a 10 mL graduated cylinder below the slot of the Drop Counter.
- b. Fill the reagent reservoir with titrant.
- c. Choose to start the calibration routine in your program.
- d. Open the bottom 2-way (on-off) valve to begin releasing drops through the Drop Counter (the top valve finely adjusts the drop rate).
- e. Continue to release drops until there are between 9 and 10 mL of liquid in the graduated cylinder.
- f. Close the bottom valve to stop the drops.
- g. Type the precise volume of liquid in the graduated cylinder in the Volume (mL) box of the Calibrate drops dialog box.
- h. Choose to stop the calibration routine of your program.
- i. The number of drops/mL will be displayed. It may be helpful to record the value for that particular reagent reservoir for future titrations.
- j. You can now continue with the titration (return to Step 7).

Alternately, the Manual choice allows you to input a previously determined value for drops/mL. Simply enter the drops/mL value (e.g., 28.0), then continue with the titration.

Typical Titration Data



## Helpful Tips for Using the Vernier Drop Counter

- It is important to remind students that a slow drip rate (two seconds per drop or slower) is important. This provides enough time for the drop to be added to the solution and thoroughly mixed, and the pH (or other sensor) to respond. When passing through the equivalence point, without adequate stirring after addition of drops of titrant, you may see a resulting delay or lag. Even if this lag is barely noticeable in the pH vs. volume graph, it will be more apparent in the follow-up first or second derivative graphs. Following some or all of these tips will reduce or eliminate this error.
- It is also helpful if the amount of titrant in the beaker is minimized. Less liquid means faster mixing. This is why we recommend using a 100 mL beaker instead of a 250 mL beaker whenever possible.
- Using the Vernier Microstirrer helps deliver solution directly to the pH bulb, increasing response to a fresh drop.
- Add only as much distilled water to the solution being titrated as is necessary to cover the bulb of the pH Sensor (or other electrode). If you are using a 100 mL beaker and a small stirring bar, you may need as little as 15–20 mL of solution. If you use the Vernier Microstirrer, you will need more solution to cover the bulb (35–40 mL), but you may get better mixing.
- Using the plastic reagent reservoir that is supplied with the Drop Counter, instead of a standard buret, provides a wider diameter and less change in the hydrostatic pressure per unit volume of titrant above the 2-way valve.
- Another advantage of using the plastic reagent reservoir is the pair of 2-way valves, using one for drop rate adjustment, and the other as an on-off valve. This eliminates the need to do a fine adjust during the initial readings, and also allows the user to set a consistent rate, along with a calibration of drops/mL.
- If you want to allow for more thorough mixing when you are near the equivalence point, you can also manually release drops at a slower rate for that region of data.

## Using Other Sensors with Drop Counter

The Vernier Drop Counter can be used with other Vernier sensors such as our Ion-Selective Electrodes, Conductivity Probe, or older Vernier pH Sensors that do not auto-ID. The Vernier Drop Counter can accommodate third-party electrodes when used in conjunction with our Electrode Amplifier. It can also take simultaneous pH and temperature readings. To use any of these other sensors, use the following instructions.

### Computers (Logger Pro 3)

1. Set up the equipment and start Logger Pro 3.
2. Open the Drop Counter folder located in the Probes & Sensors folder. If one of the file names seems appropriate, open it and proceed normally. If none of these file names seem appropriate, open the file named “Drop Counter-pH” and proceed with Step 3.
3. Choose Set Up Sensors from the Experiment menu.
4. Click the picture of the pH Sensor in Channel 1 and select Choose Sensor from the drop-down menu. Choose the sensor you will be using.

5. Close the window and proceed with data collection.

## **LabQuest 2 or LabQuest as a Standalone Device (LabQuest App)**


1. Set up the equipment and launch LabQuest App.
2. If your sensors do not auto-ID, choose Sensor Setup from the Sensors menu.
3. Open the drop down menu next to the Channel in which the sensor is connected. Select the sensor you are using from the list.
4. Select OK to continue and proceed with data collection.

## **TI Graphing Calculators**

### **EasyData**

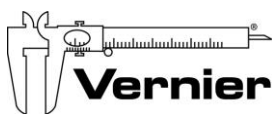
1. Set up the pH Sensor and Drop Counter.
  - a. Turn on the calculator and connect it to the data-collection interface.
  - b. Lower the Drop Counter onto a ring stand and connect it to the DIG/SONIC 1 port of the interface.
  - c. Connect the other sensor to the appropriate channel or port of the interface.
2. Set up EasyData for data collection with a Drop Counter.
  - a. Start the EasyData application, if it is not already running.
  - b. Select **[File]** from the Main screen, and then select **New** to reset the application. If the Drop Counter does not automatically identify, continue with the following steps. Otherwise, proceed to Step 3.
  - c. Select **[Setup]**, then select **Other Sensors**.
  - d. Select **DIG/SONIC1**, then select **[Next]**.
  - e. Select **Drop Counter**, then select **[Next]**. Repeat for the other sensor, if necessary.
3. Proceed with data collection.

### **DataQuest**

1. Set up the equipment and run DataQuest.
2. If your sensors do not auto-ID, choose Advanced Setup ► Configure Sensor from the  Experiment menu.
3. Select the channel your sensor is connected to from the drop down list.
4. Select OK and proceed with data collection.

## **Limited Warranty**

Vernier warrants this product to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use.



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