Colorimeter
(Order Code COL-BTA)

The Vernier Colorimeter is designed to determine the concentration of a solution by analyzing its color intensity. The cuvette slot is designed to accommodate most cuvettes with a 10 millimeter path length. The Colorimeter measures the amount of light transmitted through a sample at a user-selectable wavelength. You may choose from four wavelengths: 430 nm, 470 nm, 565 nm, and 635 nm. Features such as automatic sensor identification and one-step calibration make this sensor easy to use.

Inventory of Items Included with the Colorimeter
- Colorimeter
- 15 polystyrene cuvettes
- 15 plastic cuvette lids

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 Colorimeter
This sensor 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 Go!®Link
- Vernier EasyLink®
- Vernier SensorDAQ®
- CBL 2™
- TI-Nspire™ Lab Cradle

Data-Collection Software
- **Logger *Pro* 3** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go!Link.
- **Logger Lite** This computer program is used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, or Go!Link.
- **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, LabPro, and Vernier EasyLink. We recommend version 2.0 or newer, which can be downloaded from the Vernier website.
- **DataMate program** Use DataMate with LabPro or CBL 2 and TI-73, TI-83, TI-84, TI-86, TI-89, and Voyage 200 calculators.
- **DataQuest™ Software for TI-Nspire** This calculator application for the TI-Nspire can be used with the EasyLink or 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 for more information.

How the Colorimeter Works
Light from an LED light source passes through a cuvette containing a solution sample, as shown in Figure 1. Some of the incoming light is absorbed by the solution. As a result, light of a lower intensity strikes a photodiode.

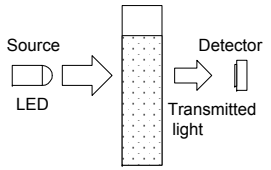


Figure 1

This sensor is equipped with circuitry that supports auto-ID. When used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, Go! Link, SensorDAQ, TI-Nspire Lab Cradle, EasyLink, 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 Colorimeter with LabQuest
1. Connect the Colorimeter to LabQuest.
2. Turn on LabQuest. (**Note:** You can connect a Colorimeter to LabQuest that is already running.) The LabQuest App will identify the Colorimeter.
3. Tap **File** and then choose **New**.
4. Press the < or > button on the Colorimeter to select the correct wavelength for your experiment (430 nm, 470 nm, 565 nm, or 635 nm).
5. Allow the Colorimeter to warm up for about 5 minutes before calibrating.
6. Calibrate the Colorimeter.
   a. Slide the lid of the Colorimeter open to reveal the cuvette slot.
   b. Insert a cuvette, filled with distilled water or other solvent used to prepare your solutions, for your calibration blank (100% transmittance or 0 absorbance). **Important:** Line up one of the clear sides of the cuvette with the arrow at the *right side* of the cuvette slot. Slide the Colorimeter lid closed.
   c. Press the CAL button on the Colorimeter to begin the calibration process. Release the CAL button when the red LED begins to flash.
   d. When the red LED stops flashing, the calibration is complete. The absorbance reading should be very close to 0.000 (100%T).
   e. Remove the blank cuvette from the Colorimeter.
7. Collect absorbance data for selected samples.
   a. There are two common modes for Colorimeter data collection.
      - Absorbance *vs.* concentration (Beer's law) On the meter screen, tap **Mode**. Change the mode to **Events with Entry**. If you wish, change the Name (e.g.,

Concentration) and Units (e.g., mol/L) to best describe the samples you are testing. Tap OK to return to the Meter screen.

- Absorbance *vs*. time This is the default mode of data collection for the Colorimeter, and it is set to collect an absorbance reading every 3 seconds for 5 minutes (300 seconds). If you wish to change the interval and/or duration, tap **Mode** and make the desired changes. Tap OK to return to the Meter screen.

b. Place a cuvette with a sample in the Colorimeter cuvette slot. Make sure to line up the clear sides of the cuvette with the arrow at the *right* of the cuvette slot.
c. Tap the green arrow in the lower corner of the LabQuest screen to start data collection.
   - In Events with Entry mode, you will be prompted to *keep* the absorbance value (when it stabilizes), and *enter* the concentration of the standard solution. Repeat the process for the remaining standards.
   - In time-based experiments, readings will be taken in real time at the interval and duration you specified.
d. Data collection ceases when you tap the red stop button or at the end of the data collection duration.
e. To analyze your data on the Graph screen, tap **Analyze** and choose among the listed options. For example, in absorbance *vs*. concentration (Beer's law) experiments, you can perform a linear fit on the data, and then interpolate along the resulting linear fit to determine the concentration of an unknown.

Note: To view detailed instructions for conducting a Beer's law experiment with the Colorimeter and LabQuest, tap the Lab Instructions tab at the top of the LabQuest screen. Tap **View** and then choose View Lab Instructions. Open the Chemistry with Vernier folder and choose **11 beer's law**.

Using the Colorimeter with Logger *Pro* 3

1. Connect a Colorimeter to an interface (LabQuest Mini, LabPro, Go! Link, etc.) and connect the interface to your computer.
2. Start Logger *Pro* 3. (**Note:** You can connect a Colorimeter to a computer that is already running Logger *Pro* 3.)
3. Press the < or > button on the Colorimeter to select the correct wavelength for your experiment (430 nm, 470 nm, 565 nm, or 635 nm).
4. Allow the Colorimeter to warm up for about 5 minutes before calibrating.
5. Calibrate the Colorimeter.
   a. Slide the lid of the Colorimeter open to reveal the cuvette slot.
   b. Insert a cuvette, filled with distilled water or other solvent used to prepare your solutions, for your calibration blank (100% transmittance or 0 absorbance). **Important:** Line up one of the clear sides of the cuvette with the arrow at the *right side* of the cuvette slot. Slide the Colorimeter lid closed.
   c. Press the CAL button on the Colorimeter to begin the calibration process. Release the CAL button when the red LED begins to flash.
   d. When the red LED stops flashing, the calibration is complete. The absorbance reading should be very close to 0.000 (100%T).
   e. Remove the blank cuvette from the Colorimeter.

6. To prepare for collecting absorbance data for selected samples, choose Open from the File menu. Choose the appropriate data-collection template from the folders listed. For example, to run a Beer's law experiment (absorbance *vs.* concentration), you may choose experiment file #11 from the *Chemistry with Vernier* folder.
7. Click the green Collect button to start data collection.
   - In Events with Entry mode, you will be prompted to *keep* the absorbance value (when it stabilizes), and *enter* the concentration of the standard solution. Repeat the process for the remaining standards.
   - In time-based experiments, readings will be taken in real time at the interval and duration you specified.
8. Data collection ceases when you click the red stop button or at the end of the data collection duration.
9. To analyze your data, choose an option from the Analyze menu. For example, in absorbance *vs*. concentration (Beer's law) experiments, you can perform a linear fit on the data, and then interpolate along the resulting linear fit to determine the concentration of an unknown.

Note: To view a detailed set of instructions for conducting experiments with the Colorimeter, please visit this web address: www.vernier.com/products/sensors/col-bta/. Scroll down the page to select an experiment and download a PDF of the instructions.

Tips for Using the Vernier Colorimeter

- Allow the Colorimeter to warm up for about 5 minutes before calibrating.
- Fill a cuvette 2/3 to 3/4 full with liquid, including the calibration blank, so that the light travels through the liquid reliably.
- After filling a cuvette with liquid, seal the cuvette with a cap to prevent spills.
- Make sure to place a cuvette in the Colorimeter so the path of the light source travels through the clear sides of the cuvette. An arrow to the right of the cuvette slot shows the light path.
- For best results, use one cuvette to make all your measurements for a given experiment.
- If you calibrate a Colorimeter and then change the wavelength, calibrate the Colorimeter again to ensure the proper identification of the new wavelength.

Absorbance and Transmittance Ranges for the Colorimeter

For best results, absorbance or transmittance values should fall within these ranges:

percent transmittance:	10–90%
absorbance:	0.05–1.0

We have found that Beer's law experiment results begin to lose their linearity at absorbance values above 1.0 (percent transmittance values less than 10%). If you have a solution that transmits such a low level of light, consider diluting the solution so that it falls within this range.

Suggested Experiments

Determining the Concentration of a Solution: Beer's Law
(Lab 11, *Chemistry with Vernier*)
This experiment guides the student to measure the absorbance of standard solutions to determine the concentration of an unknown solution.

Rate Determination and Activation Energy
(Lab 35, *Advanced Chemistry with Vernier)*
In this experiment, the student measures the reaction between crystal violet and sodium hydroxide under various conditions to write the rate law for the reaction and calculate the activation energy, E_a.

Ortho- and Total Phosphates
(Test 7, *Water Quality with Vernier*)
Instructions are provided for the testing of water samples from natural sources (streams, lakes, etc.) for orthophosphates and total phosphates.

Photosynthesis
(Lab 7, *Biology with Vernier*)
In this experiment, the student monitors the progress of photosynthesis using a blue dye (2,6-dichlorophenol-indophenol, or DPIP). As photosynthesis proceeds, the dye turns from blue to colorless when reduced.

Enzyme Analysis Using Tyrosinase
(Lab 15, *Advanced Biology with Vernier*)
In this experiment, the student observes and compares the reaction rate of two substrates – tyrosinase and DOPA. Further, the student determines the effect of modifying enzyme and substrate concentrations on the reaction rate.

The Determination of an Equilibrium Constant
(Lab 10, *Advanced Chemistry with Vernier*)
The experiment guides the student to change and measure equilibrium mixtures of potassium thiocyanate, KSCN, and iron (III) nitrate, $Fe(NO_3)_3$ solutions. The student observes LeChatelier's Principle in action and uses measurements from a Colorimeter to calculate an equilibrium constant, K_{eq}, for the reaction.

Specifications

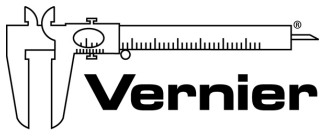
Colorimeter range		0 to 3 (absorbance)
Useful range		0.05 to 1.0 absorbance (90% to 10% T)
Wavelengths		430 nm, 470 nm, 565 nm, 635 nm
Supply voltage		5VDC ±25 mV
Supply current (typical)		40 mA
Power up time		700 ms (maximum)
Output voltage range		0–4 V
Transfer function		$V_{out} = 0.035*(\%T) + 0$
Stored calibration values		
	slope	28.571
	intercept	0

Colorimeter Accessories

Replacement cuvettes (package of 100 with 20 lids)	CUV
Replacement cuvette lids (package of 100)	CUV-LID
Cuvette rack, holds 10 cuvettes	CUV-RACK

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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