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.

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.

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.,
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 detailed instructions for conducting experiments with the Colorimeter, please visit this web address: www.vernier.com/products/sensors/colorimeter. 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**  
(Chemistry with Vernier, Lab 11)  
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**  
(Advanced Chemistry with Vernier, Lab 35)  
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**  
(Water Quality with Vernier, Test 7)  
Instructions are provided for the testing of water samples from natural sources (streams, lakes, etc.) for orthophosphates and total phosphates.

**Photosynthesis**  
(Biology with Vernier, Lab 7)  
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**  
(Advanced Biology with Vernier, Lab 15)  
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**  
(Advanced Chemistry with Vernier, Lab 10)  
The experiment guides the student to change and measure equilibrium mixtures of potassium thiocyanate, KSCN, and iron (III) nitrate, Fe(NO₃)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**

<table>
<thead>
<tr>
<th><strong>Colorimeter range</strong></th>
<th>0 to 3 (absorbance)</th>
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</thead>
<tbody>
<tr>
<td><strong>Useful range</strong></td>
<td>0.05 to 1.0 absorbance (90% to 10% T)</td>
</tr>
<tr>
<td><strong>Wavelengths</strong></td>
<td>430 nm, 470 nm, 565 nm, 635 nm</td>
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<tr>
<td><strong>Supply voltage</strong></td>
<td>5VDC ±25 mV</td>
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<tr>
<td><strong>Supply current (typical)</strong></td>
<td>40 mA</td>
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<tr>
<td><strong>Power up time</strong></td>
<td>700 ms (maximum)</td>
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<tr>
<td><strong>Output voltage range</strong></td>
<td>0–4 V</td>
</tr>
<tr>
<td><strong>Transfer function</strong></td>
<td>$V_{out} = 0.035*($_{T}) + 0$</td>
</tr>
<tr>
<td><strong>Stored calibration values</strong></td>
<td>28.571</td>
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</tbody>
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**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.