Vernier Spectrometer

Ocean Optics Red Tide Spectrometer

(Order Codes: V-SPEC, SPRT-VIS)

These spectrometers are portable light spectrophotometers, combining a spectrometer and a light source/cuvette holder. The light source/cuvette holder may be detached and an optical fiber assembly attached to the spectrometer for emission spectrum experiments.

What is included with the Spectrometer?

- One spectrometer with light source/cuvette holder (Vernier Spectrometer, Ocean Optics™ Red Tide Spectrometer)
- One package of 15 plastic cuvettes and lids
- One USB cable

Software Requirements

Logger *Pro*® 3 (version 3.8.5 or newer) software is required. If you own a previous version of Logger *Pro* 3, you may upgrade the software free of charge. You need the LabQuest® application version 1.1 or newer to use a LabQuest 2 or original LabQuest as a standalone device with a spectrometer. Visit http://www.vernier.com/LabQuest/updates

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.

Get Started

Using a Spectrometer with Your Computer

1. Install Logger *Pro* 3 software (version 3.8.5 or newer) on your computer before using an Ocean Optics spectrometer.
2. Connect the spectrometer to a powered USB port or a powered hub. Allow the spectrometer to warm up for a few minutes.
3. The first time you connect a spectrometer, your computer may ask you a few questions. **Note:** Do not go online for device drivers. The device drivers were installed when you installed Logger *Pro* 3.

- Windows computers (Windows XP or Vista) Follow the New Hardware Wizard instructions to download the drivers automatically.
- Macintosh computers (Mac OS 10.3 or newer) If it appears, follow the New Device instructions.

Calibrate the Spectrometer for Measuring Absorbance or %T

With the spectrometer connected to your computer and Logger *Pro* 3 running, choose Calibrate ▶ Spectrometer from the Experiment menu. Follow the instructions in the dialog box to complete the calibration. Click OK.

Collect Data

There are three general types of data collection measuring absorbance – absorbance *vs.* wavelength which produces a spectrum, absorbance *vs*. concentration for Beer's law experiments, and absorbance *vs.* time for kinetics experiments.

Measure the Absorbance Spectrum of an Aqueous Sample (Absorbance *vs*. Wavelength)

1. Calibrate the spectrometer as described above.
2. Fill a cuvette about ¾ full of the solution to be tested. Place the sample in the cuvette holder of the spectrometer and click ▶ Collect. Click ■ Stop to end the data collection.
3. To store the spectrum data, choose Store Latest Run from the Experiment menu.

Conduct a Beer's Law Experiment (Absorbance *vs*. Concentration)

1. Measure an absorbance spectrum as described above.
2. Click on the Configure Spectrometer Data Collection button,  .
3. Click Abs *vs*. Concentration. The wavelength of the maximum absorbance will be automatically selected (λ max). Click OK to continue or click Clear and select a wavelength on the graph or in the list of wavelengths.
4. Place your first Beer's law standard solution in the spectrometer. Click ▶ Collect and then click Keep. Enter the concentration of the sample and click OK. Repeat this step for the remaining standard samples. After you have tested the final standard, click ■ Stop to end the data collection.
5. Click linear fit,  , to see the function for the standard solutions.
6. Place an unknown sample of solution in the spectrometer. Choose Interpolation Calculator from the Analyze menu. A helper box will appear, displaying the absorbance and concentration of the unknown. Click OK.

Conduct a Kinetics Experiment (Absorbance *vs*. Time)

1. Measure an absorbance spectrum as described above. If you wish to store the data, select Store Latest Run from the Experiment menu.
2. Click on the Configure Spectrometer Data Collection button,  .
3. Click Abs *vs*. Time. The wavelength of maximum absorbance will be selected as before. Click OK to continue or click Clear and select a wavelength on the graph or in the list of wavelengths.
4. The default settings are 1 sample per second for 200 seconds. To change the data-collection parameters for your experiment, choose Data Collection from the Experiment menu and make the necessary changes. Click Done.

5. Mix the reactants, transfer ~2 mL of the reaction mixture to a cuvette and place the cuvette in the spectrometer. Click Collect. You may click Stop to end data collection early.
6. Click Curve Fit, , to calculate a function for your data.

Using a Spectrometer to Measure Emission Spectra

You may use your spectrometer to measure the emission spectrum of a light source such as an LED or a gas discharge tube. To do so, you may want to purchase an optical fiber assembly (order codes: VIS-NIR or UV-VIS).

Measure an Emission Spectrum

1. Use a small screwdriver to loosen the two screws that connect the cuvette holder to the spectrometer (see Figure 1). Remove the cuvette holder and connect an optical fiber assembly to the spectrometer.

Figure 1

2. Use a USB cable to connect the spectrometer to your computer.
3. Start Logger *Pro* 3.
4. Choose Change Units ▶ Spectrometer ▶ Intensity from the Experiment menu. Intensity is a relative measure.
5. Aim the tip of the optical fiber cable at a light source. Click Collect. Click Stop to end data collection. If the spectrum maxes out (flat and wide peaks), increase the distance between the light source and the tip of the optical fiber cable or reduce the sample time. To adjust the data collection parameters, choose Set Up Sensors ▶ Spectrometer from the Experiment menu. Set the Sample Time to a suitable value and decrease the Samples to Average to 1.

Using the Stored Emissions Files in Logger *Pro* 3

Logger *Pro* 3 contains a folder of emissions graphs from selected discharge tubes, including: argon, helium, hydrogen, mercury, oxygen, sodium, and xenon. You can display and analyze these graphs without a spectrometer connected to your computer. Follow the steps below to view one of these graphs.

1. Choose Open from the File menu.
2. Open the Sample Data folder.
3. Inside the Sample Data folder, open the Physics folder.
4. Inside the Physics folder, open the Gas Discharge Spectra. Open the desired file.

You can use the mercury emissions graph to test fluorescent lighting for the presence of mercury.

Changing the Settings in Logger *Pro* 3

Spectrometer Dialog Box

The Spectrometer dialog box lists all of the settings for the device. To display this box choose Set Up Sensors ► Show All Interfaces from the Experiment menu.

For most experiments, the default settings work well.

There are four parameters listed in the dialog box.

- Sample Time: think shutter speed of a camera. Logger *Pro* 3 automatically selects the proper sample time during calibration. **Note:** For emission studies, you may need to change the sample time manually.
- Wavelength Smoothing: the number of adjacent readings on either side of a given value that is used to calculate an average value.
- Samples to Average: the number of readings taken at a given wavelength to calculate an average reading.
- Wavelength Range: the range is determined by the type of spectrometer in use.

By clicking on the picture of the spectrometer in this dialog box, you will gain access to four options: calibrate, configure data collection, go to support web page, and units of measure. Click on an item to select it.

Configure Spectrometer Data Collection Dialog Box

To display this box, click on its icon,  , located on the right hand side of the toolbar.

There are three regions in this box and four buttons at the bottom.

- Graph: The graph displays a full spectrum analysis of the sample in the cuvette holder. By default, the wavelength of greatest absorbance (peak) will be marked with a box. You may select other wavelengths by clicking on the plot at the desired wavelength. A checkbox beneath the graph allows you select a portion of the graph and analyze it as a single range of wavelengths.
- Set Collection Mode: Three options for data collection are offered. A full spectrum analysis (Abs *vs*. Wavelength) is the default.
- Full Spectrum/Select Wavelength: This column lists all the available wavelengths. It becomes active when you select Abs *vs*. Concentration or Abs *vs.* Time. Check the box for each wavelength you wish to use in an experiment. When you select a wavelength from the list, a box appears on the graph.
- Use the 

button to remove all of the wavelengths selected on the graph.

Determining the Wavelength(s) to Use in an Experiment

When you conduct a Beer's law lab or a kinetics lab, it is common to select one wavelength at which to follow the experiment. However, in Logger Pro 3.4.6 you may select as many wavelengths as you wish. There are two ways to select the wavelength or wavelengths.

1. **Perform a Full Spectrum Analysis of the Solution to Be Tested**
   Measure the full spectrum of a sample of solution and then click Configure Spectrum Data Collection (). Select Abs *vs.* Concentration or Abs *vs*. Time. The wavelength of maximum absorbance (λ max) will be automatically selected.
2. **Use a Sample of Solution to Determine the Peak Absorbance**
   This is a variation of the previous method. After calibrating the Spectrometer, place a sample of solution in the Spectrometer and then click Configure Spectrum Data Collection (). Select Abs *vs.* Time or Abs *vs.* Concentration. The wavelength of maximum absorbance (λ max) will be automatically selected. If you don't want to use the λ max, click 

and select a wavelength on the graph or in the list of wavelengths.

Selecting a Range of Wavelengths to Use in an Experiment

You may wish to measure the absorbance or %T of a sample over a group of wavelengths rather than a single wavelength. There are two ways to select a group of wavelengths from the Configure Spectrum Data Collection dialog box.

- Select the wavelengths one at a time by checking the boxes in the Select Wavelength column.
- Place the cursor on the graph in the dialog box. Left click and drag across the region of wavelengths that you wish to analyze. Make sure to check the "Treat Contiguous Wavelengths as a Single Range" box.

Measurement

You can set up the spectrometer to measure intensity, absorbance, or % transmittance. Choose Change Units ► Spectrometer from the Experiment menu. Click on the unit of choice from the list.

Using an Ocean Optics Spectrometer with a LabQuest 2 or Original LabQuest

1. Use the USB cable to connect the spectrometer to a LabQuest 2 or original LabQuest. Allow the spectrometer to warm up for a few minutes.
2. Turn on the LabQuest 2 or LabQuest. The LabQuest app will launch automatically and the meter screen will be displayed.

Calibrate the Spectrometer

1. Fill a cuvette about ¾ full with distilled water and place it in the spectrometer. Align the cuvette so a clear side of the cuvette is facing the light source.

2. Choose Calibrate ► USB:Spectrometer from the Sensors menu. At the prompt, select Finish Calibration. After the message "Calibration Completed" appears, select OK.

Measure the Absorbance Spectrum of an Aqueous Sample (Absorbance *vs.* Wavelength)

1. Fill a cuvette about ¾ full of the solution to be tested and place it in the spectrometer.
2. Start the data collection. Tap the red Stop button to end data collection.
3. **Note:** The wavelength of maximum absorbance (λ max) is automatically selected. This λ max will be used for any subsequent data collection, such as a Beer's Law experiment (abs *vs.* conc.) or a kinetics experiment (abs. *vs*. time). If you wish to choose another wavelength, you can tap on the graph to select a new wavelength or you can used the arrow keys on the keypad to move the cursor to a new wavelength.

Conduct a Beer's Law Experiment (Absorbance *vs.* Concentration)

1. Measure an absorbance spectrum as described above. On the Meter screen, tap Mode. Change the mode to Events with Entry.
2. Enter the Name (Concentration) and Units (mol/L). Select OK.
3. A message will appear warning you to either save or discard the full spectrum run. Make your choice and proceed with the data collection.
4. Place your first Beer's law standard solution in the spectrometer. Start the data collection. After the absorbance reading stabilizes, tap Keep. Enter the concentration of the solution and select OK.
5. Place your second standard sample in the spectrometer. After the absorbance readings stabilize, tap Keep. Enter the concentration of the second sample and select OK.
6. Repeat Step 5 for the remaining standard samples. After you have tested the final standard, tap the red Stop button to end the data collection.
7. To calculate a best fit line equation for your standards, choose Curve Fit from the Analyze menu. Select Linear for the Fit Equation, and then select OK. The graph screen will appear again with the linear regression equation displayed.
8. Place a cuvette containing an unknown sample of solution in the spectrometer. Tap the Meter tab and write down the displayed absorbance value. Tap the graph tab and trace the linear regression equation to determine the concentration of the unknown.

Conduct a Kinetics Experiment (Absorbance *vs.* Time)

1. Measure an absorbance spectrum as described above. On the Meter screen, tap Mode. Change the data-collection mode to Time Based.
2. You can change the rate, interval, and/or length of time of data collection, if desired. Select OK when you are ready to proceed.

3. A message will appear warning you to either save or discard the full spectrum run. Make your choice and proceed with data collection.
4. Mix the reactants, transfer ~2 mL of the reaction mixture to a cuvette and place the cuvette in the spectrometer. Start the data collection. You may tap the red Stop button to end the data collection early.
5. To calculate a function for your data, choose Curve Fit from the Analyze menu. Select the Fit Equation, and then select OK. The graph screen will appear again.

Measure an Emission Spectrum

1. Use a small screwdriver to loosen the two screws that connect the cuvette holder to the spectrometer (see Figure 1). Remove the cuvette holder and connect an optical fiber assembly to the spectrometer.
2. Turn on the LabQuest 2 or original LabQuest. The LabQuest App will launch automatically and the meter screen will be displayed.
3. On the meter screen, tap Change Units ► USB:Spectrometer ► Intensity from the Sensors menu. The spectrometer measures intensity in relative units.
4. Aim the tip of the optical fiber cable at a light source. Start the data collection. Tap the red Stop button to end the data collection.

If the spectrum maxes out (flat and wide peaks), increase the distance between the light source and the tip of the optical fiber cable or reduce the sample time.

If data collection is unusually slow, tap Sensors and choose Data Collection. Set the Sample Time to a suitable value and decrease the Samples to Average to 1.

Determining the Wavelength to Use in an Experiment

After you collect a full absorbance spectrum of a sample, LabQuest 2 or LabQuest will identify the wavelength of maximum absorbance (λ max). If you wish to select a different wavelength, tap on the full spectrum graph or use the arrow keys on the keypad to identify the wavelength of choice. Another way to change the wavelength is to navigate to the meter screen, tap on the meter itself, and select Change Wavelength. Enter the wavelength of your choice and select OK. If the wavelength you type in is not measured by the UV-VIS unit, LabQuest 2 or LabQuest will automatically choose the wavelength closest to your choice.

Measurement

You can set up the spectrometer to measure intensity, absorbance, or % transmittance. On the Meter screen, choose Change Units from the Sensors menu. Click on the unit of choice from the list.

Sample Experiments

There are several experiments available for use with the Spectrometer. You may download the labs from our web site (www.vernier.com/spectroscopy).

Specifications

Vernier Spectrometer (order code: V-SPEC)

Dimensions: 10 cm × 8.7 cm × 3 cm (includes cuvette holder/light source)

Power: from computer via USB cable

Wavelength Range: 380 nm–950 nm

Resolution: 2 nm

Red Tide Spectrometer (order code: SPRT-VIS)

Dimensions: 10 cm × 8.7 cm × 3 cm (includes cuvette holder/light source)

Power: from computer via USB cable

Wavelength Range: 380 nm–950 nm

Resolution: 1 nm

Ocean Optics USB4000 VIS-NIR Spectrometer (order code: SP-VIS)

Dimensions: 10 cm × 8.7 cm × 3 cm (includes cuvette holder/light source)

Power: from computer via USB cable

Wavelength Range: 380 nm–950 nm

Resolution: 0.2 nm

Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of three years from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use. Bulbs for the light source are covered by a one-year warranty. This product is manufactured by Ocean Optics, Inc.

Vernier

Measure. Analyze. Learn.™

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Rev. 6/18/2012