CH142: Instructions for the Vernier LabPro

INTRODUCTION:

The Vernier LabPro is a versatile data collection interface that can be used in combination with more than 45 sensors, and with a computer, TI graphing calculator, Palm OS handheld or battery powered as a stand-alone data logger. Because of this versatility, the Vernier LabPro can be used in many different ways in the classroom or in the field.

The Vernier LabPro can be easily connected to a computer and used to titrate a strong and/or weak acid with a strong base (0.1M NaOH). The titration can be studied by monitoring changes in pH (using a pH electrode) or conductivity (using a conductivity probe). The interpretation of the differences in the shape of a titration curve and the information that can be determined from the equivalence point of a titration can be valuable information in the identification and concentration of an acid. Conductivity curves can be used to describe the behavior of these acids in an aqueous environment.

INSTRUCTIONS FOR USE:

A. Turn on the power to the power strip that is connected to the Vernier LabPro, the stir plate and the power supply for the DCU pump unit. A blinking green light occurs when the interface receives power. The Vernier system will complete series of (7) beeps as the system completes a "self check". If no other beeping sounds are given by the interface, then the system is ready for use. The pump should be connected to the DIG/Sonic1 port and an electrode amplifier with an attached pH electrode should be connected to CH1. The conductivity probe will be connected later in the procedure.

B. Calibration of the pump (finding the volume of one drop delivered by the pump): Open the desktop folder labeled "**CH142VernierLabPro**". Double click on the icon "**one minute pump cal.cmbl**". The pump will click and a blinking green light(s) will be visible on the interface when recognized by the software. (The toggle switches on the pump should always be set on the "**computer**" and "**DCU**" settings for the software to communicate to the pump.)

   - NOTE: If the equipment is not set up properly, a "**Sensor Confirmation**" window will be displayed. Be sure the sensors are securely attached to the interface and in the correct ports. If the instrument amplifier is shown to be in use in the top portion of the window, turn off this amplifier by clicking on the checkmark in the use box. Check to see that the electrode amplifier and the digital control unit (pump) are listed in the second portion of the box and given a green checkmark to the left of each listing. Click "**OK**". If the window is not displayed, continue on.

- The main calibration window should be activated and the "**Collect**" button found in the top menu bar will be colored green. The table to the left will record collected data in the appropriate columns. The smaller box below the table will count the pulses delivered by the pump. The graph will display a green signal for each pulse.

- To prime the pump with deionized water, find the inlet tubing (marked as IN on the pump) and submerge the tubing into a clean 100 ml beaker of fresh dH_2O. To prevent air bubbles from entering the line, make sure that the line is secure and that the opening of the tubing is at the bottom of the beaker. Put the outlet tubing into a waste beaker.

- Click on the green "**Collect**" button. A window will appear that will ask what you would like to do:

  *erase and continue: will erase the last set of pulses and start at zero
  *cancel: cancel or exit
  *append to latest: will add another series of pulses to the last one
  *store latest run: save data in the table before starting another run
  Each run is a series of 30 pulses.

- Click on "**erase and continue**". The pump will run for 30 pulses (refer to the small box under the table). Click on "**Collect**" again and then "**append to latest**" to add another series of 30 pulses. It will take about 90 pulses to prime the pump with water. Check for bubbles in the tubing. If you see bubbles, check your set up and add another set of pulses. If no bubbles are apparent in the lines, then continue.

- To calibrate the pump (volume in uL delivered by each pulse) find the mass of a clean dry weigh bottle (no top) to 0.1 mg. Use a clean, dry Kim Wipe to handle the bottle because fingerprints and dirt will add to the mass and result in calibration error. Set the outlet tubing into the weigh bottle and deliver 60 pulses of deionized water to the bottle. Mass the bottle again. Using the density of water at room temperature (0.9982 g/ml at 20C), convert the mass of the water delivered to the corresponding volume of water delivered. Calculate the volume of water delivered in a single pulse by the pump (in uL).

- Remove the inlet tubing from the beaker of water. Empty the line by delivering 30-60 pulses (of air). Place the outlet tubing into a waste beaker and the inlet tubing into a 100 ml beaker of your standardized NaOH (titrant). Prime the pump with the strong base. Be sure that there are no bubbles in the line.

- Exit the calibration program by using the LoggerPro menu in the main menu bar… "**Quit LoggerPro**" ….. "**Save**".

C. To set up a titration using Vernier LabPro:

- Double click on the "**CH142Titrate.cmbl**" icon (found in the desktop "**CH142VernierLabPro**" folder). The "**CH142Titrate.cmbl**" window will be displayed. As with the calibration software, the table on the left will record collected data in columns labeled with color coded headings. A small window under the table will display pH (live reading). Temperature will be displayed if the temperature probe is connected to the interface. The larger graphing window will display your data as it is being recorded by the interface. The "X" axis is the volume (uL) delivered by the pump and is set from 0 to 20,000 uL. The "Y" axis is the sensor output and is set to record pH 0 to12. (NOTE: If necessary, the axes may be rescaled at anytime by clicking on the minimum/maximum value and typing in the preferred value.)

- To calibrate the volume ("X") axis, use the scroll bar at the bottom of the table, to find the volume column and double click on the heading. A "**Calculated Column**" window will appear. Find the equation box and change ONLY the last number in the equation to the calibrated pulse volume in uL that your pump delivers. Click "**Done**".

- To calibrate the pH electrode chose the "**Experiment"** menu from the LoggerPro menu bar and choose "**Calibrate**". Sliding to the right choose "**LabPro: 1CH1: Electrode Amplifier**". The sensor settings window will appear. Make sure that the current calibration is set for "Electrode Amp pH<Sensor Page 1>. Click on the "**calibrate now**" button. This is a two buffer point calibration. Remove the pH electrode from the electrode storage solution, make sure that the hole in the blue collar is open, rinse well with deionized water and place in the pH 4 (pink) buffer solution. Always make sure the ground glass frit is covered by solution and no bubbles are caught in the protective cage. Once the mV reading has stabilized, type "4.00" into the "**enter value**" box and press the "**Keep**" button. Repeat to calibrate in pH 7 buffer solution and press the "**Keep**" button. Press "**Done**".

- Add 50 ml of deionized water to a clean, dry 100 ml beaker (lines on beaker are OK). Using a 10 ml volumetric pipet, add 10 ml of acid to the water, place the beaker on the stir plate and add a stir bar. Rinse and dry the pH electrode and carefully place it in the beaker. Rest the electrode in the extended portion of the lip of the beaker. Carefully turn the stir plate on and arrange the beaker so that the stir bar does not hit the electrode cage. Record the starting pH. Using the provided clip, attach the pump outlet tube to the beaker so that the end of the tubing is right at the level of the solution being tested. Press the green "**Collect**" button in the main window menu bar to start the titration. For the first titration, click "**erase and continue**". The data will be recorded in the table and the titration and derivative plots will automatically be displayed on the graph.

(<u>NOTE</u>: If this is not true, double click on the "**Sensor Output**" "Y" axis label and choose "**More**". Then check the pH and dpH/dV boxes for the appropriate run. Remove the check for any unwanted data being displayed on the graph.)

- Press "**Stop**" when the pH has reached 11 to 12 to end the titration ("Stop" is where the "**Collect**" button was at the start of the run). The color of the curves will match the color of the headings to the columns in the table. To help with the interpretation of the data, the color of the titration and derivative plots should be the same for each titration experiment. If they are different, double click on the pH column heading and choose "**Options**" from the "**Column Options**" box. Choose a color from the color bar and press "**Done**". Repeat this to make the derivative plot (dpH/dV) the same color for the run. Be careful to choose colors that will not to be too dark to cover other runs that will be displayed on the chart. Choose "**File**" from the **Logger Pro** Main window menu bar and "**Save**" to assure that the data is not lost while preparing the next titration or analyzing the data.

- For additional titration experiments, press "**Collect**" and "**Store latest run**". The data will be collected in the table and the titration and derivative plots will be overlayed on the graph.

- When all of the titration experiments are completed, and have been saved, the graph can be printed by choosing "**File**" from the **LoggerPro** main window menu bar and "**Print Graph**". Entering the information in the "**Printing Options**" window will provide a label to the hardcopy of your graph. Press "**OK**". Setting the printer to **HP4560** will produce a color copy of the data. Select the number of copies and press "**Print**". The copies will be printed in the Schupf Lab.

- To analyze the data points of interest on the pH and derivative plots, press the "**X=**" (also called the "**Examine**") button in the "**CH142Titrate.cmbl**" window menu bar. The color of the data values will match the color of the plotted data. Any point along the curves can be evaluated (also recorded in the table). Record the data points that are important to your experiment. Click on the "**X=**" button again to exit data analysis.

- You can also press the "**Control-Option**" keys on the keyboard while holding down the mouse with the cursor placed on the graph. Choosing "**copy**" from the menu box will allow the graph to be saved as a MicroSoft Word document. Open Word and use "**Paste**" under the "**Edit**" menu to copy the graph. The graph can be further edited in Word. If you use the "**Save as**" option to save the data, you would need the LoggerPro Software on your computer to reopen the file.

- To exit the program, choose "**Quit LoggerPro**" from the **LoggerPro** menu bar. Press "**Save**".

<u>NOTE</u>: IF YOU ARE FINISHED WITH THE VERNIER SYSTEM, THE TITRANT MUST BE FLUSHED FROM THE PUMP.

- Reopen the **"one minute pump calibration.cmbl"** and place the inlet tubing into a beaker of deionized water. Place the outlet tubing in a waste beaker. Be sure that the line is secure and that the open end of the tubing is placed at the bottom of the beaker to reduce bubbles in the line. Use at least 90 pulses to run deionized water through the pump and tubing. Then place the inlet hose on the benchtop and use 60 pulses to dry the lines.

- Please rinse the pH electrode and place it in the electrode storage solution (the hole in the blue collar should be open).

- Please turn off the power strip.

D. Using the Vernier System to measure Conductivity:

- Carefully detach the pH electrode from CH1 and place the conductivity probe into CH1. Please check to see that the toggle found on the box connected to the conductivity probe is set to the 0-2000 uS/cm range.

- Double click on the "**CH142Conductivity.cmbl**" icon in the "**CH142Vernier LabPro**" folder on the desktop. The "**CH142Conductivity.cmbl**" window will look and function like the "**CH142Titration.cmbl**" window. The software will automatically recognize the conductivity probe and the smaller box under the table will now display Conductivity in uS/cm (rather than pH).

- To calibrate the "X" axis to the calibrated pump volume used in the titration experiments, double click on the volume column heading in the table and enter the calibrated pulse volume (uL) at the end of the equation in the "**Calculated Column**" window. Press "**Done**".

- To calibrate the conductivity probe, choose "**Experiment**" from the **LoggerPro** main menu bar and choose "**Calibrate**". Slide right to choose "**LabPro:1CH1:Conductivity**". In the "**Sensor Settings**" box, check to see that the current calibration reads "**Con2000uS/cm <Sensor Page 0**>. Using "**Live Calibration**", press the "**calibrate now**" button. The units should be displayed as uS/cm. With the dry probe set on the desktop, enter "0" in the "**Enter value**" box and press "**Keep**". The place the probe into the Sodium Chloride Standard (eq. 1000 uS/cm) solution. When the mV value is stabilized, type "1000" into the "**Enter value**" box and press "**Keep**".   Then press "**Done**".

- Prepare a 10 ml sample of your acid as described in the titration instructions, and carefully rest the conductivity probe on the lip of the beaker. Be sure that the electrode surfaces in the elongated cell are completely submerged in the liquid and that no bubbles are trapped in the cell. Record the starting conductivity measurement. The stir bar should not be in contact with the probe.

- Attach the pump outlet tube to the beaker so that the end of the tubing is right at the level of the solution being tested.

- Press the green "**Collect**" button in the "**CH142Conductivity.cmbl**" menu bar to titrate the acid. Select "**erase and continue**" to start the experiment. The conductivity measurements will be recorded in the table and the conductivity plot will be displayed in the graph. (If this is not true, double click on the "**sensor output**" "Y" axis label and choose "**Conductivity**".   (Remove the check for any unwanted data being displayed on the graph.).   Press "**Stop**" when volume of approx. 15000 uL is reached to end the titration ("Stop" is where the "collect" button was at the start of the run). Choose "**File**" from the **Logger Pro** Main window menu bar and "**Save**" to assure that the data is not lost while preparing the next titration or analyzing the data.

- The graph can be printed by choosing "**File**" from the **LoggerPro** main window menu bar and "**Print Graph**". Including the information in the "**Printing Options**" window will provide a label to the hardcopy of your graph. Press "**OK**". Setting the printer to **HP4560** will produce a color copy of the data. Select the number of copies and press "**Print**". The copies will be printed in the Schupf Lab.

- To analyze the data points of interest on the conductivity plot, press the "**X=**" (also called the "**Examine**") button in the "**CH142Titrate.cmbl**" window menu bar. Any point along the curves can be evaluated (also recorded in the table). Record the data points that are important to your experiment. Click on the **"X="** button again to exit data analysis.

- You can also press the "**Control-Option**" keys on the keyboard while holding down the mouse with the cursor placed on the graph. Choosing "**copy**" from the menu box will allow the graph to be saved as a MicroSoft Word document. Open Word and use "**Paste**" under the "**Edit**" menu to copy the graph. The graph can be further edited in Word. If you use the "**Save as**" option to save the data, you would need the LoggerPro Software on your computer to reopen the file.

- To exit the program, choose "**Quit LoggerPro**" from the **LoggerPro** menu bar. Press "**Save**".

- Rinse the end of the probe with deionized H_2O between measurements.

- If you are finished using the Conductivity Probe, rinse the probe with deionized water and use a Kim Wipe to dry. The probe can be stored safely dry on the benchtop.

<u>NOTE</u>: IF YOU ARE FINISHED WITH THE VERNIER SYSTEM, THE TITRANT MUST BE FLUSHED FROM THE PUMP. (REFER TO PAGE 5 FOR THE INSTRUCTIONS FOR CLEAN UP AND SHUT DOWN.)