

# An Introduction to Computer-Based Laboratory Experiments: Using the Vernier LabPro® Interface

## ***Introduction***

Computer-based data acquisition techniques are used in upper division science courses, as well as in professional laboratories. The primary advantage of computer-based methods in any laboratory setting, including Principles of Chemistry, is the speed with which data can be gathered. Computers also assist in data analysis and can improve the overall efficiency and accuracy of laboratory processes. To be prepared to work in any college or professional laboratory, you must be familiar with computer-based methods of data collection and analysis.

## ***Learner Outcomes***

Upon completion of this laboratory activity, the student should be able to

- use Vernier's *LabPro*® interface and *Logger Pro* software to carry out a simple time-based experiment.
- copy data from *Logger Pro* into *Excel*.

## ***Background***

The science labs at both campuses of Anoka-Ramsey Community College are equipped with the following hardware:

- Computers running Microsoft *Windows*
- Vernier's *LabPro*® Interfaces
- Various types of data-gathering probes including the following:
  - pH probes
  - Temperature probes
  - Light sensors
  - Photogates
  - Sonic rangefinders

*Data-gathering probes* are simple electronic devices that respond to different types of stimuli by sending out electrical voltage signals. The signals by themselves are meaningless, but computer software can interpret and display them as meaningful data. In order for the software to correctly interpret the signals, however, it is necessary to *calibrate* the probe. Calibration consists of feeding the probe a signal of known value and teaching the software to recognize that value as a reference point. For example, the temperature of ice water is known to be 0°C. If a temperature probe is placed in ice water, the software can be instructed to recognize that signal as 0°C. Some probes will already have a calibration file built in to the hardware and software. Other probes (like the pH probes) will require that the calibration be done manually.

In each experiment, you will use different probes depending on the type of data you are collecting. Probes connect to the *signal interface*, which serves as a switchboard for routing signals into the computer, where the software interprets the signals.

### ***Procedure 1: A Time-Based Experiment***

1. Add 150 mL of cold water (no ice!) to a 250 mL beaker and place the beaker onto the hot plate.
2. Plug the temperature probe into Channel 1 of the Vernier LabPro™ interface. Open the *LoggerPro* application from the Start menu or desktop. If the temperature probe is not automatically identified by the software and interface, open the file for the stainless steel temperature probe from the **Probes & Sensors** folder of the **Experiments** folder.
3. Clamp the temperature probe to the ring stand.





#### **CAUTION**

**Be very careful when using a hot plate. Do not touch the heating surface at any time while it is in operation. Route all wires to avoid contact with the heating surface.**

4. Adjust the experiment length to 30 minutes and the sampling rate to take 1 reading every 30 seconds.
5. Make sure that your columns are labeled with the proper units. Make changes, if necessary. Adjust the time column to read to two decimal places. The temperature measurements are accurate to approximately  $\pm 0.1^\circ\text{C}$ , so adjust the temperature readings to the correct number of decimal places.
6. Format your graph. Click on each of the labels on the axes to adjust the scaling of the graph to accommodate the anticipated range of data points. Try to guess how high you think the temperature will go, then give yourself a little extra room. If you do not adjust the scaling, you will not be able to see all of your data be plotted as it is collected. You should now be ready to begin collecting data.

#### **SAVE YOUR WORK!**


**REMINDER:** Save your data *early and often* in order to avoid the accidental loss of your work. Use the following convention for naming your files: “Lastname Firstname Interface” (include both names if you are working in pairs), saving to your own flash drive or your H: drive. Backup all your computer data by saving to your own disk and/or emailing a copy to yourself.

7. Set the hot plate to the highest setting and begin heating.
8. Start the data collection by clicking the green  button on the *Logger Pro* tool bar.
9. You will notice that the time and temperature readings will be displayed on the data table and the points will be plotted as the experiment runs.
10. The experiment will stop on its own after 30 minutes. However, if you should you desire to stop the data collection early, you may click on the red  button on the tool bar. You

may stop the data collection early if the temperature rises to a point where it changes very little in a period of about three to four minutes.

11. Examine the data in the table and on the graph. What is the significance of the temperature at which the readings leveled off?
12. Save your file by clicking on the disk icon in the upper left portion of your screen. Then select “Store Latest Run” from the *Experiment* menu, so you can graph a new set of data. *(NOTE: This may require the instructor’s demonstration.) When using the Interface, get in the habit of saving your file and storing the latest run whenever you complete a trial. Failure to do so may result in all of your data being lost in an experiment. Remember – save early and often!*
13. *Repeat* the experiment, dissolving 20 g of salt into the cold water before heating.
14. Did the temperature readings level off on your second trial? If so, at which temperature? Was the temperature higher or lower than for pure water? Is this what you expected? Explain.

### ***Procedure 2: Another Time-Based Experiment***

1. Place a mixture of ice and water up to the 150 mL mark in a 250 mL beaker. *Make sure that the ice goes all the way to the bottom of the beaker.*
2. Adjust the timing for this experiment to run for 3 minutes and set the sampling rate to take a reading every 5 seconds.
3. Then adjust the scaling on the graph to accommodate the anticipated range of data points.
4. With the temperature probe at room temperature, click on the green  button, and thrust the probe into the ice-water mixture and stir gently. Allow the experiment to run for the full three minutes.
5. When the experiment is completed, examine the data in the table and on the graph. What is the significance of the temperature at which the readings leveled off?
6. Save the file, store the latest run and *repeat* the experiment by pouring 20 g of salt into the ice-water mixture. Start the timer, then stir to dissolve the salt.

### ***Assignment***

1. When you are finished with all of the trials, copy the data from each trial onto separate pages (or separate sheets) of an *Excel* spreadsheet. *Save your data in order to avoid the accidental loss of your work. Use the following convention for naming your files: "Lastname Firstname Interface" (include both names if you are working in pairs), saving to your own flash drive or to the H: drive. Remember to make backup copies of this file on your own disk and/or email a copy to yourself.*
2. If necessary, readjust the number of decimal places on the time column to two decimal places and temperature column to one decimal place. Graph each set of data, adjusting the size of the graphs and the scaling to make it easy to read and interpret. Use Print Preview to judge how large the graphs will look on a page. Remember that the more appealing you make your data and graphs the better they may be received.
3. Create a new *Word* file for the laboratory report you will hand in. Your graphs should be copied and pasted into the results section. All of the raw data points you used to create the graphs must be included in an appendix at the end of your report. If you are submitting your report as a hard copy, you may print the data from *Excel* and staple it to the back of your report. If you are submitting your report electronically, the data must be copied and pasted into the end of your *Word* file.
4. For the laboratory report, you will need to include a title section, an abstract, experimental details (you may simply refer to the URL), results, discussion and conclusion, and references.
5. The following items should be addressed in the discussion (in addition to the questions in the procedures). Your discussion should have a logical flow of ideas, and should *not* simply be individual answers to the provided questions.
  - When the water and salt water were heated, at which temperatures did the readings level off (or become more level)? Were the results what you expected? Explain.
  - When the probe was placed into the ice-water and salt ice-water mixtures, at which temperatures did the readings level off (or become more level)? Were the results what you expected? Explain.
  - How good was the calibration of the temperature probe? Comment on the accuracy and precision of the measurements made with the temperature probe.
  - Give one application of where a solute is added to a solvent to change its boiling point. Give one application of where a solute is added to a solvent to change its freezing point. Consult your text or the Internet if necessary.

### ***Laboratory Report***

For this experiment, you and your partner may submit a group report. At your instructor's discretion, you also may have the option of submitting an individual report. If you do so, please signify on your report that it is an individual report (by placing your name first and underlining it). Guidelines for Laboratory Reports may be found at

<http://webs.anokaramsey.edu/chemistry/Chem1061/Labs/Reports/Laboratory%20Reports.htm>.

Follow your instructor's directions for submission of this lab report. If you submit your file electronically, please submit a **single Word file** for your entire report, including graphs and appendices. Excel spreadsheets, *Logger Pro* files, or anything other than a single *Word* file **will not be accepted**. Use the file-naming convention specified in the lab and a subject line in your email of "Chem 1061: Interface Lab".