

# **CBL™ Made Easy!**

5 Steps to Getting Started with the CBL System, Vernier Sensors, and Texas Instruments Graphing Calculators

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# CBL Made Easy!

## Table of Contents

|   |    |
|---|----|
| <b>OVERVIEW: CBL MADE EASY!</b> .....                         | 1  |
| <b>GETTING STARTED: REQUIRED MATERIALS</b> .....              | 2  |
| <b>STEP 1: LOADING PROGRAMS ONTO YOUR COMPUTER</b> .....      | 3  |
| <i>TI-Connect and TI-GRAPH LINK Software</i> .....            | 3  |
| <i>CBL Programs</i> .....                                     | 4  |
| <b>STEP 2: LOADING PROGRAMS ONTO YOUR CALCULATOR</b> .....    | 5  |
| <i>Using Windows Computers</i> .....                          | 5  |
| <i>Using Macintosh Computers</i> .....                        | 6  |
| <i>TI-GRAPH LINK Troubleshooting</i> .....                    | 8  |
| <b>STEP 3: PUTTING IT ALL TOGETHER</b> .....                  | 9  |
| <b>STEP 4: COLLECT DATA — A TEMPERATURE EXPERIMENT</b> .....  | 10 |
| <b>STEP 5: SENDING GRAPHS AND DATA TO YOUR COMPUTER</b> ..... | 13 |
| <i>Using Graphical Analysis Software</i> .....                | 13 |
| <i>Using TI-GRAPH LINK Software</i> .....                     | 16 |

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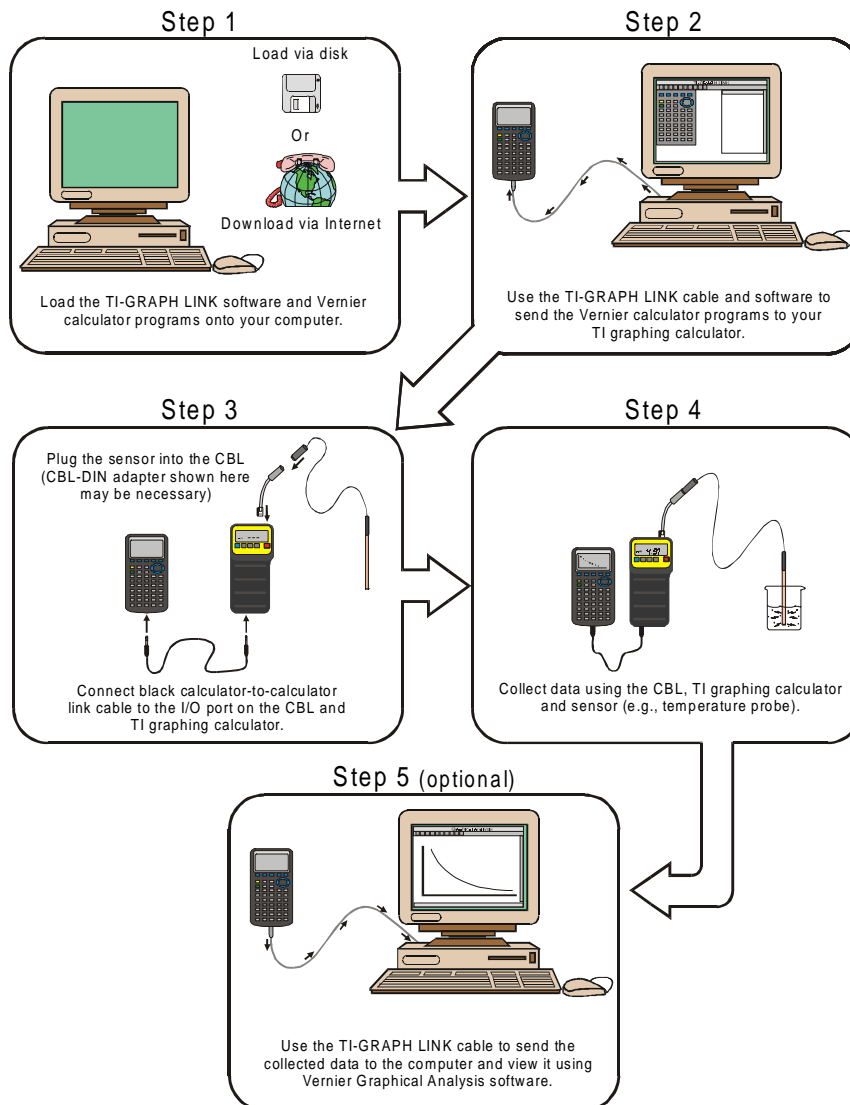
# Overview

## CBL Made Easy!

This CBL guidebook is a step-by-step guide to collecting data using the original Calculator-Based Laboratory (CBL) and a Texas Instruments graphing calculator. It was written in a sequence to be followed from the purchase of necessary materials, through the setup and data collection procedures, and on to areas of further interest.

**Note:** If you are using LabPro™ or CBL 2™, stop here! *DataMate Handbook*, *Beyond DataMate*, and *LabPro Technical Reference Manual* are resources for those interfaces, and can be downloaded from the Vernier web site.

The flowchart below is, in a nutshell, the entire CBL setup process described in this guidebook. If you lost everything but this diagram, you would still have the five steps to successfully run experiments with the CBL.



# Getting Started

## Required Materials

To load Vernier supplemental programs onto your TI handheld, you will need:

- A Texas Instruments handheld
- TI-GRAPH LINK™ cable
- TI Connect™ or TI-GRAPH LINK™ software
- Vernier CBL programs

## Supported Handhelds

The CBL supports several Texas Instruments handhelds. Program loading instructions are available in Step 2 of this manual.

- |                  |                             |              |
|------------------|-----------------------------|--------------|
| • TI-82          | • TI-83 Plus Silver Edition | • TI-92      |
| • TI-73 Explorer | • TI-85                     | • TI-92 Plus |
| • TI-83          | • TI-86                     | • Voyage 200 |
| • TI-83 Plus     | • TI-89                     |              |

## TI-GRAPH LINK Cables<sup>1</sup>

One of the steps in getting started is loading programs onto your calculator. You will need one of the following cables to do this.

TI-GRAPH LINK Serial cable for Macintosh (gray)  
Order Code: GLC-MAC

TI-GRAPH LINK Serial cable for Windows (black)  
Order Code: GLC-WIN

TI-GRAPH LINK USB cable for Windows and Macintosh (silver).  
This is commonly called the TI-Connectivity Kit.  
Order Code: GLC-USB



## Optional

- AC Adapter (IPS) lets you power the CBL from a wall outlet.
- Graphical Analysis software can import calculator-based data for further analysis and printing.
- Adapters for older sensors not included with the CBL System (these are typically sensors with round 5-pin DIN plugs).

<sup>1</sup> All TI-GRAPH LINK cables come with the TI Connect and TI-GRAPH LINK software, and are available at Vernier Software & Technology.

# Step 1: Load Programs onto Your Computer

Now load the TI Connect or TI-GRAPH LINK software and CBL programs onto your computer.

**Important:** You will need TI Connect unless you are a Windows user and you are using either the TI-82, TI-85, or TI-86 handhelds. If that's the case, you will need the TI-GRAPH LINK software for Windows.

## A: Load TI Connect or TI-GRAPH LINK onto Your Computer

There are two sources of these programs—the Resource CD that comes with the TI Connectivity Kit and the Texas Instruments web site.

### TI Resource CD

The TI Resource CD is included in the TI Connectivity Kit (USB) for Windows/Mac (order code GLC-USB), and TI-Graph Link serial cables for both Windows and Macintosh (order codes GLC-WIN, GLC-MAC).

If your computer doesn't automatically launch the CD, double-click on the CD then double-click TICD.exe. From there, click on Computer Software and Documentation, and then click on TI Connect or TI-GRAPH LINK. Accept the locations. A folder named TI Education containing TI Connect or TI-GRAPH LINK will be placed on your hard drive.

### From the Texas Instruments Web Site

If you do not have the CD, but you do have the cable, you can download and install the TI Connect or TI-GRAPH LINK program for free from the Texas Instruments web site:

<http://education.ti.com/us/product/accessory/connectivity/down/download.html>

Click on the platform (Windows or Macintosh)

- The Windows program will select a folder on your hard drive to which the setup program will be sent.
- The Macintosh version will be saved on your desktop or your hard drive depending on the settings of the internet browser.

Leave the web site and double-click the setup icon. The instructions will then lead you through the installation process. A folder named "TI Education" containing the program file will be created on your hard drive. A shortcut icon will be placed on your desktop.

## B: Load the CBL Programs onto Your Computer

These are the programs/applications you will run on your calculator when performing experiments. They should be saved on your computer before you transfer them to your calculator.

**Important:** Depending on the type of TI graphing calculator, the calculator can run program or applications. Programs reside in the calculator's RAM, while applications reside in the calculator's FLASH memory.

- A file ending with a “g” (chembio.83g, for example) is a group program. All calculator types (except for the TI-83 Plus and the TI-83 Plus Silver Edition) run group programs when using the CBL.
- A file ending with “8xk” (chembio.8xk, for example) is an application for use with the TI-83 Plus and TI-83 Plus Silver Edition.

**Sources for CBL Programs:**

- Vernier web site ([www.vernier.com](http://www.vernier.com)). Click on the Downloads tab, then select Calculator Programs (original CBL), and choose the type of program, calculator, and computer (Macintosh or Windows) you are using.
- Disks that come in the back of the Vernier lab manuals. (*e.g.*, *Chemistry with CBL*). The disks contain group files, one for each type of TI graphing calculator (“chem-bio.83g”, chem-bio.92g,” *etc.*). Each group file contains a number of programs that comprise the data collection program for the TI calculator. Copy or drag the file for your particular TI calculator onto the TI Education folder on your hard drive. The disks also contain Word files. They provide a way for you to edit student experiments to match your lab situation, equipment, or style of teaching. NOTE: On the Window platform, you will first need to double-click on the “Double-click to Install” icon before you save the programs.
- Disks that come with other lab books, such as *Real World Math with the CBL System* and *Exploring Physics and Math with the CBL System*.

You will now use the TI-GRAPH LINK cable and TI-CONNECT or TI-GRAPH LINK software to transfer CBL programs to the calculator. Move on to Step 2.

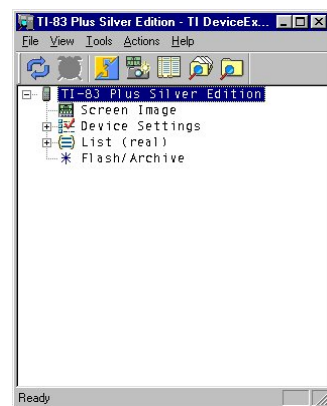
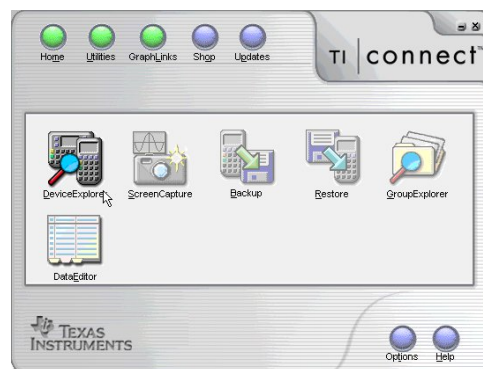
# Step 2: Load Programs onto Your Calculator

## Using TI Connect

TI Connect for Windows and Macintosh is very easy to use. It works with all TI handhelds, unless you are using a TI-82, TI-85, or TI-86 and a Windows computer. In that case, TI-GRAPH LINK must be used. The TI-83 Plus and TI-83 Plus Silver Edition needs to be running operating system version 1.15<sup>2</sup> or newer to work with TI Connect.





## Windows Computers

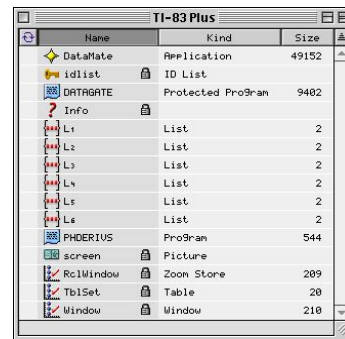
1. Connect the TI-GRAPH LINK cable to the serial or USB port of your computer and to the port at the bottom edge of the TI-73 Explorer, TI-83, TI-83 Plus, TI-83 Plus Silver Edition, TI-89, or top edge of the TI-92, TI-92 Plus, or Voyage 200 handheld.
2. Start the TI Connect software on your computer. Click on Device Explorer.
3. The program will identify the attached device and call up a window representing the contents. (See the troubleshooting appendix if the program fails to detect your handheld.)
4. Loading programs and applications onto a TI handheld is very easy. All you have to do is drag the program from wherever you have it on your computer to the Device Explorer window, and it will copy onto your handheld.
5. The program should now be loaded into your handheld. To confirm this, press **PRGM** on the TI-73 Explorer, **APPS** on the TI-83, TI-83 Plus, and TI-83 Plus Silver Edition, or **2nd** **[VAR-LINK]** on the TI-89, TI-92, TI-92 Plus, or Voyage 200.



<sup>2</sup> TI Connect comes with a recent version of the calculator operating system. The OS gets installed on the computer. Connect will notify you of the OS upgrade and recommend installation. For regular communication between an 83 Plus and Connect, the calculator has to have OS 1.12 or newer. For TI Connect to install an application, the calculator must have OS 1.13 or newer.

## Macintosh Computers



1. Connect the TI-GRAPH LINK cable to the serial or USB port of your computer and to the port at the bottom edge of the TI-82, TI-73 Explorer, TI-83, TI-83 Plus, TI-83 Plus Silver Edition, TI-85, TI-86, TI-89, or the top edge of the TI-92, TI-92 Plus, or Voyage 200 handheld.
2. Turn on the handheld and start the TI Connect software on your computer. (The TI-82 and TI-85 must be put in Receive mode. Press 2nd [LINK] then , and select 1:Receive from the RECEIVE menu. “Waiting” appears on the TI-82/TI-85 screen).
3. Select the appropriate device from the Connection menu. Confirm which port the cable is plugged into.
4. The program will identify the attached device and call up a window representing the contents.
5. Loading programs onto a TI handheld is very easy. All you have to do is drag the program to the device’s window and it will copy onto your handheld. (For the TI-82 and TI-85, you must then click on the red arrow in the upper left-hand corner of the window.)
6. The program should now be loaded into your handheld. To confirm this, press  on the TI-82, TI-73 Explorer, TI-83,  on the TI-83 Plus, TI-83 Plus Silver Edition, TI-85, and TI-86, or  [VAR-LINK] on the TI-89, TI-92, TI-92 Plus, and Voyage 200.



## Using TI-GRAPH LINK

### Windows Computers

#### TI-82 Calculators

1. Connect the TI-GRAPH LINK cable to the serial port of your computer and to the port at the bottom edge of the TI-82 calculator.
2. Start the TI-GRAPH LINK (82) software on your computer and choose Send from the Link menu.
3. Turn on the TI-82 calculator and press 2nd [LINK]. Press , then select 1:receive from the RECEIVE menu (Waiting appears on the TI-82 screen).
4. On the computer, open the folder that contains your CBL programs (for example, “TI-82”), then click the appropriate file (for example, “chem-bio.82g” or “physics.82.g”). The “g” in the name denotes a group file.
5. Click on OK. The group of programs is now loaded onto your calculator. When the file transfer is complete, click on OK.
6. You can confirm that the program has been loaded by pressing the  key on the calculator.

#### TI-73 Explorer, TI-83, and TI-86 Calculators

1. Connect the TI-GRAPH LINK cable to the serial port of your computer and to the port at the bottom edge of the TI-73, 83, 86 calculator.
2. Turn on the TI-73, 83, 86 calculator (unlike the TI-82, you do not need to put these calculators in RECEIVE mode).
3. Start the TI-GRAPH LINK (73, 83, 86) software on your computer and choose Send from the Link menu.
4. In the right-most window of the “Send to TI-73 Explorer, 83, 86” screen, open the folder that contains your CBL programs (for example, “TI-83”), then click the appropriate file (for example, “CHEM-BIO.83g” or “PHYSICS.83g”) from the left-most screen. The “g” in the name denotes a group file.

5. Click on Add. The file name is copied to the bottom window of the screen.
6. Click on OK. The sending window appears. When the file transfer is complete, click on OK. The group of programs is now loaded into your calculator.
7. You can confirm that the program has been loaded by pressing the **PRGM** key on the calculator.

### TI-83 Plus Calculators

1. Connect the TI-GRAPH LINK cable between your computer and TI-83 Plus and make sure the TI-83 Plus is on the Home Screen.
2. Start the TI-GRAPH LINK (TI-83 Plus) program.
3. Select Send Flash Software → Applications and Certificates from the Link menu. If you want to load the Chembio application, locate chem-bio.8xk on your computer. For the Physics application, locate physics.8xk on your computer. Double-click on the application to add it to the File Selected field at the bottom of the Send Application dialog box.
4. Click the OK button to send the application to your TI-83 Plus. (If you use the Flash memory of the calculator extensively, you may see a Garbage Collection message. This occurs if you try to archive when there is not enough free archive memory. The TI-83 Plus will attempt to rearrange the Flash memory to make additional room. Select Yes if you asked to collect garbage.)
5. You can confirm that the application has been loaded by pressing the **APPS** key on the calculator.

### TI-85 Calculators

1. Connect the TI-GRAPH LINK cable to the serial port of your computer and to the port at the bottom edge of the TI-85 calculator.
2. Turn on the TI-85 calculator and press **2nd** [LINK], then select <RECV>. “Waiting” appears on the TI-85 screen.
3. Start the TI-GRAPH LINK (85) software on your computer and choose Send from the Link menu.
4. Open the folder that contains your CBL programs (for example, “TI-85”).
5. Click the appropriate file (for example, “chem-bio.85g” or “physics.85g”) and click on OK. The “g” in the name denotes a group file. The Sending window appears. When the file transfer is complete, click on OK. The group of programs is now loaded into your calculator.
6. You can confirm that the program has been loaded by pressing the **PRGM** key on the calculator.

### TI-89, TI-92, TI-92 Plus, and Voyage 200 Calculators

1. Connect the TI-GRAPH LINK cable to the serial port of your computer and to the port at the bottom edge of the TI-89 or top edge of the TI-92, 92 Plus calculator. (The calculator will turn on automatically.)
2. Start the TI-GRAPH LINK (89, 92, 92 Plus) software on your computer and choose Send from the Link menu.
3. In the right-most window of the screen, select the folder that contains your CBL programs (for example, “TI-89”), then click the appropriate file (for example, “chem-bio.89g” or “physics.89g”) from the left-most window. The “g” in the name denotes a group file.
4. Click on Add. The file name is copied to the bottom window of the screen.
5. Click on OK. When the file transfer is complete, click on OK. The group of programs is now loaded into your calculator.
6. You can confirm that the program has been loaded by pressing the **2nd** [VAR-LINK] on the calculator.

## Macintosh

### TI-82 Calculators

1. Connect the TI-GRAPH LINK cable to the modem or USB port of the Macintosh computer and to the port at the bottom edge of the TI-82 calculator.
2. Start the TI-GRAPH LINK (82) software on your computer and choose Group from the Send menu.
3. Turn on the TI-82 calculator and press 2nd [LINK]. Press **▶**, then select 1:receive from the RECEIVE menu (“Waiting...” appears on the TI-82 screen).

4. Open the folder that contains your CBL programs (for example, “TI-82”) then open the appropriate file (for example, “chem-bio.82g” or “physics.82g”). The “g” in the name denotes a group file.  
NOTE: When you are selecting the group file, do not double-click it.
5. Click on Send. The group of programs is now loaded onto your calculator.
6. You can confirm that the program has been loaded by pressing the **PRGM** key on the calculator.

### TI-85 Calculators

1. Connect the TI-GRAPH LINK cable to the modem or USB port of the Macintosh computer and to the port at the bottom edge of the TI-85 calculator.
2. Turn on the TI-85 calculator and press **2nd** [LINK], then select <RCV>. (“Waiting” appears on the TI-85 screen).
3. Start the TI-GRAPH LINK (85) software on your computer and choose Group from the Send menu.
4. Open the folder that contains your CBL programs (for example, “TI-85”).
5. Select the appropriate file (for example, “chem-bio.85g” or “physics.85g”) and click on Open. The “g” in the name denotes a group file. NOTE: When you are selecting the group file, do not double-click it.
6. Click on Send. The message “Sending Data to TI-85” appears while the group of programs is loading into your calculator.
7. You can confirm that the program has been loaded by pressing the **PRGM** key on the calculator.

### TI-73 Explorer, TI-83, TI-86, TI-89, TI-92, TI-92 Plus, and Voyage 200 Calculators

1. Connect the TI-GRAPH LINK cable to the modem or USB port of the Macintosh computer and to the port at the bottom edge of the TI-73 Explorer, 83, 86, 89 or the top-left edge of the TI-92 or TI-92 Plus.
2. Turn on the calculator and start TI-GRAPH LINK 2.0 on your computer.
3. Select TI-73 Explorer, TI-83, TI-86, TI-89, TI-92, or TI-92 Plus from the Connection menu. Confirm that it is using the modem or USB port.
4. The list of items on the TI-73 Explorer, 83, 86, 89, 92, and 92 Plus is read by TI-GRAPH LINK and displayed in a window called “TI-73,” “TI-86,” *etc.* according to the type of calculator being used.
5. Open the folder that contains your CBL applications (for example, “TI-73”), then select the appropriate file (for example, “ChemBio.73g” or “Physics.73g”).
6. Drag the appropriate file onto the window titled “TI-73.” The program will copy onto your calculator.
7. The program should now be loaded into your handheld. To confirm this, press **PRGM** on the TI-73 Explorer, TI-83, or **2nd** [VAR-LINK] on the TI-89, TI-92, TI-92 Plus, or Voyage 200.

### TI-83 Plus Calculators

1. Connect the TI-GRAPH LINK cable to the modem or USB port of the Macintosh computer and to the port at the bottom edge of the TI-83 Plus.
2. Turn on the calculator and start TI-GRAPH LINK 2.0 on your computer.
3. Select TI-83 Plus from the Connection menu. Confirm that it is using the Modem Port.
4. The list of items on the TI-83 Plus is read by TI-GRAPH LINK and displayed in a window called “TI-83 Plus.”
8. Open the folder that contains your CBL applications (for example, “TI-83 Plus”), then select the appropriate file (for example, “ChemBio.8xk” or “Physics.8xk”).
5. Drag the appropriate file onto the the window titled “TI-83 Plus.” The program will copy onto your calculator. (If you use the Flash memory of the calculator extensively, you may see a Garbage Collection message. This occurs if you try to archive when there is not enough free archive memory. The TI-83 Plus will attempt to rearrange the Flash memory to make additional room. Select Yes if you asked to collect garbage.)
6. You can confirm that the application has been loaded by pressing the [APPS] key on the calculator. You will see ChemBio and/or Physics listed in the Applications menu.

You did it! The programs should now be loaded into your calculator. To confirm this, press **PRGM** on the TI-73 Explorer, 82, 83, 85 and 86, **APPS** on the TI-83 Plus, or **2nd** [VAR-LINK] on the TI-89, 92, 92 Plus. You should see a number of programs listed. All of the programs listed are sub-programs of the primary data-collection program (at the top of the list).

## TI-GRAPH LINK Troubleshooting

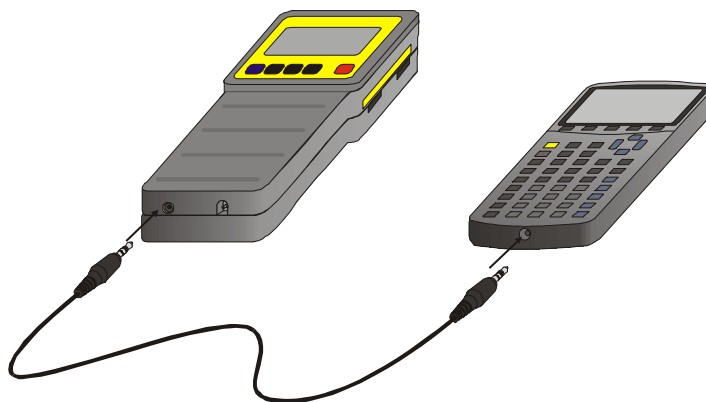
| Problem  | Solution   |
|--|--|
| My TI-GRAPH LINK for Macintosh program does not see the group file in the CBL program folder.                              | Within the older TI-GRAPH LINK for Macintosh software, you have “All Objects” selected from the pull-down menu at the bottom of the screen that comes up when you try to link. You need to have “Group” selected from that list of choices. After you select Group, you should be able to see all of the group files that we supply.   |
| I cannot get programs to transfer to my TI-83 calculator, even though the cable is good and I can transfer the LCD screen. | Are you trying to use <input type="button" value="2nd"/> [LINK] on the calculator to send the programs? Remember that a TI-83 is very different from a TI-82 in this respect. When you send programs from the computer to a TI-83, you do not touch the calculator except to turn it on and set it to the home screen.   |
| Can I load both PHYSICS and CHEMBIO on my calculator?  | The TI-73, 82, 83, 85 have only enough memory to load one of the Vernier groups. The TI-83 Plus, 86, 89, 92, and 92 Plus have enough memory to hold both.  |
| I get a Link Transmission Error message.   | <ul style="list-style-type: none"> <li>• Make certain the cable is firmly pushed into the ports.</li> <li>• You could be running Graphical Analysis at the same time, so the modem port is already being occupied. Quit Graphical Analysis and try again.</li> <li>• If you are using a Macintosh PowerBook, you need to turn off AppleTalk from the Chooser. Also, if you have an internal modem, turn it off in the Control panel.</li> <li>• Make sure you clear all the memory on your calculator before you load the group program.</li> <li>• If you are using a TI-82 or TI-85, make sure that you turn on the TI-82/85 calculator and press <input type="button" value="2nd"/> [LINK]. Press <input type="button" value="▶"/>, then select 1:receive from the RECEIVE menu (“Waiting...” appears on the TI-82/85 screen).</li> </ul> |

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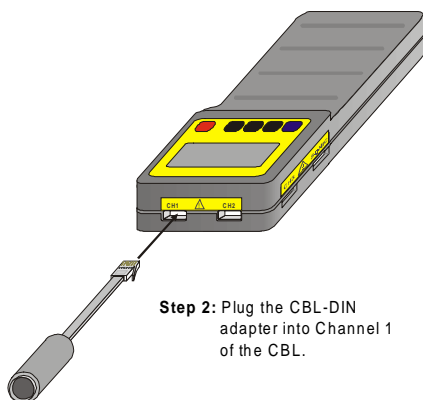
## Step 3: Putting it All Together

Now you are ready to get your hardware set up. This is the easy part. At the base of the CBL are two ports. The left port is the communications port. This connects the CBL to the calculator via the black calculator link cable. Be sure to push the cables firmly in when connecting the two components.<sup>3</sup>

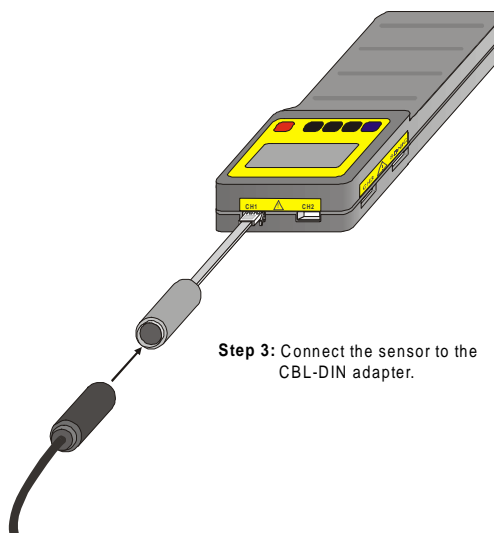
There are four jacks located along the top and the left of the CBL unit in which you can plug Vernier or TI probes. They are labeled CH1, CH2, CH3, and Sonic. You should use the lowest channel available. The Sonic port is used only for the Motion Detector. If the order code for Vernier sensors ends with the extension “-DIN,” (a 5-pin round plug) then it requires a DIN-BTA adapter. For more information about adapters, refer to Appendix B.



**Step 1:** Plug the black link cable into the link port on the bottom of the CBL and TI graphing calculator.



**Step 2:** Plug the CBL-DIN adapter into Channel 1 of the CBL.



**Step 3:** Connect the sensor to the CBL-DIN adapter.

<sup>3</sup>The right port allows you to connect an AC adapter (order code IPS). This will prolong battery life when doing experiments indoors.

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## Step 4: Collect Data - A Temperature Experiment

Now you are ready for the fun part—collecting data! Here is a simple temperature experiment to try.<sup>4</sup> It will guide you through the process of making measurements using a temperature probe and the CBL system. Once you are familiar with the basic steps, you will be able to perform any experiment with the CBL. It's that easy!

### OBJECTIVES

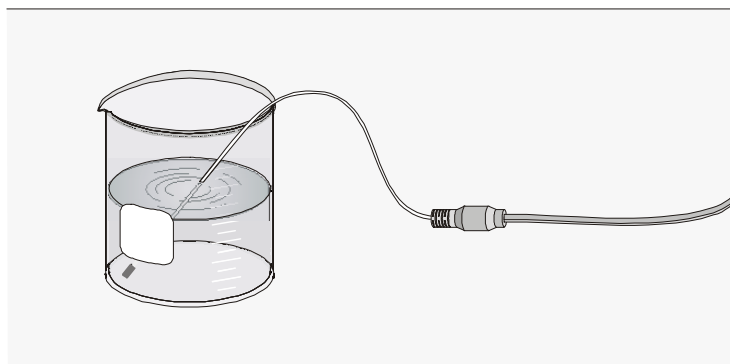
In this experiment, you will

- use a TI graphing calculator, a CBL System, and a temperature probe to measure temperature
- record data
- make a graph of the data

### MATERIALS

CBL System  
TI graphing calculator  
TI Temperature Probe  
CHEMBIO, PHYSICS, or PHYSCI program

TI-GRAPH LINK  
two 250-ml beakers or two glasses  
cold water (cooled with ice)  
hot water



*Figure 1*

### PROCEDURE

1. Place about 100 ml of tap water into a 250-ml beaker or a glass. Add two or three ice cubes.
2. Place a temperature probe into the cold water and stir briefly. Then position the probe in the cold-water beaker as shown in Figure 1.
3. Plug the temperature probe into Channel 1 of the CBL System. Connect the CBL System to the TI graphing calculator with the link cable using the port at the bottom of each unit. Firmly press in the cable ends.

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<sup>4</sup> This is a modified version of Experiment 1 in *Physical Science with CBL*, by Don Volz and Sandy Sapatka

4. Turn on the CBL unit and the calculator. Follow these steps to start the CHEMBIO, PHYSICS, or PHYSCI program on your calculator:

TI-73, 82 or 83 Calculators:

Press **[PRGM]**, then press the calculator key for the *number* that precedes CHEMBIO, PHYSICS, or PHYSCI program (usually **[1]**). Press **[ENTER]**, then press **[ENTER]** again to go to the MAIN MENU.

TI-83 Plus Calculators

Press **[APPS]**, then press the calculator key for the *number* that precedes CHEMBIO, PHYSICS, or PHYSCI program. Press **[ENTER]**, then press **[ENTER]** again to go to the MAIN MENU.

TI-85 or 86 Calculators:

Press **[PRGM]**, press **[F1]** to select < NAMES >, and press a menu key to select < CHEMB >, < PHYSIC >, or < PHYSCI > (usually **[F1]**). Press **[ENTER]**, then press **[ENTER]** again to go to the MAIN MENU.

TI-89, 92 or 92 Plus Calculators:

Press **[2nd]** **[VAR-LINK]**. Use the cursor pad to scroll down to “chembio,” “physics,” or “physci” then press **[ENTER]**. Press **[ ) ]** to complete the open parenthesis that follows “chembio,” “physics,” or “physci” on the entry line and press **[ENTER]**. Press **[ENTER]** again to go to the MAIN MENU.

5. Set up the calculator and CBL for one temperature probe and a temperature calibration.

- Select SET UP PROBES from the MAIN MENU.
- Select “1” as the number of probes.
- Select TEMPERATURE<sup>5</sup> from the SELECT PROBE menu.
- Enter “1” as the channel number (in the PHYSICS program, press **[ENTER]**).
- Select USE STORED from the CALIBRATION menu (this menu will appear only if you are using the Vernier Direct-Connect Temperature Probe or Standard Temperature Probe).

6. Set up the calculator and CBL for data collection.

- Select COLLECT DATA from the MAIN MENU.
- Select TIME GRAPH from the DATA COLLECTION menu.
- Enter “4” as the time between samples, in seconds.
- Enter “25” as the number of samples (the CBL will collect data for a total of 100 seconds).
- Press **[ENTER]**, then select USE TIME SETUP to continue. Note: If you want to change the sample time or sample number you entered, select MODIFY SETUP. Then choose, on the TI-85, “LIVE = LIVE DISPLAY.”
- Enter “0” as the minimum temperature (Ymin).
- Enter “80” as the maximum temperature (Ymax).
- Enter “10” as the temperature increment (Yscl). Do not press **[ENTER]** to begin data collection until Step 8.

7. Get about 150 ml of hot water in a second 250-ml beaker.

Note: In Step 9, you will switch the temperature probe from the cold water to the hot water at exactly 20 seconds after you have begun data collection. This will be done as the fifth data point appears on the calculator screen ( $5 \times 4$  seconds = 20 seconds).

8. When everything is ready, press **[ENTER]** on the calculator to begin data collection. Do not stir or move the water.

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<sup>5</sup> If you are using a Standard Temperature Probe (with a box in the cable), select 1:VERNRR STD TEMP.

9. When exactly 20 seconds have gone by (when the fifth data point appears on the calculator screen), quickly move the temperature probe to the beaker containing hot water and continue data collection. Do not stir the water or move the temperature probe during the remainder of the data collection period.
10. When data collection is complete, press  to display a graph of temperature vs. time on the calculator screen. Use  to examine the data points along the curve.
11. View the calculator data lists and record your temperature data.

Press , then select NO when asked if you want to repeat the trial. Select VIEW DATA from the MAIN MENU (In the PHYSICS program, select QUIT).

TI-73, 82, 83, or 83 Plus Calculators:

To view the data lists, press , then select EDIT. You can use the arrow keys to scroll through the time data (L1) and the temperature data (L2). Record the temperature values in your Data Table (round to the nearest 0.1°C).

TI-85 Calculators:

Press , then select < EDIT > by pressing . Select < L1 > (time) as the xlist Name by pressing  . Select < L2 > (temperature) as the ylist Name by pressing  . The time values are now displayed on the calculator screen as x1–x50 and the temperature values for Part II are stored as y1–y50. Press  to scroll through the data pairs.

TI-86 Calculators:

Press  , then select < EDIT > by pressing . Press  to scroll down through the data lists L1 (time) and L2 (temperature).

TI-89, 92, or 92 Plus Calculators:

To view the data matrix, press , select Data/Matrix Editor, then Current. Use the cursor pad to scroll down through the data lists c1 (time) and c2 (temperature).

## DATA TABLE

| Time<br>(s) | Temp<br>(°C) | Time<br>(s) | Temp<br>(°C) | Time<br>(s) | Temp<br>(°C) | Time<br>(s) | Temp<br>(°C) |
|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|
| 4           | _____        | 32          | _____        | 56          | _____        | 80          | _____        |
| 8           | _____        | 36          | _____        | 60          | _____        | 84          | _____        |
| 12          | _____        | 40          | _____        | 64          | _____        | 88          | _____        |
| 16          | _____        | 44          | _____        | 68          | _____        | 92          | _____        |
| 20          | _____        | 48          | _____        | 72          | _____        | 96          | _____        |
| 24          | _____        | 52          | _____        | 76          | _____        | 100         | _____        |
| 28          | _____        |             |              |             |              |             |              |

Now that you have collected data, would you like to print a graph? If so, go on to Step 5.



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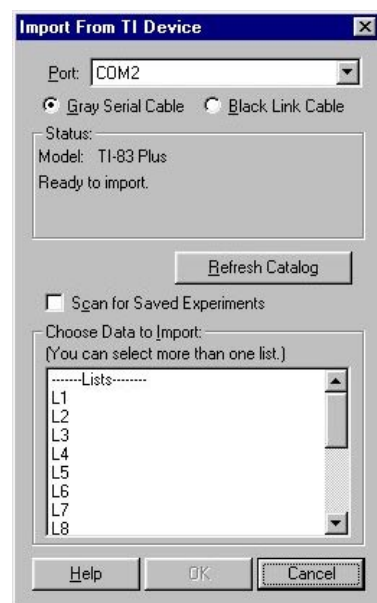
## Step 5: Sending Graphs and Data to Your Computer (optional)

Now that you have collected data, you can, of course, analyze data with your calculator. However, if you wish to analyze the data on a computer or print the data, you will need to use the TI-GRAPH LINK cable to transfer the data back to your computer.


Graphical Analysis and Logger Pro 3 programs are not required for data collection with the CBL. However, most people have found them great tools for directly moving CBL data from the graphing calculator to the computer for graphing and printing. It is also very good for performing mathematical modeling and finding the relationships between variables.

### Importing procedures for TI-73, TI-73 Explorer, TI-83, TI-83 Plus, TI-83 Plus Silver Edition, TI-86, TI-89, TI-92, TI-92 Plus, Voyage 200:

1. Connect the TI-GRAPH LINK cable to a free serial or USB port of the computer and to the TI calculator (see below if you are using the TI-82 or TI-85 models).
2. Turn on the calculator.
3. With Graphical Analysis/Logger Pro running, pull down the File menu and choose Import From → TI Calculator or LabPro/CBL... or click the  button from the toolbar. The dialog box to the right should appear.
4. From the pull-down menu, choose USB port or serial port (COM 1-4 on a PC, modem or printer on a Macintosh) to which the TI-GRAPH LINK cable is connected.
5. If you are using a PC serial cable, identify whether it is a gray or black cable.
6. Click on the Scan for Calculator button. The calculator model you are using should now be identified, and you should see a message, "Ready to Import."
7. Click on the data list(s) that you want to import. (To select more than one list on a Macintosh, hold down the  key while you click).
8. Click OK to send the data lists to the computer. The data will appear in columns in the data table. They will be labeled with the simple list names from the calculator. If you want to re-name them or add units, double-click on the column heading in the data table and enter new labels and units.



### Importing procedures for the TI-82 and TI-85:

1. Pull down the File menu and choose Import From -> TI Calculator or LabPro/CBL... or click the  button from the toolbar.
2. Scan for calculator (if needed).
3. Note message "Waiting for you to transmit data from your calculator...".
4. You can then choose which lists to transmit to the computer. Here's how:

**TI-82:**

On the TI calculator, press  [LINK], then select 2:SelectAll-... from the SEND menu.

Use  to locate the lists on the SELECT menu. Position the arrow in front of a list you want to send to Logger Pro and press  to select it. More than one list may be selected in this manner. A black square will appear beside each list that will be sent. To deselect, press . The black square will disappear.

Press , then select 1:Transmit. The lists will appear in the import window. They will be labeled with simple list names from the calculator.

**TI-85:**

On the TI calculator, press  [LINK], then choose < SEND >. Press , then choose < LIST >.

Use  to locate a list you want to send and choose < SELCT > to select it. More than one list may be selected in this manner. A black square will appear beside each list that will be sent. To deselect, choose < SELCT >. The black square will disappear.

Choose < XMIT > to transmit the list(s) to the computer. The lists will appear in the import window. They will be labeled with simple list names from the calculator.

5. Click on the data list(s) that you want to import. (To select more than one list on a Macintosh, hold down the  key while you click).

6. Click Done to send the data lists to the computer. The data will appear in columns in the data table. They will be labeled with the simple list names from the calculator. If you want to re-name them or add units, double-click on the column heading in the data table and enter new labels and units.