APPENDIX 2
**Using the Casio EA-100 Data Collector
to Collect and Transfer Data**

The Casio EA100 collects and analyzes data using a variety of probes. The EA100 is packaged with three probes: temperature, light, and voltage. It is also possible to purchase additional probes manufactured by Vernier Software and Technology: motion detector, pH sensor, EKG sensor, gas pressure sensor, humidity sensor, oxygen and carbon dioxide sensors. By utilizing this technology, classroom teachers can offer students a wide range of opportunities to explore and discover various everyday natural phenomena in a way most students and teachers have never experienced. Middle and high school students using this kind of technology can begin to see how the mathematics they do in math class can be used to help them better understand the science they discover and learn in science class. The following sections will provide information and instructions for using various probes and channels and explain to you how to connect with the FX2.0 graphing calculator so that you can draw graphs and analyze the data in deeper detail.

**The Casio EA-100 Data Collector connected to
the Casio FX2.0 Graphing Calculator**

The EA100 Keypad

There are eight keys located on the EA100. Below is a brief description of the primary function of each of the keys.

[SHIFT]   Used to activate the yellow print above the function keys. For example, to activate SET UP, located above the MODE key, you would press the [SHIFT] key then the [MODE] key.

[CH-View]   This key is used to switch between various channel displays, CH1, CH2, CH3, SONIC, DIG IN, or DIG OUT, when you are using more than one probe at a time.

[HALT]   Pressing this key will stop or halt the sampling in mid-task and will get you out of the data log setting (collecting data) and back to the communications mode (interacting with the calculator).

[ON/OFF]   This red key turns the power on and off. The EA100 has an auto power shut-off feature. If it shuts off automatically, it can restart/ boot-up as data becomes available for input.

[MODE]   Mode switches you between the collecting data and communicating with the calculator. There are two collection modes, Multimeter and Data Log, and one communication's mode, Transferring Data to a Casio graphing calculator.

[INTERNAL]   This is used to measure the internal voltage created by the 4 AA batteries, to determine if you need to replace the batteries or not. The reading should be around 6 volts.

[DataLOG]   This button is used to enter the data log area, where sample rate and number of samples are important. Repetitive selections of the [DataLOG] button while in the data log mode also allows you to move from choice to choice for sample rate, and number of samples. How to utilize this for your problems will be explained in greater detail in a later section on the data log mode.

[TRIGGER]   The trigger key is used to start the EA100 for sampling data. It is also used to select sample rate and number of samples when in the data log mode.

Three of the keys have gold words above them. These keys serve in two capacities. The word on the key is its primary function and the gold word above the key is its secondary function. The secondary function can only be activated when used in conjunction with the gold [SHIFT] key. The "gold" secondary keys are described below.

[RESTART]   This key, activated by pressing [SHIFT] [HALT] will use the previously selected settings for sample rate and numbers of samples, and then allow you to restart the sampling.

[SET UP]   This key, activated by pressing [SHIFT] [MODE], enters the set up mode for configuring the EA100 for manual stand-alone sampling.

[XMIT-9800]   Pressing [SHIFT][INTERNAL] sends data to the Casio FX-9800G graphing calculator. (We will not use this key since we are using the FX2.0 graphing calculator.)

Two of the keys have grey words above them. The grey words represent the secondary functions for those two keys as well. The secondary use of these keys is not activated by using another key but rather by entering into a particular mode of the

EA100. The [NEXT] and [ENTER] secondary keys written in grey are the secondary use of [DataLOG] and [TRIGGER] when the EA100 is in the SET UP or DataLOG mode. What they do is described below.

[NEXT]   Pressing [DataLog] activates [NEXT] while performing manual set up recalls the next setting for the item you are setting. [SHIFT][DataLOG] returns to the previous value.

[ENTER]   The [TRIGGER] key functions as an [ENTER] key in the SET UP mode. It is used to select values when manually setting up the EA100 in the SET UP mode. Thus pressing [TRIGGER] will enter the depicted value into that area of set up.

Collecting Data

       There are two ways to collect data using the EA100. One is using the Multimeter and the other is using the Data Logger. The Multimeter is used when sample rate and time are unimportant. The Data Logger is used when time is of importance. When you turn on the EA100 "RecTIME" is blinking in the upper left corner, "DONE" appears below that, and a large initial reading from some prior collection is showing on the screen. This area is called the *communications* mode, which is where the EA100 waits for commands or signals from a linked graphing calculator. We will discuss this mode later. To collect data, you will need to be in Multimeter or Data Logger mode. Data collection can occur with or without a calculator connected to the EA100.

       MULTIMETER MODE

☞ With the EA100 turned off, plug in the probe you wish to use for collecting data. It is very important that the EA100 be OFF when you plug in a probe since the EA100 only searches for attached devices when it is initially turned on.

☞ Once you have securely inserted the probe into the EA100, turn the EA100 on by pressing the red [ON/OFF] key.

☞ Press the [MODE] key and you will see MULTIMETER in the lower left corner.

☞ The EA100 immediately begins collecting data using the probe and the collected data can be read directly from the EA100 screen.

☞ Press [HALT] when you have completed your data collection.

When in Multimeter mode you can only read the collected data directly from the screen and the data cannot be sent to the graphing calculator when you are working in Multimeter mode. Since the Multimeter is the simplest way to get an initial probe reading, it is a good place to allow students to practice data collection using various probes. Students will also need to organize the data they collect by using a list or a table, and just writing down what the EA100 reads out to them. For instance, you could use the Multimeter mode to collect data using the light sensor probe. You could have a student stand at various distances from a single light source and collect the readings from the EA100. Students could construct a table with two columns, one listing the distances from the light source and the other listing the data readouts from the Multimeter.

DATA LOGGER
- ☞ For this example we will collect 10 samples of light intensity data using the light sensor probe, collecting a sample every 5 seconds. Thus the sampling rate for this example is 5 seconds and the number of samples is 10. We will use Channel 1 (CH1) as the port for connecting the light sensor probe.
- ☞ With the EA100 turned off, plug in the probe you wish to use for data collection. For this example we are using the light sensor probe in CH1, so plug the white connector into the CH1 port. It is very important that the EA100 be OFF when you plug in the probes since attached devices are only recognized by the EA100 when it is initially turned on.
- ☞ Turn the EA100 on by pressing the red [ON/OFF] key. When the EA100 is first turned on, it is in communications mode. You need to set up the EA100 to receive data whenever you turn it on. To receive data with respect to time, you will use the Data Logger. Press [SHIFT] [MODE] to enter the set up area for the Data Log. On the left side of the screen you will see "READY SAMPLING DONE" blinking and on the right side of the screen you will see a large numeric display followed by a very small time unit, such as seconds or milliseconds.
- ☞ At this screen you will choose the sample rate. The sample rate is the amount of time you want to elapse between each data item collected. Your choices are 1.00 Sec, 2.00 Sec, 5.00 Sec, 10.0 Sec, 20.0 Sec, 30.0 Sec, 60.0 Sec, .000 Sec, 10.0 Msec, 20.0 Msec, 50.0 Msec, 100 Msec, 200 Msec, and 500 Msec. You can view each of these choices by pressing the [DataLOG] key (which actually serves as the [NEXT] key when you are in Data Log mode). When you determine which of the sample rates you prefer, simply press [TRIGGER] (which serves as the [ENTER] key when you are in Data Log mode). For this example we are using 5.0 Sec, so as you press the [DataLOG] key, watch the screen for 5.0. When you see it, press [TRIGGER].
- ☞ Once you have pressed [TRIGGER] to enter your choice, the EA100 automatically enters your choice for sample rate and moves directly to the "number of samples" area. The number of samples is simply how many samples of data you want to collect. For this example, we are collecting 10 samples, 1 sample every 5 seconds. You would want to choose 10 while in this area. The choices for number of samples is 10, 20, 30, 50, 100, and 200. You can view these by pressing the [DataLOG] key and you enter your choice by pressing the [TRIGGER] key. So as you press [DataLOG], look for 10 on the screen, and press [TRIGGER] when you see it to enter this choice.
- ☞ Once you press [TRIGGER] to enter your choice for number of samples, the EA100 automatically takes you to the "time definition" area. There are three choices in this area, and again, you can view these choices by pressing the [DataLOG] key and you enter your choice by pressing the [TRIGGER] key. The three choices are 0, 1, 2. The 0 turns the time recording off. The 0 is rarely used. The 1 means absolute time, indicating that time will be transferred as a list of numbers counting from 0 up to the number of seconds or milli-seconds elapsed for the duration of the sampling, in increments of whatever rate you chose. The 1 is the choice used most often. The 2 is rarely used. It

lists the time relative to the instantaneous change from the last setting. Don't worry if that doesn't mean anything to you, since you won't be using it anyway. When you see 1, press [TRIGGER] to enter the choice.

☞ Once you have entered your choice for sample rate, number of samples, and time definition, you are ready to begin collecting data. "READY" will show on the left side of the screen. By pressing [TRIGGER] again you will begin sampling data. You can tell that the EA100 is receiving data because it will blink "SAMPLING" on the left side of the screen. [HALT] will allow you to stop the sampling and [SHIFT] [HALT] which activates [RESTART] will allow you to initialize or re-setup to the last chosen sample rate and time.

☞ When all samples have been collected DONE will appear on the left side of the screen.

☞ Pressing [DataLOG] will toggle you through each of the data samples. Pressing [CH-View] will switch you between channels if you have more than one probe connected to the EA100.

Transferring Data

The EA100 is essentially a data collection device. It must be used in conjunction with a graphing calculator or computer in order to analyze or interpret the collected data. You will use the "Receive" command on the graphing calculator to bring data from the EA100 into the calculator. Once you have transferred the data, then you can graph it and display it for analysis and interpretation.

☞ Make sure that BOTH the EA100 and the FX2.0 are turned OFF. This is important because the calculator only searches for attached devices when it is initially turned on. With both devices turned OFF, connect the EA100 to the FX2.0 using the black data transfer cord which has two identical ends, each with a gold insertion probe about 2 cm long. It is this gold insertion probe that you insert into the end of the EA100 and the FX2.0. Be sure that the cord is plugged in securely and that it "snaps" into place. The most common error for failure to transfer data is a poor connection of the cord to one or both of the devices. You will not loose your data you have just collected if you turn off the EA100 to connect to the calculator.

☞ Once you have connected the EA100 and the FX2.0, you need to turn both of them ON. Recall that the EA100 starts off in communications mode, which is the mode you need to be in if you want to transfer data to a calculator.

☞ You will need to tell the calculator to receive the data. On the FX2.0, you need to be in the RUN-MAT menu. So press [MENU] then choose [1]. Press [SHIFT] [VARS] and a menu will appear at the bottom of the screen and the choice above [F5] will be I/O for input/output. Press [F5]. A small window will pop up on the left side of the screen and you want to "Receive" data, so press [4]. Showing on the FX2.0 screen will be Receive(, with the cursor blinking behind the opened parenthesis.

☞ The Data Logger collects two different sets of data. The first set is the set of times for which the probe collected data. The second set is the information collected by the probe. The EA100 automatically sends the time data first and the probe-collected data second. To receive the time data you must indicate a

list location for the data to go to. We will use List 1. Press [OPTN], then [F1] for LIST, then [1] for List, then [1] again for List 1, and the right parenthesis [)]. Press [EXE] to receive the time data into List 1. If the transmission was successful, then DONE will appear on the FX2.0 screen.

☞ To receive probe-collected data into List 2, press [SHIFT] [VARS]. Press [F5] for I/O then [4] for Receive. Press [OPTN], then [F1] for LIST, [1] for List, [2] for List 2, and close the parenthesis [)]. Press [EXE] to receive the probe collected data into List 2. When the transmission is complete, DONE will appear on the screen.

☞ To graph and analyze the data, use the *Listing and Graphing Data Using the Casio FX2.0* instructions that are provided with this workbook.