Using the TI-83/83+

Contents

1 Introduction

Mathematics is a visual subject, and graphics calculators can provide the picture in a number of important areas of mathematics. They are also useful in allowing students to explore mathematics numerically and graphically. Graphics calculators are portable, powerful and, for what they do, relatively cheap.

What the TI-83 can do

- all the features of a scientific calculator plus matrices and complex numbers
- multi-line screen, which displays input and output of calculations simultaneously
- recall and editing of previous entries and answers
- ability to graph Cartesian, parametric, polar and sequence graphs
- statistical functions for organising, analysing and displaying data
- programmable, with a large number of programs available for downloading
- can be linked to other calculators, computers and printers for electronic transfer of programs, data, etc and downloading programs from a computer or the web
- can be used in conjunction with a calculator-based ranger (CBR) and calculator-based laboratory (CBL): these enable easy collection of real data, which can be organised, displayed and analysed
- an overhead-projector view screen is available.

Implication for teaching and learning

- a need to think about classroom dynamics
- improved student motivation
- enhanced modelling and exploration opportunities
- the potential for using an 'animated' whiteboard[1] with the overhead-projector view screen

The graphics calculator is a tool that can assist teachers, but there is a need to think about its use in the classroom. We need to take care that we don't hand over all of our teaching to the technology. The technology needs to be used to enhance students' understanding, not replace it. It provides a valuable tool for drawing links between various content strands and to complement traditional tools such as pencil and paper.

[1] Projection of the calculator screen onto a whiteboard provides an 'animated' whiteboard, on which graphs can be annotated, etc using a whiteboard marker.

It is important that teachers remain in control of the learning environment, but the classroom dynamics change — there is more exploration and a problem-solving approach to learning can be encouraged. This may require a change in teaching methodolgy, the teacher becoming a facilitator of student learning by the use of a wider variety of teaching strategies. The whole process needs to be approached with careful thought, as well as a detemination to persevere if early problems arise.

The use of graphics calculators certainly motivates students. It provides them with different ways of looking at mathematics, it is less tedious for a number of necessary tasks, promotes student investigation by allowing them to explore concepts independently and enhances modelling opportunities.

Graphics calculators are also fun. Kids pick up the operations very quickly (much faster than teachers), and if you can't get your students to use a graphics calculator, there are heaps of games to tempt them.

In the beginning

Getting started is always the hardest, especially when you have to learn the new technology and then modify or write new courses. However, this can be an evolutionary process, not an abrupt change. For students, time needs to be spent on 'button-press' activities or by allowing the students to 'play' with the calculator to see what happens. The use of simple numerical investigations can provide a starting point for the development of understanding of the operation of the calculator. Alternatively, the students can be encouraged to use the calculator in conjunction with investigative activities which highlight the various capabilities of the calculator, particularly in areas that are required in the classroom. The students themselves very quickly become valuable resources for using the calculator.

The experience at ADFA and most other schools and universities at which graphics calculators have been used for a while, is that graphics calculators should not just be an add-on to a course, but should eventually be integrated fully, including their use in tests and exams. This raises many issues, most of which are resolvable. You might like to read for example *Graphics calculators in upper secondary courses* by Barry Kissane and *Graphics calculators in the mathematics curriculum: Integration or differentiation?* by Jen Bradley, Barry Kissane and Marian Kemp about their experiences in WA.[2]

[2]Both papers are available at *wwwstaff.murdoch.edu.au/~kissane* under Publications. There are a number of other interesting papers here too.

2 Using the Calculator

2.1 Resetting the calculator

The following notes assume that all the default options are set. If the calculator has been used by someone else, it is a good idea to reset the calculator before proceeding.[3]

Turn on your calculator by pressing ON, bottom left.

Press MEM (2nd +). Press 7 for Reset..., 1 for RAM and 2 to Reset.

If you don't want to reset the calculator, use the MODE and FORMAT (on ZOOM) menus to set each of the defaults (see Section 3).

2.2 Getting started

Turn on your TI-83 by pressing ON, the lowest left key. A flashing black box ■ should appear in the upper left corner of the display screen. This screen is called the *home screen*, and is where you type in calculations and commands. Other screens are the graphics screen, the table screen, the function-entry screen and the program-editing screen.

If this box does not appear you may have to adjust the lighting of the screen. To do this, press and release the yellow 2nd key and then press the blue △. The display is made darker by 2nd △ and lighter by 2nd ▽. Each such key combination changes the screen intensity one "step"; repeat this process (or hold down the arrow key) until the screen is properly lighted.

Notice that most of the keys have yellow words or symbols above them. To access these yellow functions press the yellow 2nd key, then press the desired key for your yellow operation. Do not hold the 2nd key down; it does not act like a shift key. Once you press 2nd, the cursor changes to a ↑. To undo this (e.g. if you change your mind), just press 2nd again.

To access the green letters and characters, you first press the green ALPHA key (the shift key). Now the cursor switches to A. For caps lock, press 2nd ALPHA.

For example, to type the word MATHS, instead of typing ALPHA M ALPHA A ALPHA T..., type in 2nd ALPHA M A T.... Another press of the ALPHA key returns the cursor to normal.

To clear your screen, press the CLEAR key. If you are in the process of entering a line, one press of CLEAR clears the current line. If the current line is already clear and the cursor is at the beginning of a blank line, CLEAR clears the whole screen. DEL deletes the character the cursor is on. INS (2nd DEL) allows you to insert characters. Move the cursor to turn it off.

From now on, we will not necessarily mention 2nd or ALPHA. We will assume that you know to use one of these keys if the key we refer to appears in yellow or green above some other key.

[3]Alternatively, run the DEFAULTS program if you have it. Press PRGM, press the number against DEFAULTS and press ENTER to run the program. Unlike Reset, DEFAULTS does not delete anything.

2.3 Syntax

Calculations are performed by constructing an expression in conventional algebraic syntax (including implied multiplication) and then pressing [ENTER] (which acts as the [=] key). Brackets are used where necessary.

Some examples of acceptable syntax are given below, each of which is different from the equivalent on most scientific calculators (but is similar to the way the expressions are conventionally written). Try each of these on your calculator, observing both the screen display and the final result. It is not necessary to press [CLEAR] before each new calculation. Don't forget the [ENTER].

[2] [(] [5] [x^2] [−] [1] [)] [ENTER]	for $2(5^2 - 1) = 48$ note the implied multiplication
[4] [x^{-1}] [ENTER]	for $4^{-1} = 0.25$
[5] [SIN] [3] [π] [)] [ENTER]	for $5\sin(3\pi) = 0$ implied multiplication again
[3] [∧] [5] [ENTER]	for $3^5 = 243$
[(−)] [2] [−] [(−)] [3] [ENTER]	for $(-2) - (-3) = 1$ note [(−)] and [−] — see below
[√] [3] [)] [ENTER]	for $\sqrt{3} = 1.732050808$ [√] is [2nd] [x^2]
[e^x] [2] [)] [ENTER]	for $e^2 = 7.389056099$ [e^x] is [2nd] [LN]
-1^2 and $(-1)^2$	Which one gives the correct answer?

> The TI-83 makes a distinction between *negative* and *minus*. When you enter 'negative 2', use the grey negative key [(−)] beside [ENTER], not the dark-blue minus key [−] above [+].

2.4 Successive commands

You can construct lengthy commands on the screen if you want before pressing [ENTER], but you can also do chain calculations. The result of the most recent calculation is stored in *Ans*. This is used in chain calculations, and can be recalled using [2nd] [(–)]. As an example, try the following key sequence. Watch where *Ans* is automatically recalled.

[1] [3] [+] [1] [4] [+] [1] [5] [ENTER]

[÷] [7] [ENTER]

[x^2] [ENTER]

[x^{-1}] [ENTER]

[$\sqrt{\ }$] [Ans] [)] [ENTER] note that you have to key in *Ans* here

What is the affect of the following?

[1] [ENTER]

[×] [2] [ENTER] [ENTER] [ENTER] ......

Pressing [ENTER] repeats the previous entry.

2.5 Storing and using numbers in variables (memories)

Memories are named alphabetically, as if variables are being given values. To store a specific value in a variable (or memory), first type the value onto your screen, then press [STO▶], type a variable name ([ALPHA] followed by a single letter), and press [ENTER]. The value stored in the variable will not change unless you store something else in that variable name.

Let's store 3 in variable/memory P and 4 in variable/memory Q:

[3] [STO▶] [ALPHA] [P] [ENTER].

[4] [STO▶] [ALPHA] [Q] [ENTER].

Now try the following (don't forget the [ALPHA] key before each letter):

[P] [ENTER]

[2] [P] [ENTER]

[P] [Q] [ENTER]

[3] [P] [x^2] [Q] [ENTER]

[$\sqrt{\ }$] [P] [x^2] [+] [Q] [x^2] [)] [ENTER]

2.6 Recycling expressions

Next, let's try evaluating $\sqrt{P^2 + 3Q^2}$. Instead of typing it all over again, press $\boxed{\text{ENTRY}}$ ($\boxed{\text{2nd}}$ $\boxed{\text{ENTER}}$). $\sqrt{}(P^2 + Q^2)$ should reappear on the screen. Use the arrow keys and the insert key $\boxed{\text{INS}}$ (on the $\boxed{\text{DEL}}$ key) to change the expression and press $\boxed{\text{ENTER}}$. Thre's no need to move the cursor to the end of the line before pressing $\boxed{\text{ENTER}}$.

> When you press $\boxed{\text{INS}}$, the cursor changes from a flashing box to a flashing underline. That is the visual signal that you are in "insert mode". If you want to get out of insert mode, move the cursor.

$\boxed{\text{ENTRY}}$ returns to the screen whatever was entered last; this expression may be edited before re-evaluating it. If you press $\boxed{\text{ENTRY}}$ again, you will go back to the expression before last, and so on. $\boxed{\text{ENTRY}}$ is a powerful time-saver, especially for complicated expressions that you want to use again, with or without editing. Furthermore, the calculator keeps only *one* previous answer, but will remember as many previous entries as it can, up to 128 characters.

2.7 Using menus

The TI-83 is menu-driven, which explains why the keyboard is relatively uncluttered. For example, many functions are located in the MATH menu. To access this, press $\boxed{\text{MATH}}$ and you will see the four sub-menus displayed, with headings MATH, NUM, CPX and PRB. The arrow keys allow you to move between these.

To access a menu function, press its number (or use the up- and down-arrow keys and $\boxed{\text{ENTER}}$). Generally you construct an expression just as you would on paper. To leave a menu without selecting a function, press $\boxed{\text{CLEAR}}$, which returns you to the home screen. Try the following examples.

$\boxed{7}$ $\boxed{\text{MATH}}$ $\boxed{3}$ $\boxed{\text{ENTER}}$	for $7^3 = 343$
$\boxed{\text{MATH}}$ $\boxed{\blacktriangleright}$ $\boxed{1}$ $\boxed{(}$ $\boxed{2}$ $\boxed{-}$ $\boxed{9}$ $\boxed{\text{ENTER}}$	for $\lvert 2-9 \rvert = 7$: absolute-value function
$\boxed{\text{MATH}}$ $\boxed{\blacktriangleright}$ $\boxed{5}$ $\boxed{3}$ $\boxed{.}$ $\boxed{1}$ $\boxed{)}$ $\boxed{\text{ENTER}}$	for $[3.1] = 3$, greatest-integer function
$\boxed{1}$ $\boxed{5}$ $\boxed{\text{MATH}}$ $\boxed{\blacktriangleleft}$ $\boxed{3}$ $\boxed{4}$ $\boxed{\text{ENTER}}$	for ${}^{15}C_4 = 1365$
$\boxed{\text{MATH}}$ $\boxed{\blacktriangleleft}$ $\boxed{1}$ $\boxed{\text{ENTER}}$ $\boxed{\text{ENTER}}$	successive random numbers on $(0, 1)$
$\boxed{1}$ $\boxed{2}$ $\boxed{\text{MATH}}$ $\boxed{\blacktriangleleft}$ $\boxed{4}$ $\boxed{\text{ENTER}}$	for $12! = 479001600$
$\boxed{2}$ $\boxed{\div}$ $\boxed{7}$ $\boxed{+}$ $\boxed{3}$ $\boxed{\div}$ $\boxed{5}$ $\boxed{\text{MATH}}$ $\boxed{1}$ $\boxed{\text{ENTER}}$	for $2/7 + 3/5 = 31/35$ as a fraction

2.8 Defining and evaluating functions

The top row of keys are for defining and graphing functions, and generating tables of function values.

Defining a function is a simple task. For example, to enter the function $f(x) = x^2$, press [Y=] [X,T,θ,n] [x^2]. The [Y=] key brings up the function entry screen with seven 'empty functions,' Y1 through Y7.[4] The [X,T,θ,n] key provides the appropriate independent variable (X in this case) and the [x^2] key squares whatever precedes it. Note that, when you define a function, the equals sign after its name is highlighted. This means the function is 'selected' for tables and for graphing. We will take up graphing soon.

Next enter $g(x) = x^3$ in Y2 : in the function entry screen, press [ENTER] or [▽] to move to the next line. Then press [X,T,θ,n] [MATH] [3] or [X,T,θ,n] [∧] [3]. Return to the home screen by pressing [QUIT] ([2nd] [MODE]).

Now that we have defined some functions, we need to know how to use them. For example, how do we find out what $g(2)$ equals? g is known to the calculator as Y2, so we have to refer to it by that name.

Press [VARS] and select Y-VARS with the right arrow. That brings up a menu of possible types of function names. So far, we are interested only in the first type, called *Function*, so press [1]. Now you see a list of the possible function names: press [2] to get Y2 on the home screen.

To evaluate Y2 (2), just finish the expression with [(] [2] [)] and then [ENTER]. The calculator should display 8.

Now calculate $g(4)$. You can either repeat the steps we just did — or you can think about an easier way to do this (Section 2.6).

> You can have as many as 10 functions defined at one time, but you may not want to graph them all at once. Turn off ('deselect') any or all of them in the [Y=] screen by moving the cursor over the = sign and pressing [ENTER]. Turn them back on the same way.

[4] There are actually three more, Y8, Y9 and Y0 (scroll down), but only seven fit on the screen.

2.9 Using a table

A quicker way to find a number of function values is to use the table feature. Press Y= to check that you still have both Y_1 and Y_2 selected (selection for graphing also means selection for table-building).

Then press TBLSET (on the WINDOW key) to get the TABLE SETUP screen (the table 'window'). Set *TblStart* (the starting value of X) to 0 and Δ*Tbl* (step size between values of X) to 1. *Auto* should also be selected for both independent and dependent variables (use the cursor and ENTER if not).

Now press TABLE (on the GRAPH key) and see what happens.

Try scrolling the cursor up and down the X column, and watch the changes in the Y_1 and Y_2 columns. In particular, go beyond X = 6 in the downward direction and beyond X = 0 in the upward direction. Move the cursor into the Y columns, and watch what happens at the bottom of the screen. Move the cursor *above* the table in either of the Y columns, and again watch the bottom of the screen. Only two Y columns fit on the screen at once, but if we had more functions defined and selected, they would all get tabulated, and we could find their values by scrolling to the right.

Finally, we can change the spacing of X values in the tables by changing Δ*Tbl* in TABLE SETUP. Try it! Use QUIT to return to the home screen.

2.10 Graphing functions

To graph the formula-defined functions that are selected in the Y= screen, just press the GRAPH key. The default window for graphing (hopefully set) is from −10 (*Xmin*, *Ymin*) to 10 (*Xmax*, *Ymax*)in both the horizontal and vertical directions. You can change that by pressing the WINDOW key. Make the window go from −4 to 4 in the X direction and from −20 to 20 in the Y direction. Press GRAPH again to see the same functions graphed in the new window.

You may find that your Y axis now looks a little funny. Go back to the WINDOW screen. The entries for Xscl (X scale) and Yscl are the distances between tick marks on the axes. With both set at 1, these marks appear at every integer value in both directions. With the Y range now extending 40 units, that's a lot of tick marks. Change Yscl to 5 and graph again. Better?

Move the cursor around the screen with the left- and right-arrow keys. The cursor coordinates are shown at the bottom of the screen.

2.11 Tracing and zooming

Let's try some other keys. With your graph on the screen, press TRACE. A flashing cursor should appear on the first graph half way between the left side and the right side of the screen. (It happens that this point is on both graphs in this case.) Notice that the coordinates of this point on the graph appear at the bottom of the screen. Use the right and left arrows to move along the graph of Y1. Notice the formula for Y1 in the upper left corner. Press the up and down arrows.

To go to a specific X value on the graph (for example to find out the corresponding Y value), just type in the X value and press ENTER. If the value lies in the current WINDOW, the cursor will move there.

Now try ZOOM 6 for *Zoom Standard*. This is an easy way to recover the standard window with Xmin = −10, Xmax = 10, Ymin = −10, and Ymax = 10. Since we started in the standard window in Section 2.10, the graphs are redrawn as we first saw them.

Next try ZOOM 2 to *Zoom In*. A small cursor appears in the middle of the screen, although it may be obsured by the axes. Move it around until you can see it and then press ENTER. The TI-83 now zooms in (magnifies), centred on the spot where you left the small cursor.

Press ZOOM to go back to the Zoom menu. Try *ZBox*; again a small cursor appears on your screen. Move it a bit up and a bit left and press ENTER. The cursor now has a box shape. Move the active cursor down and to the right; the screen displays an outlined box with a fixed mark at one corner and the active cursor at the opposite corner. Move the active cursor to enclose some interesting part of the graphs, and press ENTER again. The graphs are redrawn with your selected box taking up the whole screen.

There are several more types of zooms; read the manual to see what these do. You might like to look at ZOOM MEMORY too.

2.12 Finishing up

If you don't press any keys for five minutes or so, the calculator turns itself off. However, you can also turn it off with (surprise!) 2nd ON. All settings, function definitions, variable values, etc are remembered when the calculator is off. If you turned it off yourself, the next time you turn it on, you will see the home screen, exactly as you left it. If it turned itself off, the next time you turn it on, you will see the screen you were on when it turned off.

3 The MODE and FORMAT menus

First we'll explore the modes of the TI-83: press MODE. Your screen fills with words and numbers. This is actually eight different menus, one per line.

Line 1

This determines how the TI-83 displays numbers. To change this, use the blue arrow keys to position the cursor on **Sci**, for scientific notation, and press ENTER. **Sci** now appears in reverse type, white on black. Press QUIT to leave the Mode screen. Try calculating $22 \div 100$. You should see 2.2E-1, the scientific notation for 0.22. In most calculator and computer systems, "E" (exponent) in a number stands for "times 10 to the power."

Return to MODE. Switch the numerical format back to **Normal**.

Line 2

This line controls the number of decimals displayed. **Float** means no fixed number (the calculator chooses appropriately), while the rest of the line contains numbers to designate the number of decimal places. For example, if you were doing calculations in dollar amounts, you might want everything to appear with two decimal places. Try that now: move the cursor to **2**, press ENTER and QUIT. Press ENTER again to repeat the answer already on your screen. What changes? Enter Mode again, and change the number of decimal places to **6**. Exit from Mode and repeat the previous answer. What changes this time? Change back to **Float**.

Line 3

In the third line, you can choose between **Radian** and **Degree** angle measurement. Be careful! *The wrong setting here is the most common cause of error in graphing and analysing trig functions.*

Line 4

This line indicates the different types of graphs that are possible. We were using **Func** for 'function graphs', $y = f(x)$, and this is the graph mode we will use most of the time. The other modes are parametric, polar and sequence.

Line 5

This controls whether the plotted 'dots' in a graph are connected by lines or not. Change the mode to **Dot** and graph the functions of Section 2.10 using ZOOM Standard. Change back to **Connected**, the default.

Line 6

Sequential means the functions defined are graphed sequentially, whereas **Simul**(taneous) means they are graphed simultaneously.

Line 7

Choose **Real** to work with real numbers only. In working with complex numbers, numbers can be displayed in either Cartesian $(a + bi)$ or polar $(re^{\theta i})$ form.

Line 8

This line determines how the screen is divided up. **Full** is full screen for whatever you are displaying. Select **G–T** and graph again. Press TABLE to move to the table and GRAPH to go back to the graph. Then try TRACE. You need to use the arrow keys appropriate to the graph to move around both the table and the graph.

If you choose **Horiz**, the top half of the screen shows the graph, while the home screen, Table, Y= and Window all use the bottom half of the screen. Full-screen menus (e.g. MODE) will temporarily use the whole screen and then restore the split screen (if it is still selected) when you exit from them.

Summary of MODE

The default MODE settings (the left-hand choices) are just right for most of what we will be doing. If you have any other choices selected, return them all to default settings now. At other times, you may want to return to the MODE menu to change the form of numerical display, angle measurement or graphing options.

FORMAT

Select **FORMAT** (on the ZOOM key). The Format screen works just like MODE.

Line 1

In TRACE, the cursor coordinates can be displayed in Cartesian or polar coordinates.

Line 2

In Sections 2.10 and 2.11, you used the arrows to move around the graphing screen. Each time you pressed an arrow, the cursor location appeared on the screen. If you choose **CoordOff** as part of your format, the cursor will appear and move, but no X-Y values will appear.

Line 3

GridOn tells the calculator to use the tick marks you set on the axes (with Xscl and Yscl) to create a grid on the graph screen. **GridOff** (the default) turns this option off.

Line 4

AxesOn (the default) tells the calculator to display the X axis when it is between Xmin and Xmax and the Y axis when it is between Ymin and Ymax. **AxesOff** turns off the display of axes.

Line 5

This turns on or off the display of axis labels, i.e. the characters x and y. However, the placement of these characters on the screen is not useful, because they appear in strange locations (try it and see); most of us can figure out which is the X axis and which is the Y axis anyway. Leave it set on the default setting **LabelOff**.

Line 6

The last line allows you to turn on/off the equation of the function in the top left corner of the graphics screen when you are in TRACE. Sometimes this expression obscures part of the graph and it is useful to be able to turn it off.

Summary of FORMAT

As was the case for MODE, the default selections (left-hand choices) are just right for what we want to do most of the time. However, there are situations in which we get better information from a plot by, for example, turning on the grid.

4 Further Resources

Contact for more help

We at UNSW@ADFA are happy to help any school (free of charge) with

- backup and assistance in using graphics calculators
- PD sessions at your school on general or specific applications of graphics calculators
- resource materials, programs for any activity and development of materials, in association with teachers.

Peter McIntyre

School of Physical, Environmental
and Mathematical Sciences
University College (UNSW)
Australian Defence Force Academy
Canberra ACT 2600

Email: p.mcintyre@adfa.edu.au
Phone: (02) 6268 8896
FAX: (02) 6268 8786

At ADFA

At *www.unsw.adfa.edu.au/pems/news/high_school/hsc_activities.html*

- A variety of graphics-calculator activities for Years 9 and 10 — written as part of the CQTP Program.
- TI-83/83+ programs and program information.
- *Coordinate Geometry on a TI-83/83+* — basic commands and a variety of problems; Years 9, 10.
- *Population Modelling* — a variety of problems from simple exponential growth to Leslie matrices and difference equations; Years 7–12.
- *Calculus on a TI-83/83+* — basic commands and a variety of problems; Years 11, 12.
- *Matrices on a TI-83/83+* — Year 12.
- *Sequences and Series on a TI-83/83+* — Years 11, 12.
- *Complex Numbers on a TI-83/83+* — Year 12.
- *Introduction to Complex Numbers* — complex numbers from the beginning, covering the basic operations set in the context of complex numbers in Mathematics.
- *The Graphics Screen and Accuracy* — information to help you understand the graphical and numerical limitations of a graphics calculator.
- *Programming a TI-83/83+* — for teachers and Year 12.

Other useful websites

www.prenhall.com/divisions/esm/app/calculator, a terrific site for finding out how to do specific operations on a graphics calculator (all brands).

www.connecting-t3.com.au, the local T^3 (Teachers Teaching with Technology) site. This is a good lead-in to what's available from TI.

www.aamt.edu.au, the AAMT home page is a good starting point for web links, in particular the links to other Maths sites under *3 Resources* / *Members' Sites* / *Mathematical Software and Technology*.

www.eddept.edu.au/graphcalc, the Western Australian Department of Education graphics calculator site, has a list of reviewed resources and, under Support Documents, *Using the TI-83* by M. J. Clark, an introduction for beginners in four separate documents.

smard.cqu.edu.au — a collection of resources from the QAMT, including some graphics calculator activities.

wwwstaff.murdoch.edu.au/∼kissane, Barry Kissane's home page, is another web site of general interest. This page contains some interesting discussion papers under Publications and lots of other useful stuff, including resources.

education.ti.com, the TI site. Unfortunately, most of the resources now cost money. Programs and the GraphLink software, which allows you to connect your calculator to a computer, are still free, and there's heaps of other information about TI graphics calculators. At *education.ti.com/us/product/book/books.html*, under Explorations Series Books, you will find several activities available free in most books.

Acknowledgements

This material has drawn on a variety of sources: from the Graphing Calculator Lab Manual to accompany *Calculus: Modeling and Application* by Lewis Blake, David Smith, Samuel Morris and Lawrence Moore, Heath Publications, 1996; from *Calculating on the TI-82* by Barry Kissane at *wwwstaff.murdoch.edu.au/∼kissane* under Publications; from *Using the TI-83* by M. J. Clark at *www.eddept.wa.edu.au/graphcalc/sup*; and from *Integrating the Graphic Calculator into Year 9 and 10 NSW Mathematics Syllabus*, T^3 Australasia, 1998.