Using the CFX-9850GB

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ADFA **CMA**

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 CFX-9850 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 data logger (EA-100): this enables easy collection of real data, which can be organised, displayed and analysed on the calculator
- 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 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.

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

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

be encouraged. This may require a change in teaching methodology, 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 on allowing 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]

These materials may be printed and copied for use by teachers and students for non-commercial educational purposes only.

[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.

Turn on your calculator by pressing [AC/ON], in the right-hand column of keys. The MAIN MENU screen should appear. This is where you choose what you want to do. You can always return here by pressing the [MENU] key (under [F4]).

Use the arrow keys to highlight the MEM icon (bottom right). Press [EXE]. Select Reset and press [EXE]. Press [F1] to reset the calculator.

> If the screen is too light or too dark, you should adjust the contrast of the screen. To do this, press the [cos] (E) key. Select CONTRAST with the down-arrow key if it is not already selected and press the right-arrow key to make the screen darker. Press [MENU] to return to the MAIN MENU.

If you don't want to reset the calculator, use the SETUP menu to set each of the defaults (see Section 3).

2.2 Getting started

Notice that many of the keys have yellow words or symbols above them. To access these yellow functions press the yellow [SHIFT] key, then press the desired key for your yellow operation. Do not hold the [SHIFT] key down; it does not act like a shift key for capital letters.

First we'll do some calculations, so select the RUN screen with the arrow keys and press [EXE], or just press [1].

Try calculating π^2: press [SHIFT], then [π] (the yellow function of the [EXP] key at the bottom), and then [x^2]. Now press [EXE].

To access the red letters and characters, you first press the red [ALPHA] key. The cursor switches to [A] (and several options appear at the bottom of the screen). To lock in the letter keys, press [SHIFT] [ALPHA]. Another press of the [ALPHA] key returns the cursor to normal.

To clear your screen, press the [AC/ON] key.

From now on, we will not necessarily mention [SHIFT] or [ALPHA]. We will assume that you know what to do if the character or operation we refer to appears in yellow or red above a key.

2.3 Syntax

Calculations are performed by constructing an expression in conventional algebraic syntax (including implied multiplication) and then pressing [EXE] (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 [AC/ON] (CLEAR) before each calculation. Don't forget the [EXE].

[2] [(] [5] [x^2] [−] [1] [)] [EXE]	for $2(5^2 - 1) = 48$ note the implied multiplication
[4] [x^{-1}] [EXE]	for $4^{-1} = 0.25$ [x^{-1}] is [SHIFT] [)]
[5] [SIN] [3] [π] [EXE]	for $5 \sin 3\pi = 0$ implied multiplication again
[3] [$\wedge$] [5] [EXE]	for $3^5 = 243$
[(-)] [2] [−] [(-)] [3] [EXE]	for $(-2) - (-3) = 1$ note [(-)] and [−] — see below
[$\sqrt{}$] [3] [EXE]	for $\sqrt{3} = 1.732050808$ [$\sqrt{}$] is [SHIFT] [x^2]
[e^x] [2] [EXE]	for $e^2 = 7.389056099$ [e^x] is [SHIFT] [ln]
[1] [$a^{b/c}$] [2] [+] [3] [$a^{b/c}$] [4] [EXE]	for $\frac{1}{2} + \frac{3}{4} = 1\frac{1}{4}$ as a fraction
[d/c] ([SHIFT] [$a^{b/c}$])	to toggle between proper and improper fractions
[F↔D]	to toggle between fraction and decimal
-1^2 and $(-1)^2$	Which one gives the correct answer?

> The calculator makes a distinction between *negative* and *minus*. When you enter 'negative 2', use the negative key [(-)] beside the [EXE] key, not the minus key [−] above the [EXE] key.

2.4 Successive commands

You can construct lengthy commands on the screen if you want before pressing [EXE], 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 [SHIFT] [(-)]. As an example, try the following key sequences. Watch where *Ans* is automatically recalled.

[1] [3] [+] [1] [4] [+] [1] [5] [EXE]

[÷] [7] [EXE]

[x^2] [EXE]

[x^{-1}] [EXE]

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

What is the affect of the following?

[1] [EXE]

[×] [2] [EXE] [EXE] [EXE] ...

Pressing [EXE] 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 [→], type a variable name ([ALPHA] followed by a single letter) and press [EXE]. 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 Q:

[3] [→] [ALPHA] [P] [EXE]

[4] [→] [ALPHA] [Q] [EXE]

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

[P] [EXE]   [2] [P] [EXE]   [P] [Q] [EXE]

[3] [P] [x^2] [Q] [EXE]   [$\sqrt{}$] [(] [P] [x^2] [+] [Q] [x^2] [)] [EXE]

2.6 Recycling expressions

Next, let's try evaluating $\sqrt{P^2 + 3Q^2}$. Instead of typing the first part of this again, press the left or right arrow. $\sqrt{(P^2 + Q^2)}$ should reappear on the screen. Use the arrow keys and the insert key [INS] (on the [DEL] key) to change the expression and press [EXE]. There's no need to move the cursor to the end of the line before pressing [EXE].

> When you press [INS], the cursor changes from a flashing underline to a flashing 'picture frame'. That is the visual signal that you are in insert mode. If you want to get out of insert mode, move the cursor.

2.7 Using menus

The calculator is mostly menu-driven, which explains why the keyboard is relatively uncluttered. Many of the functions used in maths calculations are accessed by pressing the [OPTN] key while in the RUN screen (and most other screens). You then see a whole lot of sub-menus displayed at the bottom of the screen; these you access by pressing the appropriate F key in the top row of keys. [F6] is opposite a right arrow, which indicates that there are more sub-menus.

Press [F6] now and select the NUM sub-menu by pressing [F4]. The commands in the NUM menu are now displayed. We will use some of these in the first few calculations below.

Abs [(] [2] [−] [9] [)] [EXE]	for $\lvert 2-9\rvert = 7$, the absolute-value function
Int [3] [.] [1] [EXE]	for $[3.1] = 3$, the greatest-integer function

Now press [EXIT] to go back one level of menus. Select the PROB menu for the next few calculations.

[1] [5] nCr [4] [EXE]	for $^{15}C_4 = 1365$
Ran# [EXE] [EXE] [EXE] ...	for successive random numbers on $(0, 1)$
[1] [2] $x!$	for $12! = 479001600$

2.8 Defining functions

Press [MENU] to return to the MAIN MENU.

Press [7] or use the arrow keys and [EXE] to select TABLE. This takes you to the Table Func screen where you enter functions. We could achieve the same thing by selecting the GRAPH.[3]

Defining a function is then a simple task. For example, to enter the function $f(x) = x^2$,

[3]Functions for tables are the same as functions for graphs.

press X,θ,T x^2. The first key provides whatever independent variable is appropriate (X in this case), and the second squares whatever precedes it. Press EXE to store the function definition. 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 in the next section.

Next enter $g(x) = x^3$ as Y2: press X,θ,T ∧ 3 EXE.

You can have as many as 20 different 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 function screen using F1 (SEL). Turn them back on the same way. Delete them using F2 (DEL).

2.9 Using a table

Check that you still have both Y1 and Y2 selected. Then press RANG (F5) to specify what range of values we want in our table.

Set Start to 0, End to 20 and Pitch, the step in the X values, to 1, pressing EXE after each. Press EXIT to return to the previous screen and then TABL (F6) to display the table. Scroll with the arrow keys.

Up to three Y columns fit on the screen at once, but if we had more functions selected they would all get tabulated and we could find their values by scrolling to the right.

To change either the function definition or table range, press FORM (F1). F5 and F6 allow you to go straight to a graph of the functions, either as a line plot (G·CON) or a point plot (G·PLT). If you generate a graph this way, F6 (G↔T) takes you back to the table.

2.10 Graphing functions

Press MENU and select GRAPH to take you to the Graph Func menu. You should see the functions you defined for the table. Press F6 (DRAW) to display the graph. If a sensible viewing window was set, you should see both curves.

You can change the window by pressing F3 (V-Window) if a graph is displayed or SHIFT F3 if it isn't. Note three preset windows at the bottom. Press each of INIT, TRIG and STD to see their effect.

Here we'll do it manually. Make the window go from -5 to 5 in the X direction and from -20 to 20 in the Y direction, pressing EXE after each new entry.

Press EXIT and DRAW 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 (F3). The entries for scale determine where tick marks are placed 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 the Y scale to 5 and graph again. Better?

2.11 Tracing and zooming

Let's try some other keys. With your graph on the screen, press F1 (Trace). A blinking cursor will appear on the left-hand end of the first graph, although here it is hidden by the formula for Y1. Notice that the coordinates of this point appear at the bottom of the screen. Use the right arrow to move the cursor along the graph of Y1. Press the up and down arrows to see what they do.

Next try F2 (Zoom) and F3 (IN) to zoom in (magnify). The calculator now zooms in on the spot where the cursor was. Move the cursor to a different spot on the screen and press IN again. OUT works in the same way, but zooms out.

Now try BOX. Move the cursor a bit up and a bit left and press EXE. Move the cursor down and to the right; the screen displays an outlined box with a fixed mark at one corner and the cursor at the opposite corner. Make the box enclose some interesting part of the graph and press EXE again. The graphs are redrawn with your selected box taking up the whole screen.

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!) SHIFT AC/ON. All settings, function definitions, variable values, etc are remembered when the calculator is off.

3 The SETUP Menu

Press MENU. Select RUN and press SET UP (SHIFT MENU).

Mode

Selects the number base you are using in your calculations. **Comp** for general computations is the default.

Func Type

Determines the type of function to graph: standard graphs (Y=), polar graphs (r=), parametric graphs, vertical-line graphs (X=C) or inequality graphs (press F6 to see these).

Draw Type

Sets a connected (line) graph (**Con**) or a point graph (**Plot**).

Angle

Set either degrees or radians.

Coord

Earlier in Trace you used the arrow keys to move along graphs, with the cursor location shown at the bottom of the screen. If you choose **Off** here, the cursor will appear and move, but no X and Y values will appear.

Grid

On tells the calculator to use the tick marks you set on the axes (with scale) to create a grid on the graph screen. Try it now — press MENU 5 and DRAW to display the graph. Return to the SETUP menu when you have finished. **Off** (the default) turns this option off.

Axes

On (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. **Off** turns off the display of axes.

Label

On turns on 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 can 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 **Off**.

Display

This controls how numbers are displayed. Selecting **Fix** and choosing a number of decimal places displays all numbers with the specified number of decimal places. This is useful, for example, if you are working with dollars and cents (Fix 2).

Select **Sci** for scientific notation, '2' for the number of significant digits and press EXIT. Try calculating $22 \div 100$. You should see 2.2E-01, the scientific notation for 0.22. In most calculators, 'E' (exponent) in a number stands for 'times 10 to the power'. Return to SET UP. Switch *Display* back to **Norm1**. With **Norm** selected, the calculator displays an appropriate number of digits and changes to scientific notation when needed.

4 Further Resources

Contact for more help

Peter McIntyre

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

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

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 for Sharp, Casio and TI calculators.
- *The Graphics Screen and Accuracy* — information to help you understand the graphical and numerical limitations of a graphics calculator.
- *Coordinate Geometry on a CFX-9850GB* — basic commands and a variety of problems, suitable for Years 9 and 10.
- *Population Modelling* — a variety of problems from simple exponential growth to Leslie matrices and difference equations, covering Years 7–12.
- *Sequences and Series on an CFX-9850GB* — basic commands and a variety of problems, suitable for Years 10–12.
- *Matrices on an CFX-9850GB* — suitable for Years 11 and 12.
- *Calculus on an CFX-9850GB* — suitable for Years 11 and 12.
- *Complex Numbers on a CFX-9850* — suitable for Year 12.
- *Introduction to Complex Numbers* — complex numbers from the beginning, covering the basic operations, but set in the context of complex numbers as a mathematical structure.

Other useful websites

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*.

world.casio.com/edu — the Casio education web site.

www.casio.edu.shriro.com.au — the Australian Casio web site, with activities, books and programs.

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

www.eddept.edu.au/graphcalc, the Western Australian Department of Education graphics calculator web site. Look under Support Documents.

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

Acknowledgements

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