

Introduction to TI Graphic Calculator

A. TI 83

1. NOTATION

The keys on this machine do up to 3 different things. The yellow 2nd key performs the function in yellow above left of a key, the ALPHA key displays the symbol in green above right of a key. The TI is a menu driven calculator, pressing $Y =$, WINDOW, ZOOM, MATH, STAT, MATRX, PRGM, VARS, MODE or pressing 2nd TEST, ANGLE, LIST, DRAW, CATALOG brings up a menu onto the screen. You select an item from the menu by pressing the number of the item wanted, or by using the arrow buttons to move the cursor to the item wanted and pressing ENTER. Use 2nd QUIT to leave a menu screen.

A keying sequence is always read from left to right; spaces are left between keystrokes or menu items except for numbers. To enter the cube root, $\sqrt[3]{}$, press MATH, then press 4, we will write $\sqrt[3]{}$. A table giving the names of functions is in the back of the manual. TI answers are underlined in the following examples.

2. ARITHMETIC CALCULATIONS

The TI calculator is algebraic; operations are performed in order from left to right. First exponentiation, then multiplication and division, then addition and subtraction. Parenthesis must be used to change the algebraic order. Use $(-)$ for a negative number and $-$ for subtraction. Use ENTER to perform a calculation.

ex. $4 \times 2 + 3 \times 5$ ENTER 23
 $4 \times (2 + 3) \times 5$ ENTER 100
 $4 + 8 \div 2$ ENTER 8
 $(4 + 8) \div 2$ ENTER 6

3. EDIT

The TI has some of the same features as a word processor. A blinking box determines the current position on the screen. DEL deletes the symbol blinking at the cursor. INS inserts a symbol before the one blinking at the cursor. The arrow keys move the cursor around the screen. After an expression has been evaluated by pressing the ENTER key, it may be retrieved by pressing 2nd ENTRY. A copy of the previous line is displayed on the screen and can be edited and reevaluated.

ex. Enter $123 + 456$
Change to $133 + 456$ use \blacktriangleleft to move cursor to 2, type 3
Change to $1233 + 456$ use \blacktriangleleft to move cursor to first 3, then press 2nd INS 2
Change to $123 + 456$ use DEL
ENTER 579
Press 2nd ENTRY the expression is copied on the next line
Change to $123 - 456$ use \blacktriangleleft to move cursor to +, then type $-$.

ENTER -333.

4. EVALUATE A FUNCTION (ASSIGN numbers to memory)

Variables are represented as single alphabetic characters A through Z, plus θ . Enter the value or expression you want to store. Press STO ►, we will write STO. The instruction \rightarrow is entered into the text at the cursor location. Press the letter n to name the storage area (Press ALPHA first, the TI is not in ALPHA mode). Press ENTER.

Store 0 (zero) to clear a memory.

Store a new value to overwrite a previous value.

Use ENTER to retrieve a memory value.

An algebraic expression may be stored in a standard memory, but it will be evaluated for the current numeric value of the variables. Changing A and B now will not change C.

ex. 12.32 STO ALPHA A ENTER 12.32 stores 12.32 in storage area A

ALPHA A ENTER 12.32 retrieves the number in A

ALPHA A + 15 STO ALPHA B ENTER 27.32 stores 12.32 + 15 in B

5 STO ALPHA A ENTER changes the value of A to 5

0 STO ALPHA A ENTER clears the memory

ex. 2 STO ALPHA A ENTER stores 2 in memory area A

3 STO ALPHA B ENTER stores 3 in memory area B

ALPHA A \wedge 2 - 2ALPHA A \times ALPHA B + 1 STO ALPHA C ENTER -7 stores the polynomial $A^2 - 2AB + 1$ in C and evaluates it for the given values of A and B. The number -7 is now stored in C. Changing A and B now will not change the value of C.

5. USING THE Y = EDIT SCREEN

This screen allows you to define functions and save them for future use. Press Y = to access this screen. The display shows labels for ten functions. To define a function place the cursor to the right of the = for the selected function, enter the expression using the X, T, θ key or any other alphabetic characters. Press ENTER to move to the next function. To clear a function, place the cursor on the first character in the expression (the character to the right of the equal sign) and press clear.

ex. To enter $x^2 + 1$ in Y_1 and $\sin x$ in Y_2 , press Y =. If necessary, press CLEAR to clear Y_1 . Press $Xx^2 + 1$ ENTER $\sin X$ ENTER. These functions are now stored for use with other operations.

6. BUILDING TABLES: EVALUATING FUNCTIONS

The algebraic expression is stored in the Y = menu. The values of the variable are stored as above. Change the variable then evaluate the expression for these different choices of the independent variables.

ex. Press Y = then type $X \wedge 2 + 2X - 1$ in Y_1 ENTER. 2nd QUIT

2 STO X ENTER

VARS► place the cursor on 1: FUNCTION. ENTER ENTER ENTER 7

to evaluate the same function at $x = 3$, $x = 4$ and $x = -2$,

3 STO X ENTER

VARSP▶ 1 1 ENTER 14

4 STO X ENTER

VARSP▶ 1 1 ENTER 23

(-)2 STO X ENTER

VARSP▶ 1 1 ENTER -1

7. BUILDING TABLES

The TI 83 has a built in Table function used to evaluate functions for different values of x . The algebraic expression for the dependent variable is stored in the Y-menu. The minimum value for x in the table and the increment value is set on the table setup screen, or you can enter the independent values for x by setting Ask.

ex: Enter $X^2 + 2X - 1$ in Y_1

Press 2nd Tbl Set. Set the following values:

Tblstart = 1, Δ Tbl = 1, Input: Auto, Depend: Auto

Press 2nd TBL—A table of values for $x^2 + 2x - 1$ is displayed for 7 values of x .

8. RANGE

As the graphics screen is a finite size, we can only view part of the graph of most functions. We determine the part that we want to look at, called the viewing window, with the WINDOW menu. Press WINDOW. The settings for X min and X max give the domain of the function while the settings for Y min and Y max give the range. The Scl (scale) entries give reference marks on the X and Y axis. They do not affect the graph itself. Scl settings of 0 leave the axis unmarked.

a) To change the WINDOW values, press WINDOW to see the menu and current settings. Use the arrow keys to move to the digit that you want to change. Type over it or use DEL. Use ENTER to move to the next line. To leave the WINDOW edit screen, select another screen or press 2nd QUIT.

Special viewing rectangles can be accessed from the ZOOM menu.

b) ZOOM 6 sets X to $[-10, 10]$ and Y to $[-10, 10]$. This is called the STANDARD viewing rectangle.

c) ZOOM 7 ENTER sets X to $[-2\pi, 2\pi]$ and Y to $[-3, 3]$. On this rectangle the standard trig functions display entire periods.

d) ZOOM 4 ENTER sets X to $[-4.7, 4.7]$ and Y to $[-3.1, 3.1]$ this is the DEFAULT range on other calculators. Each pixel is 0.1 unit.

e) ZOOM 5 sets X to the values that make pictures their true shape. The Y values remain the same as the previous setting. This range is called SQUARE.

9. GRAPH

a) Functions

ex: To graph $y = \ln(x - 5)$,
Press $Y =$ CLEAR $\ln(X - 5)$
GRAPH

If you don't like the picture, change the window.

Try WINDOW 4 ENTER 10 ENTER 1 ENTER (-)5 ENTER 5 ENTER 1 GRAPH

You may change the shape of the graph by changing the WINDOW ENTER ENTER ENTER ENTER (-)2 ENTER 2 GRAPH

b) You may graph up to 10 functions at a time using the $Y =$ screen. Each function to be graphed must be selected.

c) Points

1) The Free-Moving Cursor

You can use the arrow keys to move the cursor point around the graph. The point starts at the center of the viewing rectangle. As the cursor moves, its current coordinate values are displayed at the bottom of the screen. This cursor moves on the pixels on the screen, its values will be close but might not satisfy the equation being graphed. The values are accurate to within the size of a pixel.

2) Drawing a point

To turn on a point while a graph is displayed, press GRAPH

2nd DRAW ► Points 1

Then move the cursor to the point you want drawn

Press ENTER. The point is drawn.

You can also enter the coordinates of the point on the home screen. Start with a clear screen. Set the window at STANDARD in the ZOOM menu. CLEAR to return to home screen. Turn off all functions in $Y =$ menus. Press 2nd DRAW ► ENTER 2, 3) ENTER. The point 2,3 is marked on the graph screen.

iii) Drawing a line segment.

To draw a line segment on the graph screen

Press 2nd DRAW 1

2nd DRAW 2

Move the cursor to the beginning point of the line ENTER

Move the cursor to the end point of the line ENTER

The line is drawn between the 2 points.

To use the home screen press CLEAR CLEAR

Press 2nd Draw 2

Complete the instruction Line (X beg, Y beg, X end, Y end)

ENTER to see the line.

ex. Turn off all functions in $Y =$ menu. 2nd QUIT
 Press 2nd DRAW 1 ENTER to clear the graph screen, Done.
 Use ZOOM 4 to set the decimal window
 CLEAR to return to the home screen
 2nd DRAW 2 screen shows Line(
 3, 2, 1, 2) ENTER CLEAR
 2nd DRAW 2 screen shows Line(
 1, 2, 0, 0) ENTER CLEAR
 2nd DRAW 2 screen shows Line(
 0, 0, 3, 2) ENTER You have drawn a triangle

These values are not saved. If you change the Range they are erased and you must start over. 2nd DRAW 1 clears the graph screen.

10. INTERSECTIONS

When two or more functions are plotted on the same screen, the points they have in common are called intersections. When a function intersects the x axis, these intersections are called roots or zeros of the functions.

After a graph is drawn, press TRACE. A cursor (blinking star) appears on the graph near the middle of the screen, and the coordinates of this pixel are displayed on the bottom of the screen. Remember, the cursor is on a pixel and may not exactly satisfy the equation. The cursor can be moved with the left and right arrow keys until it lies on an intersection. The cursor can be moved from one curve to the other using the up and down arrow keys.

ex. To graph $y = x^2 - 2$ and $y = x + 1$ on the same screen.
 Set the range by pressing ZOOM 6 CLEAR
 Press $Y =$ and enter $X \wedge 2 - 2$ in Y_1 ENTER
 enter $X + 1$ in Y_2 ENTER GRAPH
 to get a better picture of the graphs, change the window to $[-5, 5] \times [-5, 5]$
 GRAPH TRACE

The blinking cursor is at the vertex of the parabola and its approximate coordinates are displayed at the bottom of the screen. Use the left arrow key to move the cursor to the left intersection. The co-ordinate values are approximately $x = -1.28$, $y = -.37$. Use the right arrow key to move the cursor to the right intersection. The co-ordinate values are approximately $x = 2.23$, $y = 2.99$. Now check your work algebraically.

$$x^2 - 1 = x + 1 \text{ so } x^2 - x - 3 = 0$$

$$\text{Using the quadratic formula } x = \frac{1 \pm \sqrt{13}}{2} \approx 2.303, -1.303$$

This should give you another way to solve the equations graphically. If you plot $y = x^2 - x - 3$ and find its roots, you should get the same x values as before.

Press $Y = \blacktriangleleft$ ENTER \blacktriangledown ENTER \blacktriangleright $X \wedge 2 - X - 3$ ENTER GRAPH TRACE use \blacktriangleleft to

move the cursor to the left intersection read $x = -1.27$.

Use ► to move the cursor to the right intersection read $x = 2.34$.

Now to find the y values of the intersections, we need to evaluate either function for the y values. CLEAR CLEAR

-1.27 STO X ENTER -1.27

$X + 1$ STO ALPHA Y ENTER $-.27$ is the Y value

2.34 STO X ENTER

$X + 1$ STO ALPHA Y ENTER 3.34 is the Y value

Note that these values are approximate as we have the position of the cursor on a pixel, not the exact value of the intersection. If we want better accuracy, we can enlarge the picture.

11. ZOOM

A zoom in shows a smaller piece of the graph.

A zoom out shows a larger piece of the graph.

Press the key ZOOM for the Zoom menu.

There are 3 ways to Zoom on the TI 83.

- Change the window settings with the Window menu.
- In the zoom menu, use item 2 to zoom in or item 3 to zoom out. The X Fact and Y Fact settings in item 4 determine the amount of magnification. The default value is 4 for both settings. The center of the new screen is centered at the cursor on the original screen.
- Use the Zoom Box, item 1 in the Zoom menu. Use the cursor to select opposite corners of a rectangle. The graph is replotted using that rectangle as the new viewing window.

ex. Graph the functions $y = x^2 - 2$ and $y = x + 1$ on the same screen in the Decimal Window. Enter $x^2 - 2$ in Y_1 , $x + 1$ in Y_2 GRAPH ZOOM 4. Use TRACE to move the cursor to the intersection. If necessary, set X FACT = 4 and Y FACT = 4 (ZOOM 4 ENTER 4 ENTER) ZOOM 2 ENTER TRACE

Move the cursor to the left intersection with ◀

Read $x = -1.3$, $y = -.31$ approximately. Press ZOOM 2 ENTER the graph is retraced on the new axis with the cursor in the center. Continue in this manner until you have the desired accuracy.

Pressing ZOOM 3 ENTER will reverse the process and enlarge the picture.

ex. ZOOM using the ZOOM BOX

Return to standard viewing screen ZOOM 6

Decide what area you want enlarged. ZOOM 1

Move the cursor to the lower left corner of this area. ENTER

Move the cursor to the upper right corner of this area.

(As you do this a box is drawn). ENTER

You may now trace to the intersection.

12. CALCULUS

a) To find the numeric derivative at a point.

ex. Find $f'(x)$ for $f(x) = x^3 + 2x$

Press MATH 8 $x^3 + 2x$, X, 2) ENTER 14.000001

b) To find the definite integral

ex. $\int_1^2 x^2 dx$

MATH 9 Xx^2 , X, 1, 2) ENTER 2.333333333

MATH ENTER ENTER 7/3

13. PROGRAMMING

The program menu PRGM accesses the program operations: Execute, Edit and New for the program spaces 1–0, A–Z and θ .

A program consists of program commands, a colon indicates the beginning of each command. The commands and symbols needed for the program are keyed in using a key from the keyboard or from a menu. Commands can *not* be spelled out while you are in program mode. (The TI is a numeric calculator.) While you are in Program mode, pressing PRGM accesses a set of menus containing programming instructions.

To begin a program, press PRGM ►► 1, type in a title (the TI is in ALPHA mode) and press ENTER. Enter each command on a new line after the colon, press ENTER to go to the next line. When you have finished, press 2nd QUIT to return to the Home screen.

To execute the program, begin on the Home screen. Press PRGM, select the program you want and press ENTER. To break a program during execution press ON and hold J down until the Error screen is displayed. To edit the program press 1, to end the program press 2.

14. USEFUL PROGRAMS

Programs are listed in the Applications Chapter 15 of the Manual.

Remember that the commands must be entered from a menu screen. The table of commands with their key strokes is in the manual starting on page A-2 in the back of the book in Appendix A.