

TI-83+/TI-84 Tutorial: The Basics, Graphing, and Matrices

In this tutorial, I will be assuming you have never used a TI graphing calculator before. We will cover what you would need in a basic algebra or precalculus class. Detailed answers/keystrokes for all examples are at the end of each section.

If you are following this tutorial on a TI-84 calculator you may have Mathprint installed. Turn Mathprint off if you want to follow the keystrokes given in the answers. You can turn Mathprint off by going to [MODE] and pressing the [UP ARROW] key until MATHPRINT is highlighted. Use the [RIGHT ARROW] key so that CLASSIC is highlighted instead and press [ENTER]. Now that Mathprint is turned off, use [2nd][MODE] to go back to the home screen.

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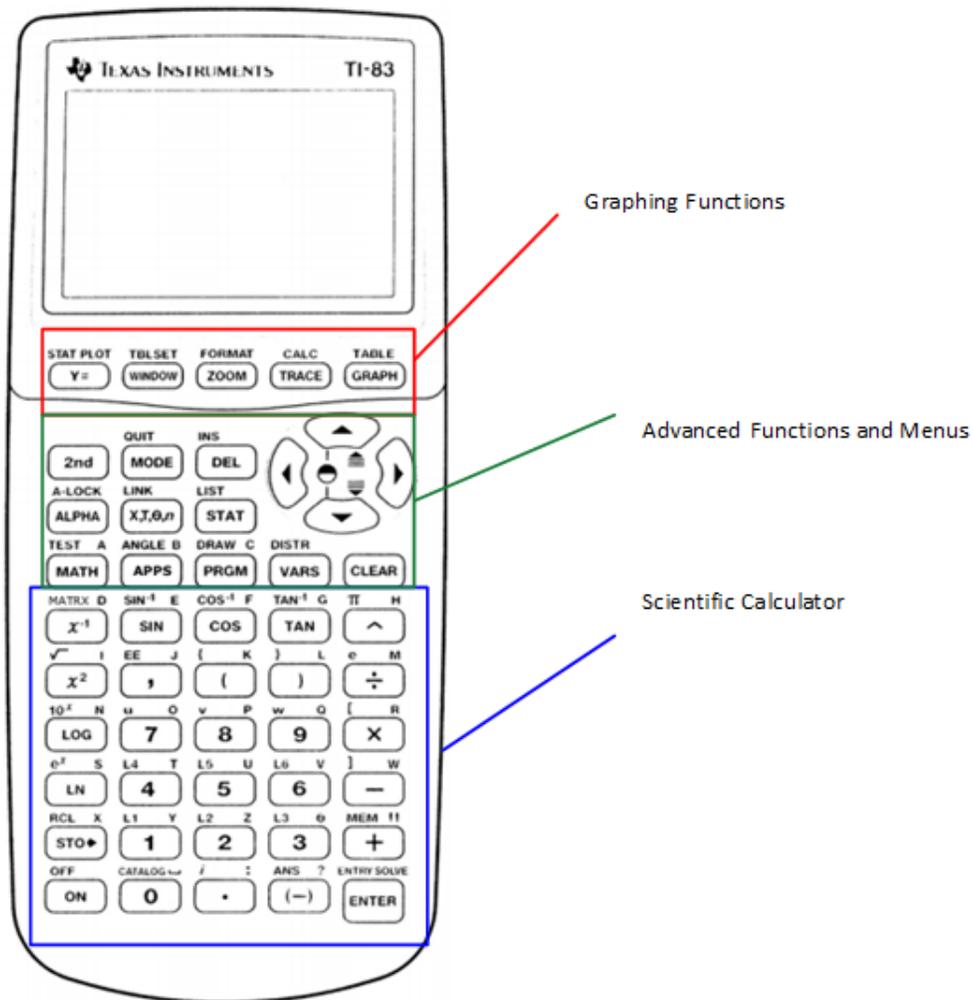
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I. Basic Layout and Functions

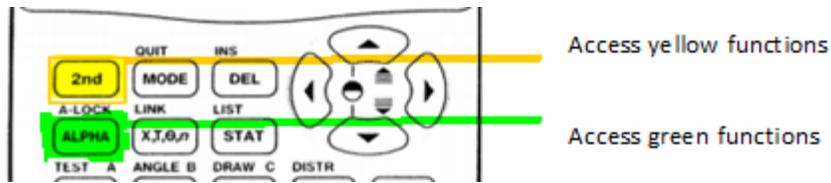
Basic Layout – First Look:

Before you even turn on your calculator, look at how it is organized.

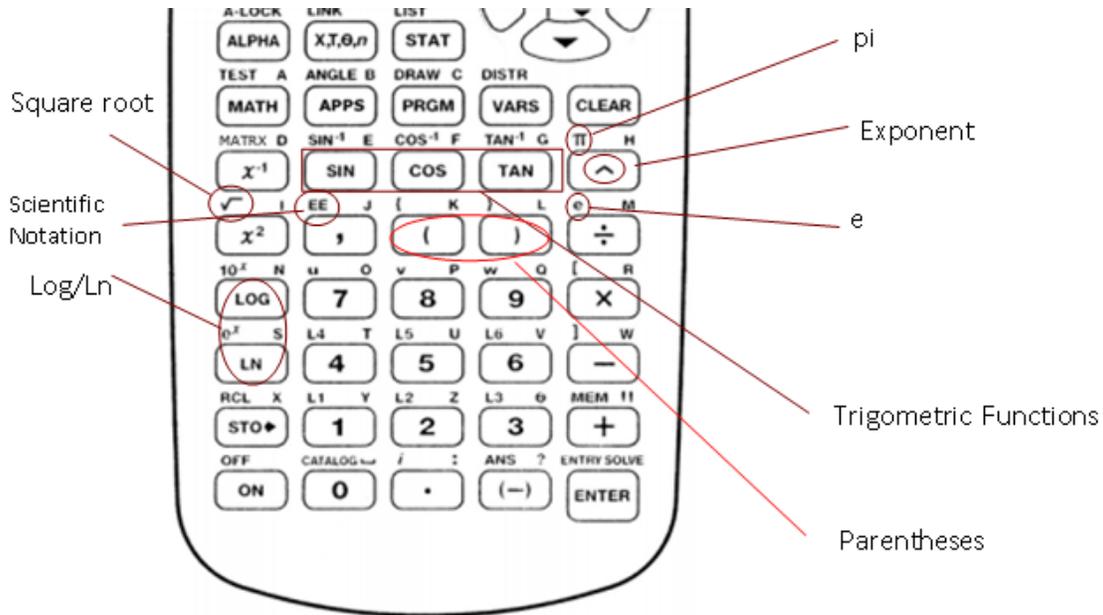
The TI-83 can be divided roughly into three sections: Graphing is along the top row, advanced functions and menus is the top middle, and the scientific calculator takes up the bottom half.



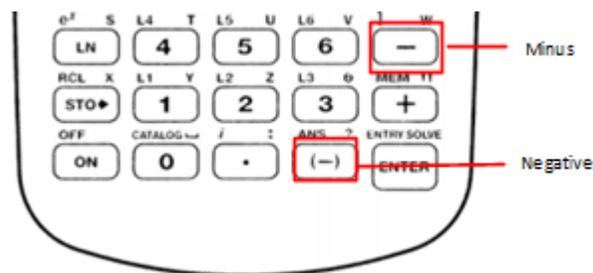
Above every key you'll see a secondary function in yellow lettering (blue on a TI-84) or green lettering. To access them, press the [2nd] or [ALPHA] keys first. This is the equivalent of shift on a keyboard.



In the bottom half you have basic operations and constants. I've marked a few common ones.



It is important to note that there is a difference between “negative” and “minus”. Negative has one operand and minus has two operands. For instance, “2 minus 1” versus “negative 2 minus 1”.



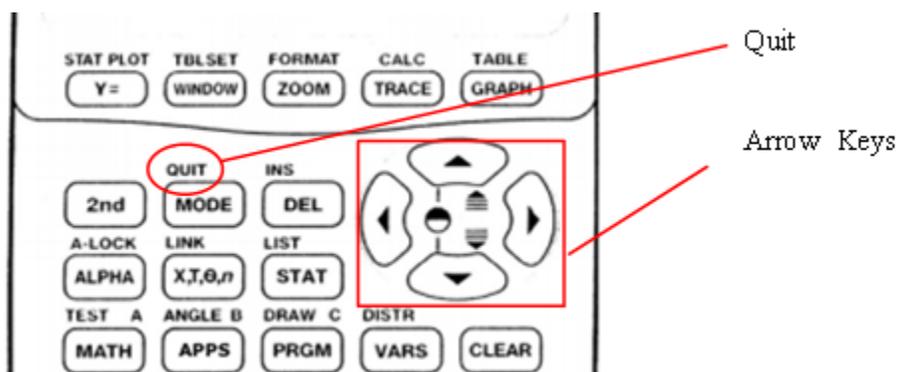
Turn the calculator on in the lower left-hand corner. (Turn it off again with the [2nd] key.) The screen you see when you first turn on the calculator is called the **home screen**. The home screen is where most calculations are carried out. Simply type out the operations you want and hit [ENTER]. You can always reach the home screen again from any menu with the [QUIT] function ([2nd][MODE]). And you can always clear the home screen by hitting [CLEAR] twice.

Try calculating the following examples on the home screen:

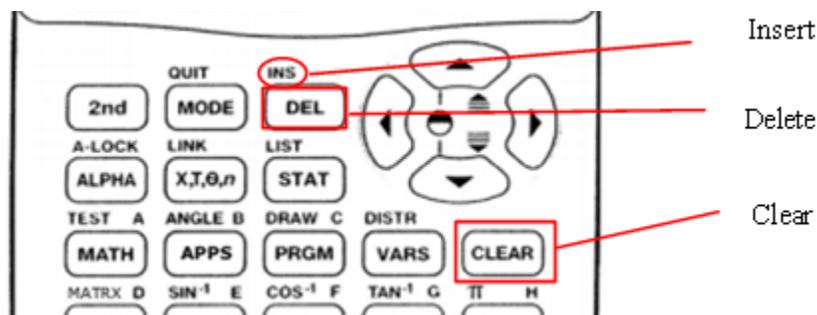
- 1) $3-3 = 0$ (Basic Arithmetic)
- 2) $-9+6(8-5) = 9$ (Basic Arithmetic)
- 3) $1+(1+.05)^{14} = 2.979931599$ (Exponents)
- 4) $\log_5(48) = 2.405312427$ (Logs)
- 5) $6.022E23/1.6E-14 = 3.76375E37$ (Scientific Notation)
- 6) $\frac{4-(1+0.5)}{7+3} = .25$ (Basic Arithmetic)

Navigating and Editing:

To move the cursor around the home screen and any menus, use the arrow keys. Also, as stated before, use [2nd][MODE] to quit back to the home screen whenever you wish.



One advantage of a graphing calculator is that you can correct mistakes. Use [CLEAR] to delete a line entirely. [DEL] deletes the character your cursor is on. [INS] changes the cursor to begin *inserting* what you type rather than *overwriting*.



When you've made a mistake on a long calculation, try editing it rather than retyping it entirely. It will save time and help to familiarize yourself with the controls.

Section answers:

1) 3^{-3} [ENTER]

2) $(-9)^{6(8-5)}$ [ENTER]

3) $1 + (1 + .05)^1$ [ENTER]

4) $\frac{\log(48)}{\log(5)}$ [ENTER]

5) $6 \cdot 2^2 \cdot 2^3 / 1 \cdot 6 \cdot (-1)^4$ [ENTER]

or

$(6 \cdot 2^2 \cdot 2^3) / (1 \cdot 6 \cdot 10^{-4})$ [ENTER]

6) $(4 - (1 + .05)^5) / (1.07^3)$ [ENTER]

II. Graphing

Overview:

Everything related to graphing is in the top row of keys. Very quickly, here is a summary of what they do. You won't be using all these menus equally, and I've bolded the most important ones. It will be easier to see how they interact through the examples.

- **Y=** : Enter the equations to graph.
- Stat Plot: Set options for plots.
- **Window**: Manually set the window boundaries.
- Tblset: Options for the Table.
- **Zoom**: Preset window boundary options.
- Format: Options for the appearance of the graphing window.
- Trace: Brings up a cursor so you can "trace" a line using the arrow keys.
- **Calc**: Menu with a list of available graphing commands.
- **Graph**: The graphing window itself.
- Table: Table of x and y coordinates for each line.

It is important to know how to change the boundaries of the graphing window, so that you can view lines that are out of range. [WINDOW] lets you manually set the boundaries, and [ZOOM] has a variety of preset boundaries. (We will do an example in Example 1.)



The most useful ZOOM commands are:

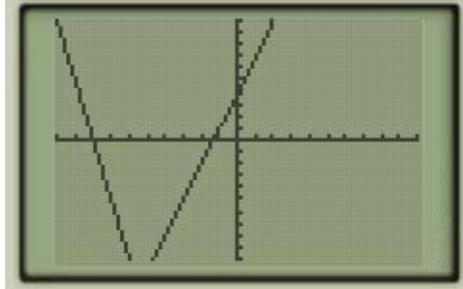
- Zoom In: Zooms into the blinking cursor when ENTER is pressed.
- Zoom Out: Zooms out from the blinking cursor when ENTER is pressed.
- ZStandard: Resets the window to $[-10,10]$ $[-10,10]$

Example 1:

Let's experiment with the windowing with some simple graphs. We will graph two linear lines

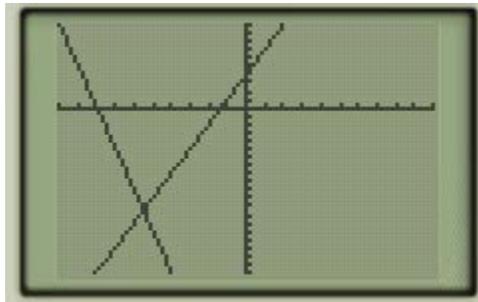
and adjust the window to see where they intersect.

- 1) In the [Y=] menu type $3x+4$ into Y_1 . (The shortcut for 'x' is [X,T,θ,n])
- 2) Type $-5x-40$ into Y_2 . (Typing these equations into [Y=] means these will be graphed when [GRAPH] is selected. All equations need to be in $y=$ format.)
- 3) Select ZStandard in the [ZOOM] menu. The two lines should be drawn on the screen



4) As you can see, the intersection of the two lines is past the bottom of the screen. We will need to increase Y_{\min} in order to see the intersection. Go to the [WINDOW] menu and change Y_{\min} from -10 to -20.

5) Select [GRAPH]. By changing the window boundary, we can now see the intersection.

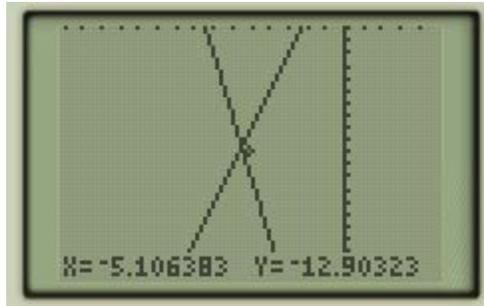


6) Select [TRACE]. Use this to practice navigating along the lines. Using the arrow keys, UP and DOWN switch you from line to line. LEFT and RIGHT move you along a single line. The x and y coordinates of the cursor will show up along the bottom of the screen. The line the cursor is currently on will show up on the upper left corner of the screen.

7) Select ZStandard in the [ZOOM] menu again. As you can see, the window resets to $[-10,10]$ $[-10,10]$.

8) Select Zoom Out in the [ZOOM] menu. You should now see a small blinking cursor on the graph. You can move the cursor around with the arrow keys. Press [ENTER] when you're ready to zoom out, and the graph expand from where the cursor is. You should be able to see the intersection again.

9) Select Zoom In from the [ZOOM] menu. Move the cursor as close to the intersection you can and hit [ENTER]. The graph should be zoomed into where the cursor was, near the intersection.

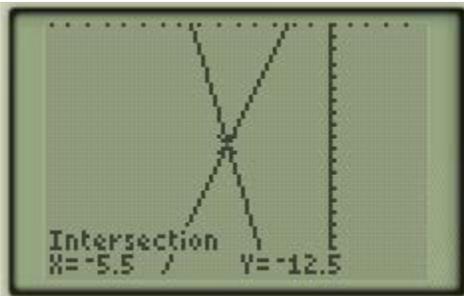


This shows you how the [Y=], [WINDOW], [ZOOM], and [GRAPH] menus interact. [Y=] defines what to graph, [ZOOM] and [WINDOW] define the boundaries of the graph, and [GRAPH] is where the actual graph is drawn.

Example 2:

Let's carry on from the previous example by actually calculating the intersection of the two lines. Intersect and all other graphing calculations are found in the [CALC] menu.

10) Select intersect from the [CALC] menu. You will see three questions in turn in the lower left corner: *First Curve?*, *Second Curve?*, and *Guess?*. Hit [ENTER] to select $3x+4$ as the first curve, and [ENTER] again to select $-5x-40$ as the second curve. (If there are many lines, use the up and down arrow keys as needed to select the correct lines.) *Guess* means to select a suitable starting point for the calculation. In this example, any starting point will do. After you hit [ENTER] one more time, the point $(-5.5, -12.5)$ should be highlighted. (Any starting point works here because there is only one intersection. If there is more than one intersection, it will find the one closest to your cursor. Use the left and right arrow keys to move the cursor along a line.)



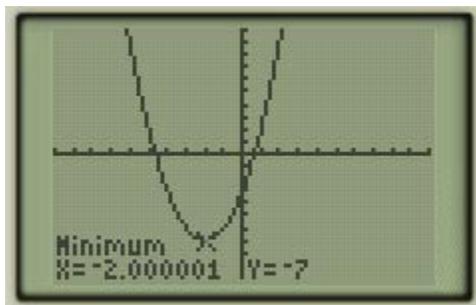
Example 3:

Another common calculation is to find the minimum or maximum of a function. Because straight lines don't have minimums or maximums, let's clear Y_1 and Y_2 and try a different curve.

11) Clear Y_1 and Y_2 . Enter x^2+4x-3 into Y_1 .

12) Select ZStandard in the [ZOOM] menu.

13) Select minimum from the [CALC] menu. You will again see three questions in turn in the lower left corner: *Left Bound?*, *Right Bound?*, and *Guess?*. The *Left Bound* and *Right Bound* questions are asking you to set the left and right boundaries of where to search for the minimum. Use the left and right arrow keys to move the cursor to the left of the minimum (hit [ENTER]) and to the right of the minimum (hit [ENTER]). Once again, *Guess* means to select a suitable starting point for the calculation. Because there is only one minimum in this example, any starting point will do. After you hit [ENTER] one more time, the point (-2,-7) should be highlighted. (If there is more than one minimum, it will find the one closet to your cursor.)



All the [CALC] menu commands work like this, including maximum. In the lower left corner it tells you what kind of input it wants. Move the cursor as needed and press [ENTER] for each input.

Section answers:

- 1) [Y=][3][X,T,Θ,n][+][4][ENTER]
- 2) [(-)][5][X,T,Θ,n][(-)][4][0]
- 3) [ZOOM][6]
- 4) [WINDOW][DOWN ARROW][DOWN ARROW][DOWN ARROW][(-)][2][0]
- 5) [GRAPH]
- 6) [TRACE]
- 7) [ZOOM][6]
- 8) [ZOOM][3][ENTER]
- 9) [ZOOM][2][LEFT ARROW]x6 [DOWN ARROW]x10
- 10) [2nd][TRACE][5][ENTER][ENTER][ENTER]
- 11) [Y=][CLEAR][DOWN ARROW][CLEAR][UP ARROW][X,T,Θ,n][^][2][+][4][X,T,Θ,n][-][3]
- 12) [ZOOM][6]
- 13) [2nd][TRACE][3][(-)][5][ENTER][0][ENTER][ENTER]

III. Matrices

Overview:

Everything to do with matrices is in the [MATRIX] menu. This menu has three submenus:

Names: Where you store the list of matrices you've entered.

Math: A list of matrix commands.

Edit: Where you enter or change a matrix.

After you've entered a matrix, using the Edit menu, calculations for matrices are done as usual on the home screen by calling the variables listed on the Names menu. You can see how this works in the following examples.

Entering a Matrix:

In the EDIT submenu, choose any name for your matrix and hit enter. Here you can set the dimensions of your matrix and fill in all the cells. When you are done, [QUIT] back to the home screen.

1) Enter this in matrix [A]:

$$[A] = \begin{pmatrix} 1 & 2 & -1 \\ 2 & -4 & 1 \\ 4 & 4 & -2 \end{pmatrix}$$

Arithmetic on a Matrix:

All arithmetic is done on the home screen. You can call the name of a matrix through the NAME submenu of the [MATRIX] menu.

2) Find the inverse of the previous matrix by using $[x^{-1}]$. You should get

$$[A]^{-1} = \begin{pmatrix} 1 & 0 & .5 \\ 2 & -.5 & .75 \\ 6 & -1 & 2 \end{pmatrix}$$

3) Enter this inverse into matrix [B]. Then multiply [A] and [B]. You should get:

$$[A] * [B] = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Adding and subtracting matrices works the same way:

4) In matrices [A] and [B] enter:

$$[A] = \begin{pmatrix} 5 & 2 \\ 1 & 4 \end{pmatrix} \quad [B] = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$$

5) When you add and subtract them you should get:

$$[A] + [B] = \begin{pmatrix} 6 & 4 \\ 4 & 8 \end{pmatrix} \quad [A] - [B] = \begin{pmatrix} 4 & 0 \\ -2 & 0 \end{pmatrix}$$

Row Reduction on a Matrix :

More advanced commands are available in the MATH submenu of the [MATRIX] menu. The most commonly used is rref, which takes one matrix as a variable and returns its reduced row echelon form.

For example,

7) Given this system of linear equations, find x, y, and z.

$$2x + 2y - z = 3$$

$$4x + y = 5$$

$$-x - 2y - z = 2$$

We can represent this system as a matrix. Let's use matrix [A]:

$$[A] = \begin{pmatrix} 2 & 2 & -1 & 3 \\ 4 & 1 & 0 & 5 \\ -1 & -2 & -1 & 2 \end{pmatrix}$$

Now we can solve for x, y, and z using row reduction. After entering it into matrix [A], select rref in the MATH submenu and call matrix [A] from the NAME submenu.

$$\text{rref}([A]) = \begin{pmatrix} 1 & 0 & 0 & 1.461538462 \\ 0 & 1 & 0 & -.8461538462 \\ 0 & 0 & 1 & -1.769230769 \end{pmatrix}$$

Therefore,

$$x = 1.461538462 \quad y = -.8461538462 \quad z = -1.769230769$$

Section answers:

1) [2nd][x-1][LEFT ARROW][ENTER][3][ENTER][3][ENTER][1][ENTER][2][ENTER][(-)][1][ENTER][2][ENTER][(-)][4][ENTER][1][ENTER][4][ENTER][4][ENTER][(-)][2][ENTER][2nd][MODE]

2) [2nd][x-1][ENTER][x-1][ENTER]

3) [2nd][x-1][LEFT ARROW][2][3][ENTER][3][ENTER][(-)][1][ENTER][0][ENTER][.][5][ENTER][(-)][2][ENTER][(-)][.][5][ENTER][.][7][5][ENTER][(-)][6][ENTER][(-)][1][ENTER][2][ENTER][2nd][MODE]

[2nd][x⁻¹][ENTER][*][2nd][x⁻¹][2][ENTER]

4) [2nd][x⁻¹][LEFT ARROW][ENTER][2][ENTER][2][ENTER][5][ENTER][2][ENTER][1][ENTER][4][ENTER]
[2nd][x⁻¹][LEFT ARROW][2][2][ENTER][2][ENTER][1][ENTER][2][ENTER][3][ENTER][4][ENTER][2nd][MODE]

5) [2nd][x⁻¹][ENTER][+][2nd][x⁻¹][2][ENTER]
[2nd][x⁻¹][ENTER][-][2nd][x⁻¹][2][ENTER]

6) [2nd][x⁻¹][LEFT ARROW][ENTER][3][ENTER][4][ENTER][2][ENTER][2][ENTER][(-)][1][ENTER][3][ENTER]
[4][ENTER][1][ENTER][0][ENTER][5][ENTER][(-)][1][ENTER][(-)][2][ENTER][(-)][1][ENTER][2][ENTER][2nd]
[MODE]
[2nd][x⁻¹][RIGHT ARROW][ALPHA][APPS][2nd][x⁻¹][ENTER][)][ENTER]

IV. Tips and Tricks

Degrees and Radians:

You can change between degrees and radians in the [MODE] menu. To change between the two, use the arrow keys to highlight either RADIAN or DEGREE and hit [ENTER].

For example,

1) $\sin(\pi/6) = .5$ (in radians)

2) $\sin(\pi/6) = .0091383954$ (in degrees)

Fractions and Decimals:

You can convert between decimal and fraction by going to the [MATH] menu and using either >FRAC or >DEC.

For example,

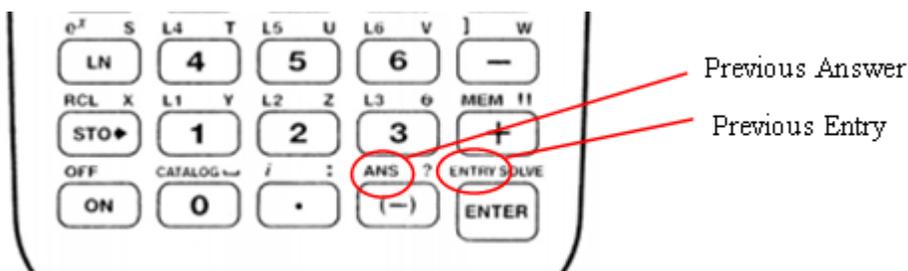
3) $.875 >FRAC = 7/8$

4) $7/8 >DEC = .875$

5) $\begin{pmatrix} .875 & .4 \\ .3125 & .6 \end{pmatrix} >FRAC = \begin{pmatrix} 7/8 & 2/5 \\ 5/16 & 3/5 \end{pmatrix}$

Recalling Previous Answers:

You can refer back to the most recent calculation with the [ANS] key. You can also recall the entire previous line with [ENTRY]. (Using [ENTRY] multiple times in a row goes further back into your history.) This makes it very easy to chain calculations together or make minor adjustments to previous lines.



Use [ANS] and [ENTRY] to help in the following calculations.

6) $5^2 = 25$

$$\sqrt{ANS} = 5$$

ANS+6*ANS = 35 (notice how ANS is automatically added if the first character on a new line is an operation.)

7) $5+7+8 = 20$

$$5+7+8+9 = 29$$

$$6+7+8+9 = 30$$

Section answers:

1) [MODE][DOWN ARROW][DOWN ARROW][ENTER][2nd][MODE][SIN][2nd][^][/][6][)][ENTER]

2) [MODE][DOWN ARROW][DOWN ARROW][RIGHT ARROW][ENTER][2nd][MODE][SIN][2nd][^][/][6][)][ENTER]

3) [.] [8] [7] [5] [MATH] [ENTER] [ENTER]

4) [7] [/] [8] [MATH] [2] [ENTER]

or

[7] [/] [8] [ENTER]

5) [2nd][x⁻¹][LEFT ARROW][ENTER][2][ENTER][2][ENTER][.] [8] [7] [5] [ENTER][.] [4] [ENTER][.] [3] [1] [2] [5] [ENTER][.] [6] [ENTER][2nd][MODE]

[2nd][x⁻¹][ENTER][MATH][ENTER][ENTER]

6) [5][^][2][ENTER][2nd][x²][2nd][(-)][)][ENTER][+][6][*][2nd][(-)][ENTER]

7) [5][+][7][+][8][ENTER][2nd][ENTER][+][9][ENTER][2nd][ENTER][UP ARROW][6][ENTER]

V. Troubleshooting

Changing Brightness:

The screen contrast can be changed by pressing the [2nd] key and holding down the up or down arrows until the brightness is set to the desired level. Pressing up darkens the screen and pressing down lightens the screen.

Hanging Calculation/Not Responsive:

If the calculator is not responding to input, check to see if it is in the middle of a calculation. The busy signal is a dotted line on the upper right corner of the screen. If there is a busy signal, [ENTER] pauses and unpauses a calculation, and [ON] stops it completely.

Resetting Memory:

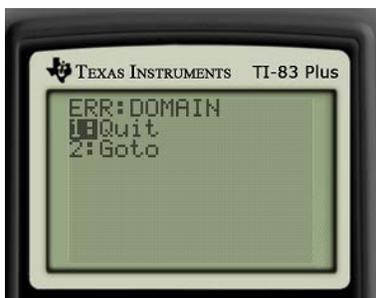
You can reset the memory by going to the Memory menu, selecting Reset, and selecting All RAM:

[2nd][+][7][ENTER][2]

Error Screens:

Errors on the TI graphing calculators often show themselves as an error screen. You will see a screen with the word “ERR”, with the name of the type of error. There will be two options. Quit, which returns you to the home screen on new line, where you can start from scratch. And Goto, which returns the cursor to place where the error occurred, or the best approximation to where the error is, so you can correct it.

This is an example of an error screen where the calculator says a DOMAIN error occurred.



A full list of errors can be found online or in the manual. Common types of errors include:

ERR:SYNTAX

Syntax errors are usually typos. Something was entered incorrectly in a way that calculator cannot understand the input.

Some possibilities include:

1. Using the [(-)] (negative) sign instead of the [-] (minus) sign or vice versa.

2. Mismatched parentheses.
3. Incorrect use of symbols, such as trying to do $3++2$ instead of $3+2$.

ERR:NONREAL ANS

The answer exists but it is partially or completely imaginary. For example, square roots and logs of negative numbers are imaginary. You can allow imaginary answers by going to MODE and selecting $a+bi$ instead of REAL.

ERR:DOMAIN

This tells you that the calculator understood your input, but that what you entered was not valid. For example, you will get this error if you try to do $\sin^{-1}(5)$ because the domain of \sin^{-1} is always between -1 and 1.

ERR:WINDOW RANGE

This error occurs if you define a window range in WINDOW which is invalid. For instance, you cannot define $X_{\min} = -10$ and $X_{\max} = -20$ because then X_{\min} is greater than X_{\max} .

VI. - Conclusion

That should help get you started. There are many other resources out there to help you learn more.

Google/Youtube:

If you are stuck doing something specific or encounter an unknown error, 99% of the time, you are not the first person to have similar questions. Searching “TI-83” and a description of your goal will bring up many different walkthroughs. For example, “Ti-83 finding intercepts between two lines.”

Rockville’s Self-paced Calculator Tutorials

There are two tutorials, one general and one for statistics, available on Rockville’s website. You can use them to familiarize yourself with the capabilities of the calculator. They are at: <http://cms.montgomerycollege.edu/EDU/Department2.aspx?id=27975>

The manual:

The manual lists every function and button in the calculator and what it does. There are copies in the M.A.P.E.L Center. Alternatively, searching “TI-83 plus manual” will bring up many sites that have a copy. One example is:

<http://education.ti.com/en/us/products/calculators/graphing-calculators/ti-83-plus/downloads/guidebooks>

TI-Basic Developer Website: <http://tibasicdev.wikidot.com/>

This site is designed for TI programmers, and has much of the same information the manual has and more. You can find a list of every command on the calculator at <http://tibasicdev.wikidot.com/command-index>.