Addison-Wesley's

Graphing Calculator Reference Card

Created in conjuction with Texas Instruments

Basics

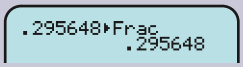
Converting Fractions to Decimals

The calculator will automatically convert a fraction to a decimal. Type in a fraction, 3 ÷ 1 5, on the home screen and press ENTER. The decimal will appear as the answer:

Converting Decimals to Fractions

The calculator will convert some decimals to fractions. Type the decimal .258 into the home screen. Press MATH ENTER ENTER, and the screen will display the fraction.

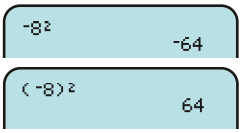
NOTE If the fraction is too big for the calculator to computer, it will output the same decimal again, as in the screen below.



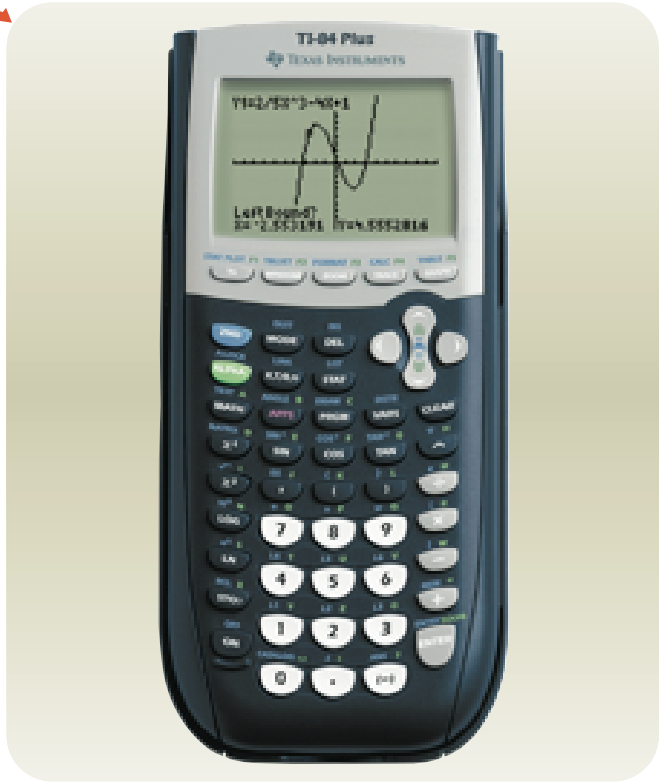
Inputting Information

The most important thing to remember when putting information into the calculator is to follow the **order of operations.** For example, to evaluate the expression -8^2, if (−) 8 x^2 is input, the calculator will display this:

This clearly isn't the answer. -8^2 is 64. Use parenthesis around the **negative** number to compute properly: Enter ((−) 8) x^2 to get

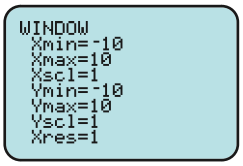


NOTE − (subtraction) and (−) (negative) are *different* keys and can't replace one another. SYNTAX ERROR will appear if the keys are used improperly.



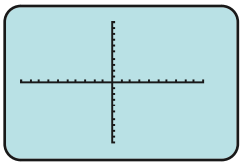
Setting the Window

To modify the window, enter WINDOW. You should be looking at this screen:



NOTE If your calculator's window screen doesn't look like this, inputting ZOOM 6 will reset the calculator to its default window.

This window should produce a graph that looks like this:



These are the default settings for the calculator.

continued on page 2

The TI-84 Plus model was used to demonstrate the key stroke sequences and resulting screen captures for this reference card. Please note, other TI models may produce slightly different results.

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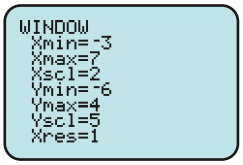
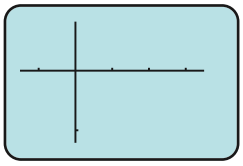
Modify the window by changing the values for the Xmin, Xmax, Ymin, and Ymax. The Xscl and Yscl are the distances between tick marks on the graph. For example, if the default window is changed to:



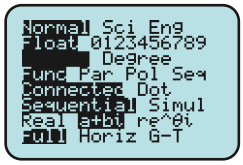
Its screen will look like this:



Notice the Xmin of -3 is on the graph, but isn't marked by a tick mark. This is because of the change in Xscl.

Operations on Complex Numbers

For operations on complex numbers, the calculator must be changed into complex mode. Press MODE, then scroll down and select **a+bi** on the menu by pressing ENTER.

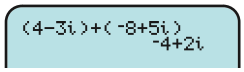


Press 2ND MODE to return to the home screen.

To add $(4 - 3i) + (-8 + 5i)$, press:

(4 − 3 2ND .)

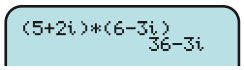
+ ((−) 8 + 5 2ND .) ENTER



To multiply $(5 + 2i) \times (6 - 3i)$, press:

(5 + 2 2ND .)

× (6 − 3 2ND .) ENTER

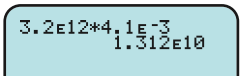


Division and subtraction work the same way.

NOTE Don't forget to reset the calculator back to real numbers by pressing MODE and scrolling down to select Real by pressing ENTER.

Scientific Notation

Your calculator is capable of doing operations with scientific notation. For example, if you want to simplify $(3.2 \times 10^{12})(4.1 \times 10^{-3})$, press 3 . 2 2ND , 1 2 × 4 . 1 2ND , (−) 3 and ENTER.

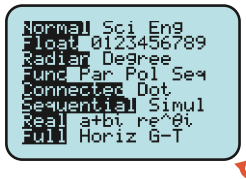


Notice the answer is in scientific notation, using the same format as was input.

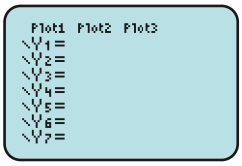
Setting the Defaults/Troubleshooting

Certain keys can be hit accidentally that will alter the way the calculator performs. If your calculator begins to act strangely, check the following screens:

1. Press MODE. The default setting should look like this. If your screen doesn't look this way, change it by using the arrow keys to place the blinking cursor on the setting you want and pressing ENTER.

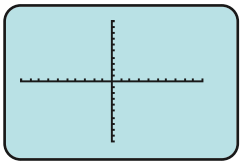


2. Press Y=. The screen should look like this.



NOTE Statistical plots that are turned on (highlighted) will affect the grapher. Suppose Plot1 is turned on (highlighted). Use the arrow keys to place the cursor on Plot1 and press ENTER. This will turn off the plot.

3. Press GRAPH. The screen should look like this.



If the graphing window has been altered, it can affect the way a function is seen. To reset the default window, press ZOOM 6.

Resetting the Calculator's Memory

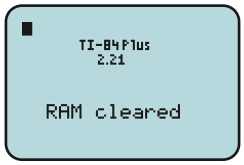
Resetting the memory will erase all stored variables, programs, and commands. To do this, press 2ND +,

Press 7,

Press 1,

Press 2.

The calculator's memory is now cleared.



Evaluating Functions

You can use your calculator to evaluate functions using either the TRACE utility or the VARS option.

Using TRACE to Evaluate Functions

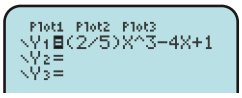
Press the Y= key and input the function you wish to evaluate.

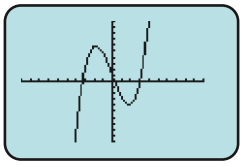
Remember to turn off any other graphs in the grapher. To evaluate $f(1.9)$ when $f(x) = \frac{2}{5}x^3 - 4x + 1$, input

Y= (2 ÷ 5) X,T,θ,n

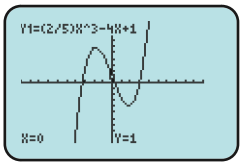
^ 3 − 4 X,T,θ,n + 1

and GRAPH.

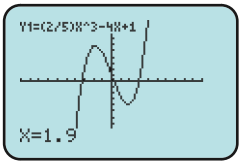




Press TRACE

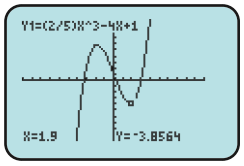


then input 1 . 9 (notice that $X = 1.9$ appears in the bottom left corner of the screen) and ENTER.

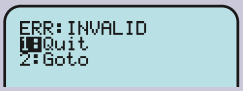


The y value of -3.8564 will appear in the bottom right of the screen.

This tells you that $f(1.9) = -3.8564$.



NOTE If an x value is input that is outside the window range, an ERR: INVALID message will display:

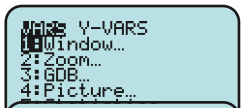


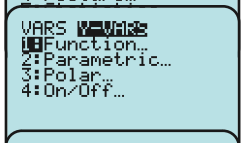
Press 1 then WINDOW to adjust the x values to include the value you wish to evaluate.

Using VARS to Evaluate Functions

To evaluate $f(1.9)$ when $f(x) = \frac{2}{5}x^3 - 4x + 1$, input the function into the grapher by pressing Y= (2 ÷ 5) X,T,Θ,n ^ 3 − 4 X,T,Θ,n + 1 and GRAPH.

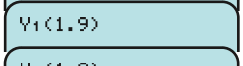
Press 2ND MODE, which will quit to the home screen. Press VARS. Using the arrow keys, scroll right to highlight "Y-VARS" and ENTER.

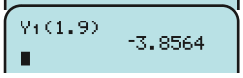




ENTER again to get Y_1 on your home screen.

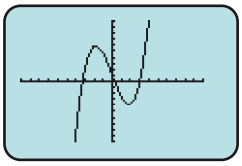
Then, enter (1 . 9) and ENTER and the screen will display -3.8564, which means that $f(1.9) = -3.8564$. If a function that you want to evaluate is in Y_2, find Y_2 in the VARS menu and proceed in exactly the same manner.



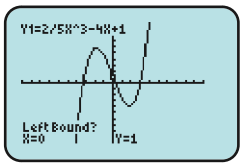


Finding the Maximum/Minimum Value of a Function

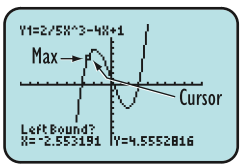
Finding extreme values (max/min) is useful in mathematics. To find the maximum and minimum of a function, say $f(x) = \frac{2}{5}x^3 - 4x + 1$, input the function into the grapher and press GRAPH. Find the local maximum value of the function first.



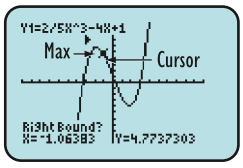
Press 2ND TRACE 4 for maximum. Notice the cursor blinking in the middle of the screen and the Left Bound prompt.

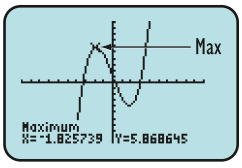


Using the arrow keys, run the cursor to a point left of the maximum and press ENTER. Try to get the cursor reasonably close to the maximum. Notice the screen is now prompting for a Right Bound.

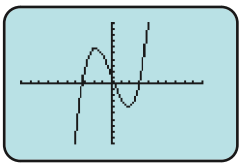


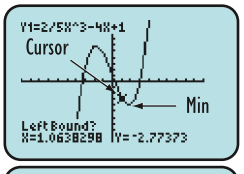
Now run the cursor along the function to a point right of the maximum and press ENTER. The screen will prompt you for a guess. Ignore this, and press ENTER one more time. The cursor is now sitting on the local maximum value of the function. In this case, the maximum occurs when $x = -1.825739$ and the function has a maximum value of $y = 5.868645$.

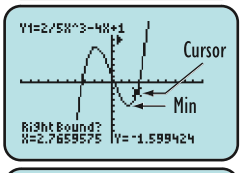


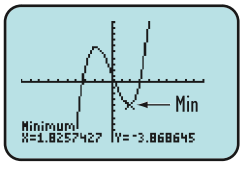


The procedure for finding the local minimum value of $f(x) = \frac{2}{5}x^3 - 4x + 1$ is exactly the same. Graph the function, press 2ND TRACE 3 (for minimum). Place the cursor just slightly *left* of the minimum and press ENTER. Then place the cursor just slightly *right* of the minimum and press ENTER. Ignore the guess by pressing ENTER one more time, and the cursor should be sitting on the minimum value with the numbers displayed below. In this case, the minimum occurs when $x = 1.8257427$ and has a minimum value of $y = -3.868645$.





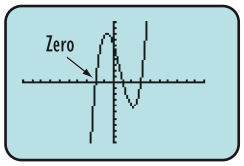


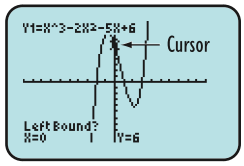


continued on page 4

Finding Zeroes/*x*-Intercepts

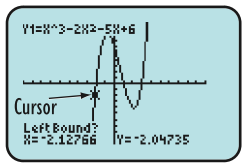
Zeros of functions and/or *x*-intercepts of graphs of functions can be determined with the same steps. To demonstrate, use $f(x) = x^3 - 2x^2 - 5x + 6$. Input the function to the graphing utility and press GRAPH to look at the function. We will be solving for the zero on the far left of the screen. To do this, press 2ND TRACE 2. The cursor will be somewhere on the function and the screen will be prompting you for a Left Bound. Use the arrow keys to move the cursor so that it is just to the left of the zero you want to solve for. Press ENTER.



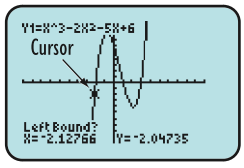


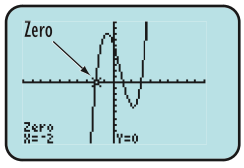
NOTE It doesn't matter if the cursor is above or below the *x*-axis, only that it is to the left of the intersection.

Now the screen should be prompting you for a Right Bound. Use the arrow keys to move the cursor just to the right of the zero you want to solve for. Press ENTER.



Ignore the Guess prompt by pressing ENTER for a third time. The cursor should now be sitting on the zero with the *x*- and *y*-values written at the bottom of the screen (note that the *y*-value should always be 0, hence the word). In this case, the zero is at $x = -2$. You can find the two other zeroes of this function in the same manner.

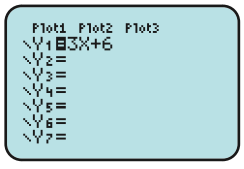




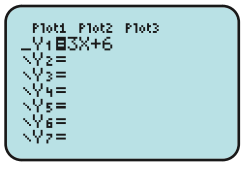
Graphing

Graphing Linear and Nonlinear Inequalities

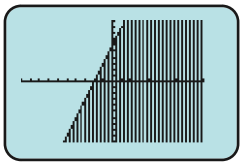
The shading required to change a regular function into an inequality is easily inserted using the graphing utility. For example, to graph $y < 3x + 6$ press Y= 3 X,T,Θ,n (−) 6 to get this screen:



To change the grapher so that it shades under the line (because the inequality is less than), use ◀ to move the cursor to the left of Y_1:

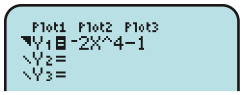


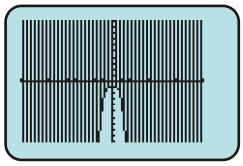
Press ENTER until the line type looks like ▙, then press GRAPH. Your screen should look like this:



NOTE The calculator will automatically reset the line type to the default setting by clearing the function out of Y_1.

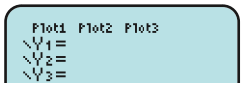
To graph nonlinear inequalities such as $y > -2x^4 - 1$, press Y= (−) 2 X,T,Θ,n ^ 4 (−) 1, use ◀ to move the cursor to the left of Y_1, press ENTER until the line type looks like this ▛, then press GRAPH.



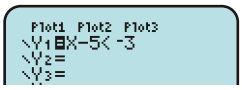


Graphing Inequalities of a Single Variable and Absolute Value

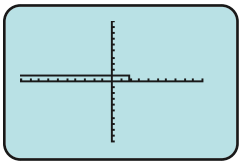
The grapher can easily be used for inequalities of one variable. For example, to graph $x - 5 < -3$ press Y= to get to the home graphing screen:



Press X,T,Θ,n (−) 5 2ND MATH 5 (−) 3. Your screen should look like this:

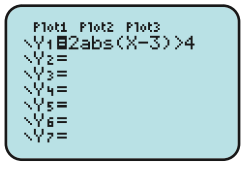


Press GRAPH to graph the inequality.

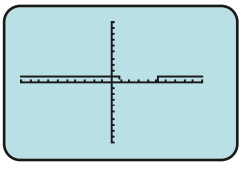


NOTE Depending on the inequality you are trying to graph, you may have to adjust your window to see the graph properly.

The grapher can also be used to graph inequalities involving absolute values, with only a few more keystrokes. For example, to graph $2|x - 3| > 4$, press Y= 2 2ND 0 ENTER (this finds the **absolute value** command from the catalog) X,T,Θ,n (−) 3) 2ND MATH 3 4 to get this screen:

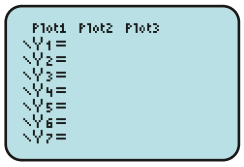


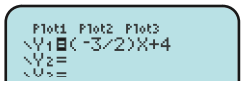
Press GRAPH to graph the inequality.



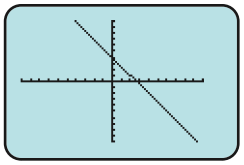
Graphing Linear Functions

For your calculator to be able to graph an equation in the utility, it must always be in the form $y = mx + b$ (slope-intercept). If you have a linear equation like $3x + 2y = 8$, use algebra to put it in the slope-intercept form of $y = \frac{-3}{2}x + 4$. Press Y= to go to the graphing utility. Delete or turn off any existing functions or plots in the grapher so the screen looks like this:





Press ((−) 3 ÷ 2) X,T,Θ,n + 4 and GRAPH to get a screen that looks like this:



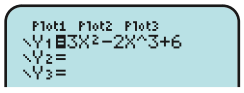
NOTE If our screen doesn't look like this, press ZOOM 6 to reset your window. Otherwise, check to see if any other graphs or plots are turned on.

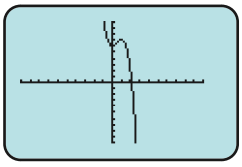
Graphing Polynomial Functions

The key to graphing functions successfully is to remember that the calculator uses the **order of operations** when inputting the function. Using (−) and − properly can also save a great deal of frustration. The examples shown here are as complicated as you're likely to see in your text. Most functions that you graph will be much simpler.

Polynomials graph much like linear functions. All equations must be solved for y before being input into the grapher. In addition, you must be careful with the use of parentheses.

Graph $y = 3x^2 - 2x^3 + 6$ by pressing Y= 3 X,T,Θ,n x² − 2 X,T,Θ,n ^ 3 + 6 and GRAPH to get the following:



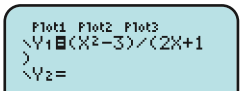


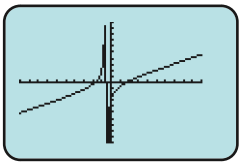
NOTE Always remember to turn off other graphs and plots before graphing a function. If your window isn't in the default setting, press ZOOM 6 to reset it.

Graphing Rational Functions

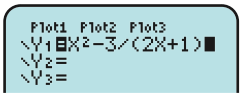
Rational functions can be tricky to graph correctly with the calculator. A good rule of thumb is that all of the numerator *and* all of the denominator must be put in parentheses for the calculator to graph correctly.

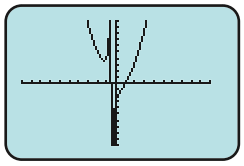
For example, to graph $y = \frac{x^2 - 3}{2x + 1}$, press Y= (X,T,Θ,n x² − 3) ÷ (2 X,T,Θ,n + 1) and GRAPH.





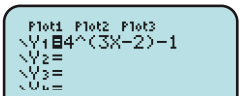
Notice that if you do not use the parentheses properly, the graph that you get is entirely different.

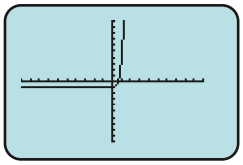




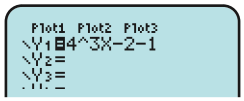
Graphing Exponential Functions

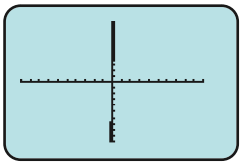
Exponential functions can be tricky to graph because using parentheses is imperative to graphing the correct equation. To graph $y = 4^{3x-2} - 1$, remember to use parentheses. Press Y= 4 ^ (3 X,T,Θ,n − 2) − 1 and GRAPH to get:





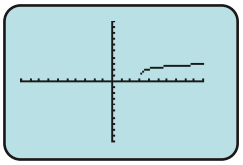
Notice that if you do not use the parentheses properly, the graph that you get is entirely different:



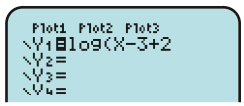


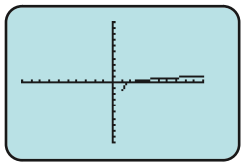
Graphing Logarithmic Functions

It is critical to use parentheses correctly when graphing logarithmic functions. For instance, graphing $y = \log(x - 3) + 2$ requires parentheses (although the calculator provides the first parentheses). Press Y= LOG X,T,Θ,n − 3) + 2 GRAPH to get:

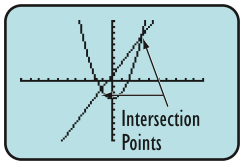


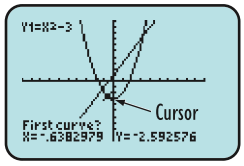
Notice that if you don't use the parentheses properly, you get a subtly different graph:





Intersections of Functions To find the point where two functions intersect, for instance $f(x) = x^2 - 3$ and $g(x) = 2x + 1$, input both functions into the graphing utility (say $f(x)$ as Y_1 and $g(x)$ as Y_2). Be sure to turn off any other functions or plots. After the functions have been input, press GRAPH to look for the intersection points. Press 2ND TRACE 5 to find the intersection points. The calculator should prompt you with a cursor asking First Curve?

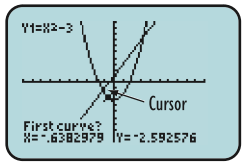




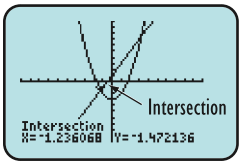
Press ENTER to confirm the first curve. You will now be prompted for Second Curve by the cursor. Confirm by pressing ENTER. The calculator will prompt you for a guess. Ignore this and press ENTER one last time.

NOTE The calculator will usually find the *closest* intersection point from where you place the cursor initially. You should move the cursor so that it is closest to the intersection point you want to solve for.

The cursor should now be sitting on the point of intersection with the x- and y-values on the bottom of the screen. In this case, $x = -1.236068$ and $y = -1.472136$. Now you can find the second intersection point.



Solving an Equation: The intersection calculation can be used to solve *almost any* equation. For example, if you want to solve the equation $x^2 - 3x + 4 = \frac{2}{5}x - 9$, input the left side of the equation into Y_1 and the right side into Y_2 and use the instructions above.

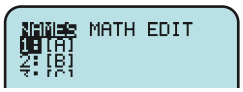


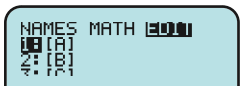
Solving Systems of Equations with Matrices and Reduced Row Echelon Form

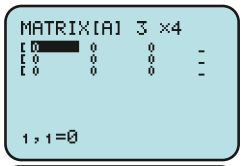
Using Matrices Your calculator can use matrices to solve most system of equations. However, they must be in standard form. An example of a system of equations in standard form is

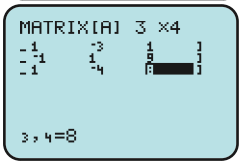
$$\begin{cases} x + y - 3z = 1 \\ 2x - y + z = 9 \\ 3x + y - 4z = 8 \end{cases}.$$

Notice the coefficients and variables are on one side of the equation—in the same order—and the constants are on the other. Press 2ND x^{-1} to put the calculator in matrix mode. Use the ▷ key to move the cursor to EDIT mode and press ENTER. The calculator will prompt you for the dimensions of matrix A, which is the one you should use. In this case, the dimensions are 3 by 4. Input this by pressing 3 ENTER 4 ENTER. Input the coefficients and constants of the system by pressing the number and pressing ENTER. Your screen should look like this:

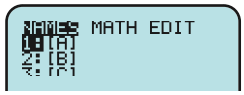




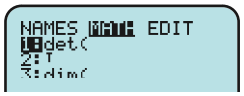


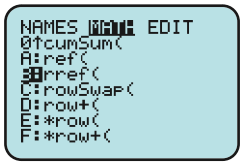


First, press 2ND MODE to reach the home screen.



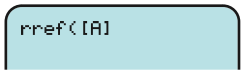
Press 2ND x^{-1} and move the cursor to MATH. Move the cursor down until it rests on a command **rref(**. You will have to move down to the next page to do this. Press 2ND MODE. You should be on the home screen.



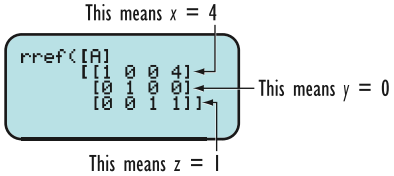


Using Reduced Row Echelon Form To have the calculator perform a reduced row echelon on matrix A, press 2ND x^{-1} ENTER.

Your screen should look like this:



Press ENTER to perform the calculation, producing the following screen. It has to be interpreted a bit.



The solution to the system is (4, 0, 1).

NOTE If you ever get an answer where the bottom row of the matrix is all zeros, but otherwise looks as above, then the system has *infinitely many solutions*. If the bottom row of the answer matrix is all zeros except one 1 in the rightmost position, then the system has *no solutions*.