TI-83 Plus GRAPHING CALCULATOR

BASIC OPERATIONS

by

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B-1 Getting Started

Press [ON] to turn on the calculator.

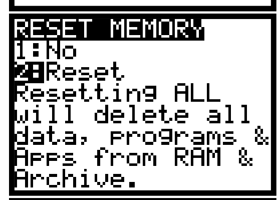
Press [2nd] [+] to get the MEMORY screen (shown at the right).

Use the down arrow [▼] to choose 7:Reset…

and press [ENTER] .

The display now shows the RAM menu (second screen shown at the right).

Use the right arrow to select ALL. Press [1] :All Memory... .



A third menu is displayed as shown at the right. Use the down arrow [▼] to choose 2: Reset and press [ENTER] .

The screen should now indicate that the Mem is cleared.

However, the screen may look blank. This is because the contrast setting may also have been reset and now needs to be adjusted.

Press [2nd] and then hold the [▲] down until you see Defaults set in the middle of the screen. Now the contrast will be dark enough for you to see the screen display.

Press [2nd] [▲] to make the display darker.

Press [2nd] [▼] to make the display lighter.

To check the battery power, press [2nd] [▲] and note the number that will appear in the upper right corner of the screen. If it is an 8 or 9, you should replace your batteries. The highest number is 9.

Press [CLEAR] to clear the screen.

Press [2nd] [OFF] to turn off the calculator.

B-2 Special Keys, Home Screen and Menus

[2nd]
This key must be pressed to access the operation above and to the left of a key. These operations are a yellow color on the face of the calculator. A flashing up arrow arrow [↑] is displayed as the cursor on the screen after [2nd] key is pressed.

In this document, the functions on the face of the calculator above a key will be referred to in square boxes just as if the function was printed on the key cap. For example, [ANS] is the function above the [(-)] key.

[ALPHA]
This key must be pressed first to access the operation above and to the right of a key. A flashing [A] is displayed as the cursor on the screen after the [ALPHA] key is pressed.

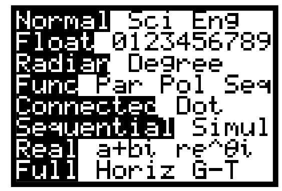
[A-LOCK]
[2nd] [A-LOCK] locks the calculator into alpha mode. The calculator will remain in alpha mode until the [ALPHA] is pressed again.

MODE

Press MODE . The highlighted items are active. Select the item you wish using the arrow keys.

Press ENTER to activate the selection.

Normal Sci Eng	Type of notation for display of numbers.
Float 0123456789	Number of decimal places displayed.
Radian Degree	Type of angle measure.
Func Par Pol Seq	Function or parametric graphing.
Connected Dot	Connected/not connected plotted points on graphs.
Sequential Simul	Graphs functions separately or all at once.
Real a+bi re^θi	Allows number to be entered in rectangular complex mode or polar complex mode.
Full Horiz G-T	Allows a full screen or split screen to be used.



Home Screen

The screen on which calculations are done and commands are entered is called the Home Screen. You can always get to this screen (aborting any calculations in progress) by pressing

QUIT

2nd MODE . From here on, this will be referred to as 2nd QUIT in this manual.

Menus

The TI-83+ Graphics calculator uses menus for selection of specific functions. The items on the menus are identified by numbers followed by a colon. There are two ways to choose menu items:

1. Using the arrow keys to9n pressing ENTER .
2. Pressing the number corresponding to the menu item.

In this document the menu items will be referred to using the key to be pressed followed by the meaning of the menu. For example, on the ZOOM menu, 1 :ZBox refers to the first menu item.

B-3 Correcting Errors

It is easy to correct errors on the screen when entering data into the calculator. To do so use the arrow keys, [DEL] , and [INS] keys.

[◄] or [►]	Moves the cursor to the left or right one position.
[▲]	Moves the cursor up one line or replays the last executed input.
[▼]	Moves the cursor down one line.
[DEL]	Deletes one or more characters at the cursor position.
[2nd] [INS]	Inserts one or more characters at the cursor position.

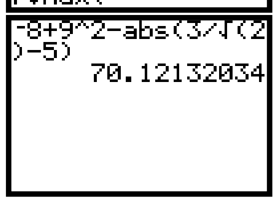
B-4 Calculation

Example 1 Calculate $-8 + 9^2 - \left| \frac{3}{\sqrt{2}} - 5 \right|$.

Turn the calculator on and press [2nd] [QUIT] to return to the Home Screen. Press [CLEAR] to clear the Home Screen. Now we are ready to do a new calculation.

Numbers and characters are entered in the same order as you would read an expression. Do not press [ENTER] unless specifically instructed to do so in these examples. Keystrokes are written in a column but you should enter all the keystrokes without pressing the [ENTER] key until [ENTER] is displayed in the example.

Solution:

Keystrokes	*Screen Display*	*Explanation*
[2nd] [QUIT] [CLEAR] [(-)] [8] [+] [9] [^] [2] [-]		It is a good idea to clear the screen before starting a calculation.
[MATH] [▶] [1] :abs([(] [3] [÷] [2nd] [√] [2] [)] [-] [5] [)] [ENTER]	 	Watch for parentheses that are entered automatically with the operation.

B-5 Evaluation of an Algebraic Expression

Example 1 Evaluate $\frac{x^4 - 3a}{8w}$ for $x = \pi$, $a = \sqrt{3}$, and $w = 4!$.

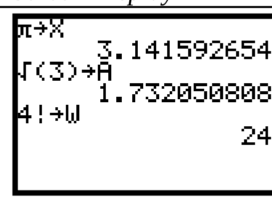
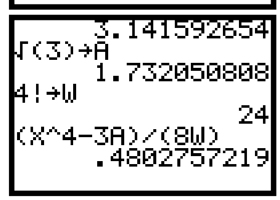
Two different methods can be used to evaluate algebraic expressions:

1. Store the values of the variable, enter the expression, and press [ENTER] to evaluate the expression for the stored values of the variables.
2. Store the expression and store the values of the variables. Recall the expression and press [ENTER] to evaluate the expression for the stored values of the variables.

The advantage of the second method is that the expression can be easily evaluated for several different values of the variables.

Solution:

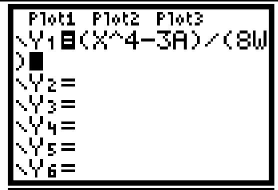
Method 1

Keystrokes	*Screen Display*
[2nd] [QUIT] [CLEAR]	
[2nd] [π] [STO▸] [X,T,θ,*n*] [ENTER]	
[2nd] [√] [3] [)] [STO▸] [ALPHA] [A] [ENTER]	
[4] [MATH] [▶] [▶] [▶] [4] :! [STO▸] [ALPHA] [W] [ENTER]	
NOTE: In this document the notation [4] :! refers to the fourth menu item.	
[(] [X,T,θ,*n*] [^] [4] [-] [3] [ALPHA] [A] [)] [÷]	
[(] [8] [ALPHA] [W] [)] [ENTER]	

Method 2

Keystrokes	*Screen Display*

[CLEAR] [NOTE: Plot1 Plot2 Plot3 at the top of the screen should not be highlighted. If they are, use the up arrow so the highlighting is flashing, press [ENTER], and use the down arrow to return to \Y1=.

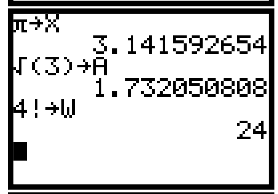


[Y=] [CLEAR] [(] [X,T,θ,*n*] [^] [4] [-] [3] [ALPHA]

[A] [)] [÷] [(] [8] [ALPHA] [W] [)]

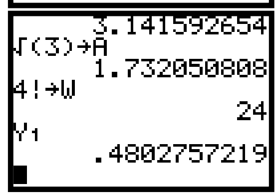
[2nd] [QUIT]

[2nd] [π] [STO▸] [X,T,θ,*n*] [ENTER]



[2nd] [√] [3] [)] [STO▸] [ALPHA] [A] [ENTER]

[4] [MATH] [▶] [▶] [▶] [4] :! [STO▸] [ALPHA] [W] [ENTER]



[VARS] [▶] [1] :Function [1] :Y1 [ENTER]

Example 2 For $f(x) = 3x+5$ and $g(x) = \sqrt{x - \sqrt{x}}$ find $f(2) - g(2)$.

Solution: (Using Method 2 above.)

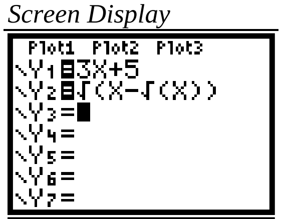
Keystrokes	*Screen Display*	*Explanation*

[Y=] [CLEAR] [3] [X,T,θ,*n*] [+]

[5] [ENTER] [CLEAR]

[2nd] [√] [X,T,θ,*n*] [-]

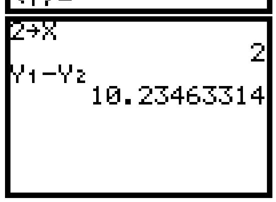
[2nd] [√] [X,T,θ,*n*] [)] [)]



Clear Y1 and store $f(x)$ as Y1.
Clear Y2 and store $g(x)$ as Y2.

[2nd] [QUIT]

[2] [STO▸] [X,T,θ,*n*] [ENTER]



Store 2 as X.

[VARS] [▶] [1] :Function [1] :Y1

[-] [VARS] [▶]

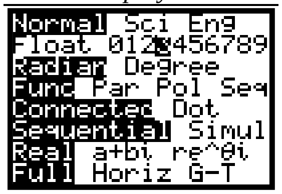
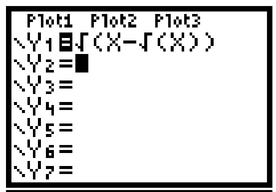
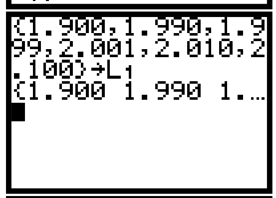
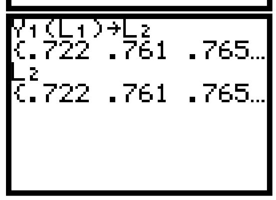
[1] :Function [2] :Y2

[ENTER]

Algebraically form $f(x) - g(x)$ and evaluate at $x = 2$.

Example 3 Evaluate the function $g(x) = \sqrt{x - \sqrt{x}}$ to three decimal places for x = 1.900, 1.990, 1.999, 2.001, 2.010, and 2.100 using a list.

Solution: Store the expression in the calculator as was done in Example 2 above. Store the values of *x* in a list and simultaneously evaluate the expression for each value of *x* as shown below.

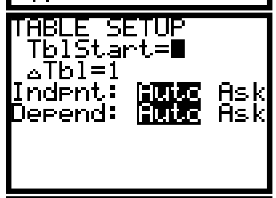
Keystrokes	*Screen Display*	*Explanation*
[MODE] [▼] [▶] [▶] [▶] [▶] [ENTER] [2nd] [QUIT] [Y=] [CLEAR] [▼] [CLEAR] …		Change the mode to three decimal places. Return to the home screen. Clear any existing expressions in the in the Y= list by clearing or deselecting them.
[2nd] [√] [X,T,θ,*n*] [-] [2nd] [√] [X,T,θ,*n*] [)] [)] [2nd] [QUIT]		Store the expression as Y1 and return to the home screen.
[2nd] [{] [1.900] [,] [1.990] [,] [1.999] [,] [2.001] [,] [2.010] [,] [2.1] [2nd] [}] [STO▶] [2nd] [L1] [ENTER]		Store the values of *x* in the list L1.
[VARS] [▶] [1] :Function [1] :Y1 [(] [2nd] [L1] [)] [STO▶] [2nd] [L2] [ENTER] [2nd] [L2] [ENTER]		Calculate the value of the expression stored as Y2 for the values of *x* in list L1 and store in list L2. To view the results, use the [◀] and [▶] keys. To recall L2, press [2nd] [L2] . The results are 0.722, 0.761, 0.765, 0.766, 0.770, and 0.807.

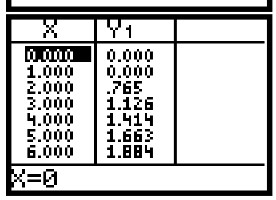
Example 4

Evaluate the expression $g(x) = \sqrt{x - \sqrt{x}}$ to three decimal places for values of x at each integer from 0 to 10 using a table.

Solution: First store the expression in the Y= list. Set the table parameters to begin at $x = 0$ and to have an increment of 1. Get the table.

Keystrokes	*Screen Display*	*Explanation*
[MODE] [▼] [▶] [▶] [▶] [▶] [ENTER] [2nd] [QUIT]		Change the mode for numbers to three decimal places. Return to the home screen.
[Y=] [CLEAR] [▼] [CLEAR] …		Clear any existing expressions in the in the [Y=] list by clearing or deselecting them.
[2nd] [√] [X,T,θ,*n*] [-] [2nd] [√] [X,T,θ,*n*] [)] [)] [2nd] [QUIT]	(screen 1)	Store the expression as Y1 and return to the home screen.
[2nd] [TblSet] [0] [ENTER] [1] [ENTER] [▼] [ENTER]	(screen 2)	Set the table to begin evaluating the expression at $x = 0$ with a step size of 1 Set the calculator to automatically display values of x and Y1.
[2nd] [TABLE] [▼] ...[▼]	(screen 3)	Get the table. Arrow down to see more of the table. The highlighted value will appear at the bottom of the table.
[MODE] [▼] [ENTER]		When finished viewing the table, set the mode for numbers to Float.



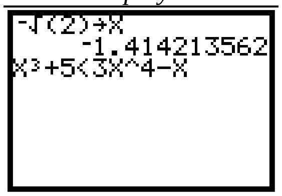


B-6 Testing Inequalities in One Variable

Example 1 Determine whether or not $x^3 + 5 < 3x^4 - x$ is true for $x = -\sqrt{2}$.

Solution:

Set the mode to `Float`. See Section B-2 of this document.

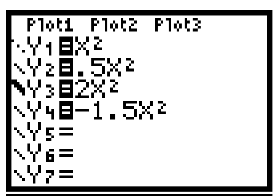
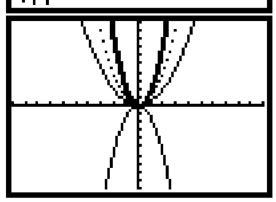
Keystrokes	*Screen Display*	*Explanation*
[CLEAR]		Clear the Home Screen
[(-)] [2nd] [√] [2] [)] [STO►]		Store the value for *x*.
[X,T,θ,*n*] [ENTER]		
[X,T,θ,*n*] [MATH] [3] :³ [+] [5]		Enter the expression.
[2nd] [TEST] [5] :< [3]		The result of 1 indicates the expression is true for this value of *x*. If a 0 was displayed, the expression would be false.
[X,T,θ,*n*] [^] [4] [-] [X,T,θ,*n*]		
[ENTER]		

B-7 Graphing, the ZStandard Graphing Screen, and Style of Graph

> Before doing any graphing on the calculator, the statistical graphing commands need to be turned off.
>
> [2nd] [STAT PLOT] [4] :PlotsOff [ENTER]

Example 1 Graph $y = x^2$, $y = .5x^2$, $y = 2x^2$, and $y = -1.5x^2$ on the same coordinate axes. Graph the first function with a dotted line, the second function with a thin line, the third function with a thick line, and the fourth function with a thin line.

Solution:

Keystrokes	*Screen Display*	*Explanation*
[Y=] [CLEAR] [X,T,θ,*n*] [x2] [ENTER]		Clear the existing function and store the first function as Y1.
[CLEAR] [.5] [X,T,θ,*n*] [x2] [ENTER]		Clear and store the second function as Y2.
[CLEAR] [2] [X,T,θ,*n*] [x2] [ENTER]		Clear and store the third function as Y3.
[CLEAR] [(-)] [1.5] [X,T,θ,*n*] [x2]		Clear and store the fourth function as Y4.
[▲] [▲] [▲] [▲] [◄] [◄] [ENTER] [ENTER] [ENTER] [ENTER] [ENTER] [ENTER]	 	Go to the symbol to the left of Y1. Press [ENTER] repeatedly until the dotted line appears.
[▼]		Press the down arrow and repeatedly press enter to change the symbol to the left of Y2 to a thin line (the default setting).
[▼] [ENTER]		Press the down arrow and repeatedly press enter the change the symbol to the left of Y3 to a thick line.
[▼]		Change the symbol to the left of Y4 to a thin line (the default setting).
[ZOOM] [6] :ZStandard		Choose the ZStandard option from the [ZOOM] menu.
		Note the ZStandard option automatically sets the graph screen dimentions at $-10 \le x \le 10$ and $-10 \le y \le 10$.

The ZStandard screen automatically sets the graph for $-10 \le x \le 10$ and $-10 \le y \le 10$. Press [WINDOW] to see this.

These window dimensions will be denoted as [-10,10]1 by [-10,10]1 in this document.

The graphs will be plotted in order: Y1, then Y2, then Y3, then Y4, etc.
If there is more than one function graphed, the up [▲] and down [▼] arrow keys allow you to move between the graphs displayed.

B-8 TRACE, ZOOM, WINDOW, Zero, Intersect and Solver

[TRACE] allows you to observe both the *x* and *y* coordinate of a point on the graph as the cursor moves along the graph of the function. If there is more than one function graphed the up [▲] and down [▼] arrow keys allow you to move between the graphs displayed.

[ZOOM] will magnify a graph so the coordinates of a point can be approximated with greater accuracy.

Ways to find the *x* value of an equation with two variables for a given *y* value are:

1. Zoom in by changing the [WINDOW] dimensions.
2. Zoom in by seting the Zoom Factors and using Zoom In from the ZOOM menu.
3. Zoom in by using the Zoom Box feature of the calculator.
4. Use the Zero feature of the calculator.
5. Use the Intersect feature of the calculator.
6. Use the Solver feature of the calculator.

Three methods to zoom in are:

1. Change the WINDOW dimensions.
2. Use the [2] :Zoom In option on the [ZOOM] menu in conjunction with [ZOOM] [▶] [4] :Set Factors.
3. Use the [1] :ZBox option on the [ZOOM] menu.

Example 1 Approximate the value of x to two decimal places if $y = -1.58$ for $y = x^3 - 2x^2 + \sqrt{x} - 8$.

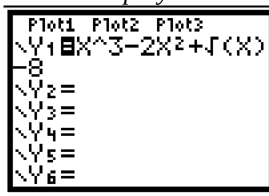
Solution:

Method 1 Change the [WINDOW] dimensions.

Enter the function in the [Y=] list and graph the function using the Standard Graphing Screen (see Section B-7 of this document).

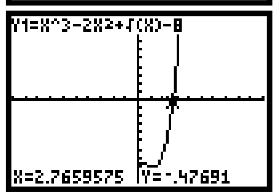
Keystrokes / *Screen Display* / *Explanation*

[Y=] [CLEAR] [X,T,θ,*n*]
[^] [3] [-] [2] [X,T,θ,*n*] [x2] [+]
[2nd] [√] [X,T,θ,*n*] [)] [-] [8]
[ENTER]



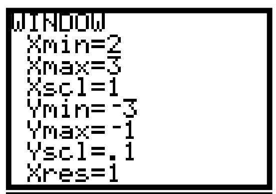
Enter the function as Y1.

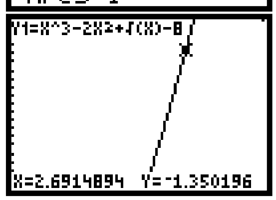
[TRACE] [▶] … [▶]



Get the [TRACE] function and press the right arrow repeatedly until the new type of cursor gives a y value as close to -1.58. The closest point is (2.7659575, -.47691).

[WINDOW] [2]
[ENTER] [3] [ENTER] [.1]
[ENTER] [(-)] [3] [ENTER]
[(-)] [1] [ENTER] [.1]
[GRAPH]
[TRACE] [▶] … [▶]





The x coordinate is between 2 and 3. So we set the [WINDOW] at $2<x<3$ with scale marks every .1 by $-3<y<-1$ with scale marks every .1. This will be written as [2, 3].1 by [-3, -1].1.

Also, set the xRes to 1. This means that the calculator will calculate a value for y for each value for x for which there is a column of pixels on the graph screen. Use [TRACE] again to estimate a new x value.

Change the [WINDOW] appropriately. Repeat using [TRACE] and changing the [WINDOW] until the approximation of (2.67,-1.58) has been found. Hence the desired value for x is approximately 2.67.

> When using TRACE, the initial position of the cursor is at the midpoint of the x values used for xMin and xMax. Hence, you may need to press the right or left arrow key repeatedly before the cursor becomes visible on a graph.

> Occasionally you will see a moving bar in the upper right corner. This means the calculator is working. Wait until the bar disappears before continuing.

Method 2 Use the [2] :Zoom In option on the [ZOOM] menu.

Enter the function in the [Y=] list and graph the function using the ZStandard Graphing Screen (see Method 1 of this example).

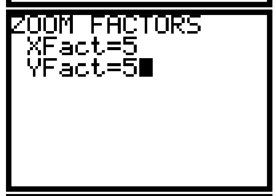
Keystrokes | *Screen Display* | *Explanation*

[ZOOM] [6] :ZStandard

[ZOOM] [▶] [4] :Set Factors

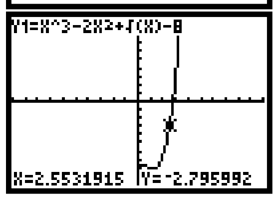
Graph the function using the standard graphing screen. Magnification factors need to be set.

[5] [ENTER] [5]



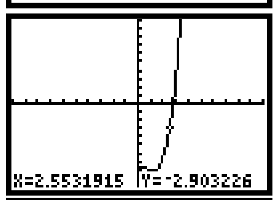
For this example let us set them at 5 for both horizontal and vertical directions.

[TRACE] [▶] …[▶]



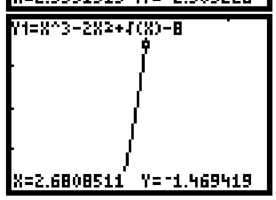
Get the TRACE function and move the cursor using the arrow keys to the point (2.5531915, -2.795992).

[ZOOM] [2] :Zoom In [ENTER]



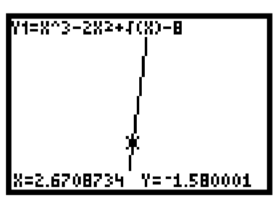
Press [2] :Zoom In from the [ZOOM] menu. Move the cursor to (2.5531915, -2.903226) and press [ENTER] .

[TRACE] [▶] …[▶]



Now press [TRACE] to see the coordinates of a point on the graph. Use the right and left arrow keys to move the cursor to (2.6808511, -1.469419).

Repeat the trace and zoom procedure until you get a value for the *x* coordinate accurate to two decimal places for $y = -1.58$.

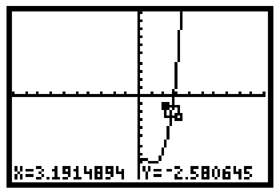
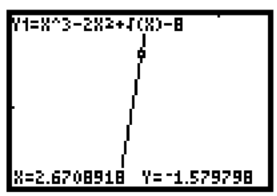


After several zooms your should have a screen similar to the one shown at the left.

The point has coordinates (2.67, -1.58). Hence the desired value for *x* is approximately 2.67.

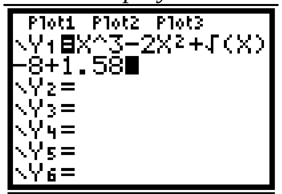
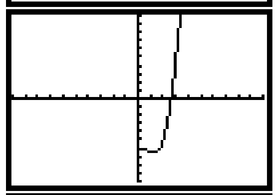
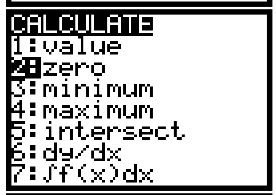
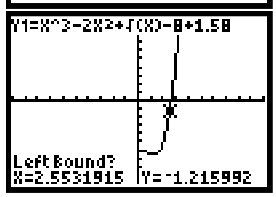
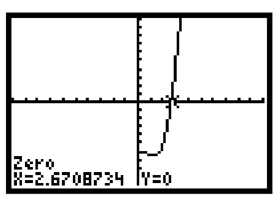
Method 3 Use the [1] :Box option on the [ZOOM] menu.

Graph the function using the ZStandard Graphing Screen. (See Section B-7 of this document).

Keystrokes	*Screen Display*	*Explanation*
[ZOOM] [6] :ZStandard		Graph the function using the standard graphing screen.
[ZOOM] [1] :ZBox		Get the ZOOM BOX feature.
[▶] …[▼] [ENTER]		Use the arrow keys until the cursor is a little to the left and above the point we are trying to find, say at (2.1276596, -1.290323).
		Press ENTER. This anchors the upper left corner of the box.
[▼] …[▶] [ENTER]		Now use the arrow keys to locate the lower right corner of the box, say at (3.1914894, -2.580645).
		Press [ENTER] to get the new display.
		Use [TRACE] to see the coordinates of the point on the graph where *y* is closest to -1.58.
		Repeat the [ZOOM BOX] procedure to get the *x* value of 2.67.

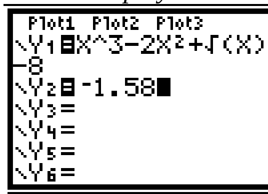
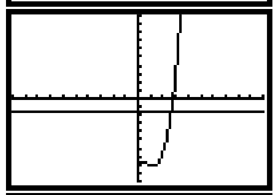
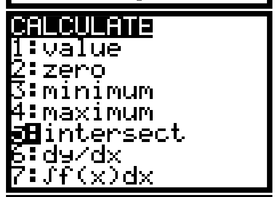
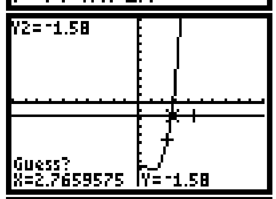
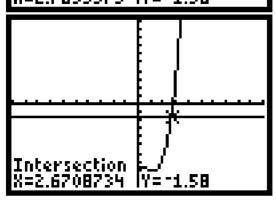
Repeat using trace and zoom box until you get a value for the *y* coordinate accurate to two decimal places. The point has coordinates (2.67, -1.58). Hence the desired value for *x* is approximately 2.67.

<u>Method 4</u> Use the Zero feature of the calculator.

Keystrokes	*Screen Display*	*Explanation*
		Algebraically set the expression involving *x* equal to -1.58, the value of *y*. $x^3 - 2x^2 + \sqrt{x} - 8 = -1.58$
ZOOM 6 :ZStandard		Now change the equation so it is equal to zero. $x^3 - 2x^2 + \sqrt{x} - 8 + 1.58 = 0.$ Enter the left side of the equation into the function list and graph.
2nd CALC 2 :zero ◄ or ► ENTER		Get the zero feature.
◄ or ► ENTER		Place the cursor at a point on the graph to the left of the *x* intercept, say at (2.55…, -1.21…) and press ENTER . Place the cursor at a point on the graph to the right of the *x* intercept, say at (2.76…, 1.10…) and press ENTER .
◄ or ► ENTER		Place the cursor at a point between the left and right bounds, near to the intercept, for the guess. In this case we can leave the cursor at (2.76…, 1.10…).
		Press ENTER to calculate the *x* intercept. The *x* intercept is approximately 2.67. Hence the desired value for *x* is approximately 2.67.

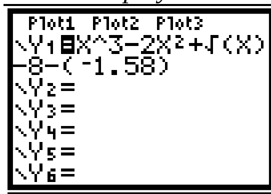
Method 5 Use the Intersect feature of the calculator.

Graph the function using the ZStandard Graphing Screen. (See Section B-7 of this document).

Keystrokes	*Screen Display*	*Explanation*
[Y=] [▼] [▼] [(-)] [1.58] [2nd] [QUIT]		Enter the original function as Y1 and enter -1.58 as Y2 in the function list.
[ZOOM] [6] :ZStandard		Graph the functions using the standard graphing screen.
[2nd] [CALC] [5] :intersect [◀] …[▶] [ENTER]		Get the intersect feature.
[◀] or [▶] [ENTER] [◀] or [▶] [ENTER]		Place the cursor at a point on the first graph near the point of intersection and press [ENTER] . Place the cursor at a point on the second graph near the intersection point and press [ENTER] .
		Move the cursor and press enter for the guess. The intersection point is (2.67, -1.58). Hence the desired value for *x* is approximately 2.67.

Method 6 Use the Solver feature of the calculator

Keystrokes | *Screen Display* | *Explanation*



Write the function as

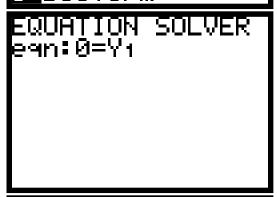
$x^3 -2x^2 +\sqrt{x} - 8 - (-1.58)$.

Enter this as Y1 in the function list.

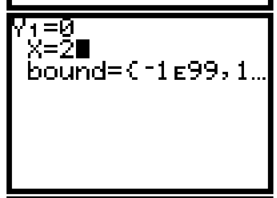
[MATH] [0] :Solver…

Get the EQUATION SOLVER. Recall Y1 from the function list.

[VARS] [▶] [1] :Function

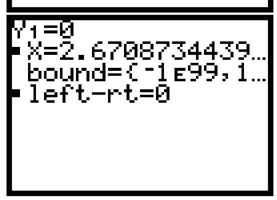


[ENTER] [ENTER] [2]



Continue with the Solver function. Type 2 as the guess.

[ALPHA] [SOLVE]



[SOLVE] is above the [ENTER] key.

Hence the desired value for *x* is approximately 2.67.

Example 2 Approximate the x intercept to two decimal places for $y = x^3 - 2x^2 + \sqrt{x} - 8$.

There are several ways to get a closer look at the intercept:

1. Change the [WINDOW] dimensions.
2. Set the Zoom Factors and zoom in.
3. Use the Zoom Box feature of the calculator.
4. Use the Zero feature of the calculator.
5. Use the Intersect feature of the calculator.
6. Use the Solver feature of the calculator.

Method 1 Change the [WINDOW] dimensions.
This method is described in Section B-8 Example 1 Method 1 of this document.

Method 2 Set the Zoom Factors and zoom in.
This method is described in Section B-8 Example 1 Method 2 of this document.

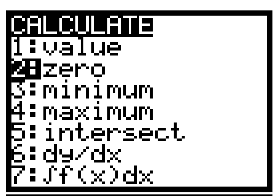
Method 3 Use the Zoom Box feature of the calculator.
This method is described in Section B-8 Example 1 Method 3 of this document.

Method 4 Use the Zero feature of the calculator.

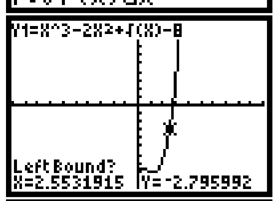
Keystrokes | *Screen Display* | *Explanation*

[ZOOM] [6] :ZStandard — Graph the function.

[2nd] [CALC] [2] :zero — Get the zero feature.

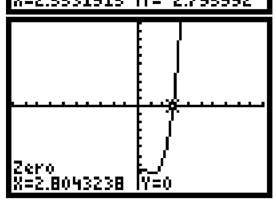


[◄] or [►] [ENTER] — Place the cursor at a point on the graph to the left of the x intercept and press [ENTER] .



[◄] or [►] [ENTER] — Place the cursor at a point on the graph to the right of the x intercept and press [ENTER] .

[◄] or [►] [ENTER] — Place the cursor near the point of intersection for the guess. Press [ENTER] to get the x intercept.



The x intercept is 2.80.

Method 5 Use the Intersect feature of the calculator.
This method is described in Section B-8 Example 1 Method 4 of this document

Method 6 Use the Solver feature of the calculator
This method is described in Section B-8 Example 1 Method 5 of this document.

B-9 Determining the WINDOW Dimensions and Scale Marks

There are several ways to determine the limits of the x and y axes to be used in setting the WINDOW. Three are described below:

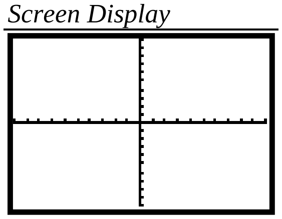
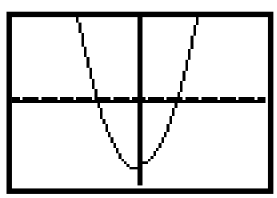
1. Graph using the default setting of the calculator and zoom out. The disadvantage of this method is that often the function cannot be seen at either the default settings or the zoomed out settings of the [WINDOW].
2. Evaluate the function for several values of x. Make a first estimate of the window dimensions based on these values.
3. Analyze the leading coefficient and/or the constant terms.

A good number to use for the scale marks is one that yields about 20 marks across the axis. For example if the [WINDOW] is [-30, 30] for an axis then a good scale value is $\frac{30-(-30)}{20}$ or 3.

Example 1 Graph the function $f(x) = .2x^2 + \sqrt[3]{x} - 32$.

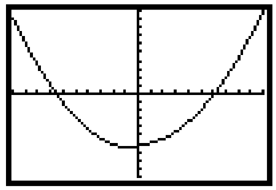
Solution:

Method 1 Use the default setting and zoom out.

Keystrokes	*Screen Display*	*Explanation*
[Y=] [CLEAR] [.2] [X,T,θ,n] [^] [2] [+] [MATH] [4] :$\sqrt[3]{\ }$ [X,T,θ,n] [)] [-] [32] [ZOOM] [6] :ZStandard		Nothing is seen on the graph screen because no part of this curve is in this [WINDOW].
[ZOOM] [▶] [4] :Set Factors [4] [ENTER] [4] [ZOOM] [3] :Zoom Out [▼] …[▶] [ENTER]		Set the zoom factors to 4. See Section 8 Example 1 Method 2 in this document. Then press [ZOOM] [3] and use the arrow keys to move the cursor to the point you wish to be the center of the new zoom screen. We chose (0, 0). The cursor will be a flashing + which looks like a single point flashing when the + is placed at (0, 0). Zooming out shows a parabolic shaped curve.

Method 2 Evaluate the function for several values of x. (See Section B-5 on how to evaluate a function at given values of x.)

x	f(x)
-20	45.3
-10	-14.2
0	-32.0
10	-9.8
20	50.7



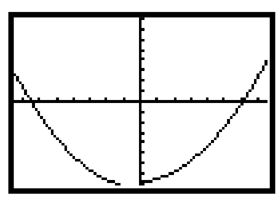
Analyzing this table indicates that a good WINDOW to start with is [-20,20]2 by [-50,50]5. Note the scale is chosen so that about 20 scale marks will be displayed along each of the axes. The scale is chosen as 2 for the x axis since $\frac{20-(-20)}{20} = 2$ and 5 for the y axis since $\frac{50-(-50)}{20} = 5$.

Method 3 Analyze the leading coefficient and constant terms.
Since the leading coefficient is .2 the first term will increase .2 units for each 1 unit x^2 increases or 2 units for each 10 units x^2 increases. This means that the first term will increase for every $\sqrt{10}$ (or about 3 units increase) in x. A first choice for the x axis limits can be found using:

$$\frac{10\times(\text{unit increase in } x)}{(\text{first term increase})} = \frac{10\times 3}{2} = 15$$

A first choice for the scale on the x axis (having about 20 marks on the axis) can be found using $\frac{\text{Xmax}-\text{Xmin}}{20} = \frac{15-(-15)}{20} = 1.5$ (round to 2). So the limits on the x axis could be [-15,15]2.

A first choice for the y axis limits could be ±(constant term).
The scale for the y axis can be found using $\frac{\text{Ymax}-\text{Ymin}}{20} = \frac{32-(-32)}{20} = 3.2$ (round to 4). So a first choice for the y axis limits could be [-32,32]4. Hence a good first setting for the WINDOW is [-15,15]2 by [-32,32]4.



[-15, 15]2 by [-32, 32]4

> A good choice for the **scale** is so that about 20 marks appear along the axis.
> This is $\frac{\text{Xmax}-\text{Xmin}}{20}$ (rounded up to the next integer) for the x axis and $\frac{\text{Ymax}-\text{Ymin}}{20}$ (rounded up to the next integer) for the y axis.

B-10 Piecewise-Defined Functions

There are two methods to graph piecewise-defined functions:

1. Graph each piece of the function separately as an entire function on the same coordinate axes. Use trace and zoom to locate the partition value on each of the graphs.

2. Store each piece of the function separately but include an inequality statement following the expression which will set the WINDOW of values on *x* for which the function should be graphed. Then graph all pieces on the same coordinate axes.

Example 1 Graph $f(x) = \begin{cases} x^2+1 & x < 1 \\ 3x-5 & x \geq 1 \end{cases}$

Solution:

Method 1

Keystrokes

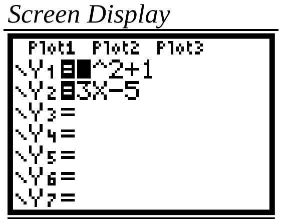
[Y=] [CLEAR] [X,T,θ,*n*] [^]

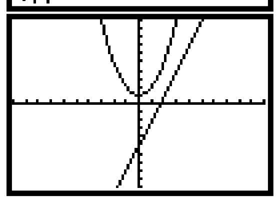
[2] [+] [1] [ENTER]

[CLEAR] [3] [X,T,θ,*n*]

[-] [5] [ZOOM] [6] :ZStandard

Screen Display





Explanation

Store the functions. Graph. Both functions will be displayed. Use trace and zoom to find the point on the graphs where *x*=1. When drawing this curve on paper, place an open circle on as the endpoint of the piece of the graph not including *x*=1 and a closed circle as the endpoint of the piece of the graph including *x*=1.

Method 2

Keystrokes

[Y=] [CLEAR] [X,T,θ,*n*] [^]

[2] [+] [1] [)] [÷]

[(] [X,T,θ,*n*] [2nd]

[TEST] [5] :< [1] [)]

[ENTER]

[CLEAR] [(] [3]

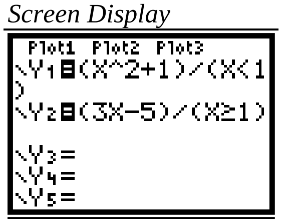
[X,T,θ,*n*] [-] [5] [)] [÷]

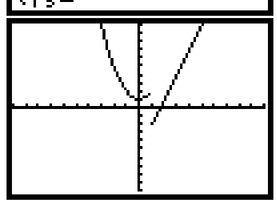
[(] [X,T,θ,*n*] [2nd] [TEST]

[4] :≥ [1] [)]

[ZOOM] [6] :ZStandard

Screen Display





Explanation

The logical statement *x*<1 will give a 1 when the value of *x* is less than 1 and a 0 when the value of *x* is greater than or equal to 1. Hence the first part of the function is divided by 1 when *x*<1 and 0 when *x*≥1. The function will not graph when it is divided by 0. Similarly for the logical statement *x*≥1 for the second part of the function. The 1 and 0 are not shown on the screen but are used by the calculator when graphing the functions.

B-11 Solving Equations in One Variable

There are three methods for approximating the solution of an equation:

1. Write the equation as an expression equal to zero. Graph y=(the expression). Find the x intercepts. These x values are the solution to the equation. This can be done using [TRAC] E and [ZOOM] or using the Solver from the [MATH] menu. See Section B-8 of this document.

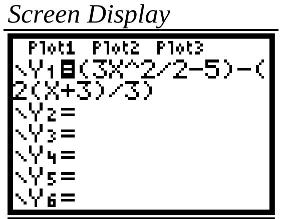
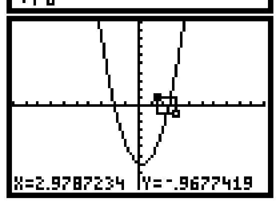
2. Graph y=(left side of the equation) and y=(right side of the equation) on the same coordinate axes. The x coordinate of the points of intersection are the solutions to the equation. This can be done using [TRACE] and [ZOOM] or using intersect from the [CALC] menu.

<u>Example 1</u> Solve $\frac{3x^2}{2} - 5 = \frac{2(x+3)}{3}$.

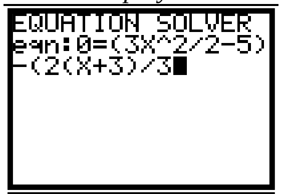
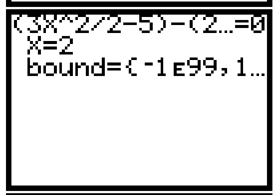
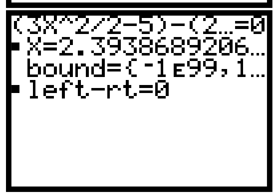
Solution:

<u>Method 1 Using TRACE and ZOOM</u>

Write the equation as $\left(\frac{3x^2}{2} - 5\right) - \left(\frac{2(x+3)}{3}\right) = 0$. Graph $y = \left(\frac{3x^2}{2} - 5\right) - \left(\frac{2(x+3)}{3}\right)$. Now we want to find the x value where the graph crosses the x axis. This is the x intercept.

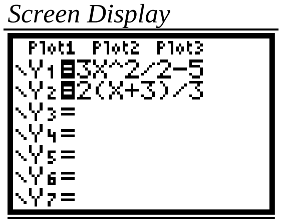
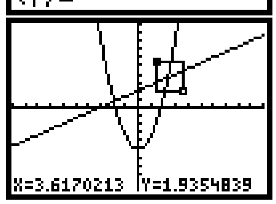
Keystrokes	*Screen Display*	*Explanation*
[Y=] [CLEAR] [(] [3] [X,T,θ,*n*] [^] [2] [÷] [2] [-] [5] [)] [-] [(] [2] [(] [X,T,θ,*n*] [+] [3] [)] [÷] [3] [)] [ZOOM] [6] :ZStandard	 	Store the expression as Y1. Use trace and zoom to find the x intercepts. They are: $x\approx -1.95$ and $x\approx 2.39$. Hence, the solutions are: $x\approx -1.95$ and $x\approx 2.39$. A typical zoom box is shown on the graph at the left. (See Section B-8 Method 3 of this document.)

Method 1 Using Solver

Keystrokes	*Screen Display*	*Explanation*
[MATH] [0] :Solver [▲] [(] [3] [X,T,θ,*n*] [^] [2] [÷] [2] [-] [5] [)] [-] [(] [2] [+] [3] [)] [÷] [3] [)] [ENTER] [2]	 	The keystrokes given require the function to be entered in the Solver command. You could store the left and right side of the equation as Y1 and Y2 and put Y1-Y2 as the function in the Solver command. Enter 2 as the initial guess. The approximate solutions to this equation are -1.95 and 2.39, rounded to two decimal places.
[ALPHA] [SOLVE]		

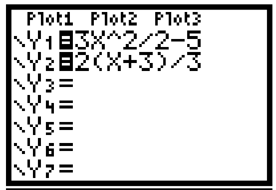
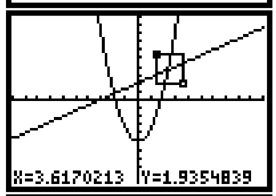
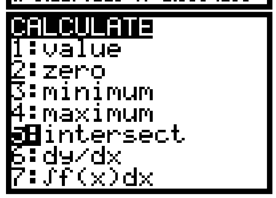
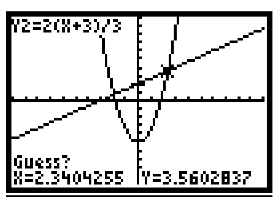
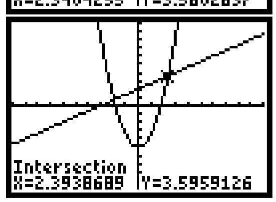
Method 2 Using TRACE and ZOOM

Graph $y = \frac{3x^2}{2} - 5$ and $y = \frac{2(x+3)}{3}$ on the same coordinate axes and find the x coordinate of their points of intersection.

Keystrokes	*Screen Display*	*Explanation*
[Y=] [CLEAR] [3] [X,T,θ,*n*] [^] [2] [÷] [2] [-] [5] [ENTER] [CLEAR] [2] [(] [X,T,θ,*n*] [+] [3] [)] [÷] [3]		Store the two functions. Find the points of intersection using trace and zoom.
[ZOOM] [6] :ZStandard		Use trace and zoom to find the x values: $x \approx -1.95$ and $x \approx 2.39$. A typical zoom box is shown on the graph at the left.

Method 2 Using Intersect

Graph $y = \frac{3x^2}{2} - 5$ and $y = \frac{2(x+3)}{3}$ on the same coordinate axes and find the x coordinate of their points of intersection.

Keystrokes	*Screen Display*	*Explanation*
Y= CLEAR 3 X,T,θ,*n* ^ 2 ÷ 2 - 5 ENTER CLEAR 2 (X,T,θ,*n* + 3) ÷ 3 ZOOM 6 :ZStandard	 	Store the two functions and graph using the standard window dimensions.
2nd CALC 5 :intersect ENTER		Select intersect from the CALC menu.
ENTER		Select the first curve. Look in the upper right corner for the function number.
ENTER		Select the second curve.
▶ …▶ ENTER		Move the cursor so it is near the intersection point and press ENTER .
		The approximate solution is 2.39. Use intersect again to find the other solution of -1.95.

Hence the approximate solutions to this equation are -1.95 and 2.39.

B-12 Solving Inequalities in One Variable

Two methods for approximating the solution of an inequality using graphing are:

1. Write the inequality with zero on one side of the inequality sign. Graph *y*=(the expression). Find the *x* intercepts. The solution will be an inequality with the *x* values (*x* intercepts) as the cut off numbers. The points of intersection can be found using [TRACE] and [ZOOM] or using the [SOLVER] from the [MATH] menu.

2. Graph *y*=(left side of the inequality) and *y*=(right side of the inequality) on the same coordinate axes. The *x* coordinate of the points of intersection are the solutions to the equation. Identify which side of the *x* value satisfies the inequality by observing the graphs of the two functions.
   The points of intersection can be found using [TRACE] and [ZOOM] or using intersect from the [CALC] menu.

Example 1 Approximate the solution to $\frac{3x^2}{2} - 5 \le \frac{2(x+3)}{3}$. Use two decimal place accuracy.

Solution:

Method 1

Write the equation as $\left(\frac{3x^2}{2} - 5\right) - \left(\frac{2(x+3)}{3}\right) \le 0$. Graph $y = \left(\frac{3x^2}{2} - 5\right) - \left(\frac{2(x+3)}{3}\right)$ and find the *x* intercepts. This was done in Section B-10 Example 1 Method 1.

The *x* intercepts are -1.95 and 2.39. The solution to the inequality is the interval on *x* for which the graph is below the *x* axis. The solution is $-1.95 \le x \le 2.39$.

Method 2 Graph $y = \frac{3x^2}{2} - 5$ and $y = \frac{2(x+3)}{3}$ on the same coordinate axes and find the *x* coordinate of their points of intersection. See Section B-10 Example 1 Method 2. The *x* coordinate of the points of intersections are -1.95 and 2.39. We see that the parabola is below the *x* line for $-1.95 \le x \le 2.39$. Hence the inequality is satisfied for $-1.95 \le x \le 2.39$.

To test this inequality, choose -2 as a test value. Evaluating the original inequality using the calculator yields a 0 which means the inequality is not true for this value of x. (See Section D-6 of this document.) Repeat the testing using 0 and 3. We see that the inequality is true for *x*=0 and not true for *x*=3. Hence the inequality is satisfied for $-1.95 \le x \le 2.39$.

B-13 Storing an Expression That Will Not Graph

Example 1 Store the expression $B^2 - 4AC$ so that it will not be graphed but so that it can be evaluated at any time. Evaluate this expression for A=3, B=2.58, and $C=\sqrt{3}$.

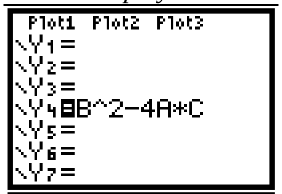
Solution:

Keystrokes | *Screen Display* | *Explanation*

[Y=] [▼] [▼] [▼] [CLEAR]

[ALPHA] [B] [^] [2] [-] [4]

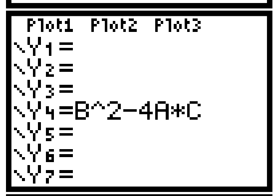
[ALPHA] [A] [x] [ALPHA] [C]



Choose Y4 using the arrow keys. (Any of Y1, Y2, Y3, … could be used.) Store the expression.

[◄] …[◄] [ENTER]

[2nd] [QUIT]



Use the left arrow repeatedly until the cursor is over the = sign. Press [ENTER] . The highlighting will disappear from the = sign. Now you can still evaluate the expression by recalling it, but it will not graph.

[3] [STO▶] [ALPHA] [A] [ENTER]

[2.58] [STO▶]

[ALPHA] [B] [ENTER]

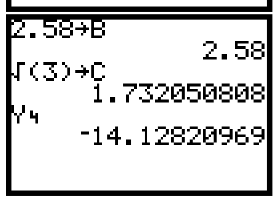
[2nd] [√] [3] [STO▶] [ALPHA]

[C] [ENTER]

Store the value of the variables.

[VARS] [▶] [1] :Function…

[4] :Y4 [ENTER]



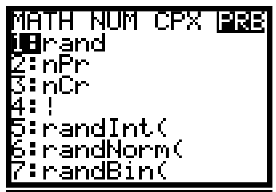
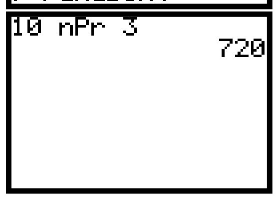
Recall the function from the function list. The value of the expression is -14.128 rounded to three decimal places.

B-14 Permutations and Combinations

Example 1 Find (A) $P_{10,3}$ and (B) $C_{12,4}$ or $\binom{12}{4}$.

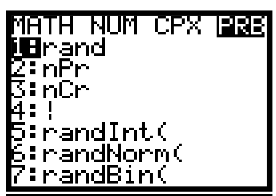
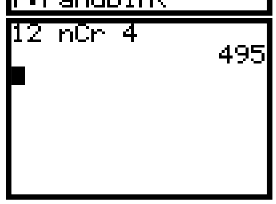
Solution (A):

The quantity can be found by using the definition $\frac{10!}{7!}$ or the built-in function nPr.

Keystrokes	*Screen Display*	*Explanation*
[10]		Enter the first number.
[MATH] [▶] [▶] [▶]		Get the math menu and choose PRB using the arrow keys.
		Choose nPr and press [ENTER] .
[2] :nPr [3] [ENTER]		Enter 3 and press [ENTER] .

Solution (B):

The quantity can be found by using the definition $\frac{12!}{4!8!}$ or using the built-in function nCr.

Keystrokes	*Screen Display*	*Explanation*
[12]		Enter the first number.
[MATH] [▶] [▶] [▶]		Get the math menu and choose PRB using the arrow keys.
		Choose nCr and press [ENTER] .
[3] :nCr [4] [ENTER]		Enter 4 and press [ENTER] .

B-15 Matrices

Example 1 Given the matrices

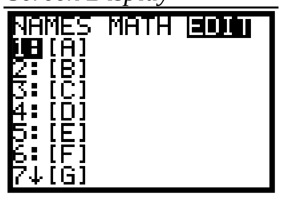
$$A = \begin{bmatrix} 1 & -2 \\ 3 & 0 \\ 5 & -8 \end{bmatrix} \quad B = \begin{bmatrix} 2 & 1 & 5 \\ 3 & 2 & -1 \\ 0 & 8 & -3 \end{bmatrix} \quad C = \begin{bmatrix} 1 \\ -5 \\ 10 \end{bmatrix}$$

Find (A) -3BC (B) B^{-1} (C) A^T (D) det B

Solution (A):

Keystrokes | *Screen Display* | *Explanation*

[2nd] [MATRX] [▶] [▶]



Enter the matrix mode.

Choose EDIT using the arrow keys.

[1] :[A]

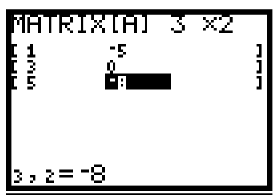
[3] [ENTER] [2] [ENTER]

Choose the A matrix.
Enter the dimensions of the matrix.

[1] [ENTER] [(-)] [2] [ENTER]

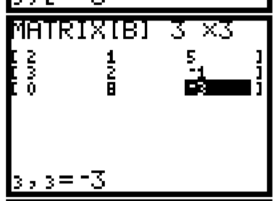
[3] [ENTER] [0] [ENTER]

[5] [ENTER] [(-)] [8] [ENTER]



Enter the matrix elements.

[2nd] [MATRX] [▶] [▶] etc.

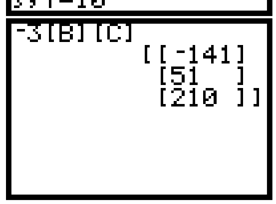


Return to the matrix menu and repeat the procedure to enter matrix B and C.

[2nd] [QUIT] [CLEAR]

[(-)] [3] [2nd] [MATRX] [2] :[B]

[2nd] [MATRX] [3] :[C]



Return to the home screen to do calculations.
Operations are entered as usual except use the matrix symbols from the MATRX NAMES menu.

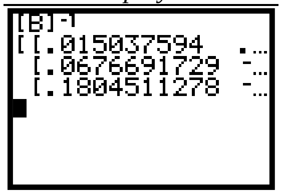
Solution (B):

Keystrokes

[2nd] [MATRX] [2] :[B]

[x-1] [ENTER]

Screen Display



Explanation

Notice the way inverses are found. The rest of the matrix can be seen using the right arrow keys.

Solution (C):

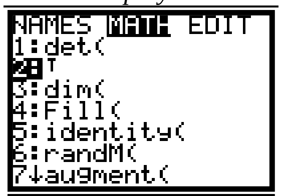
Keystrokes

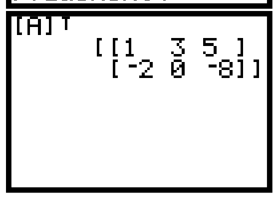
[2nd] [MATRX] [1] :[A]

[2nd] [MATRX] [▶] [2] :ᵀ

[ENTER]

Screen Display





Explanation

Get the matrix from the NAMES menu.

Choose the transpose from the MATRX MATH menu.

Solution (D):

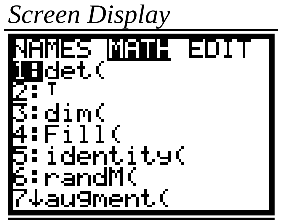
Keystrokes

[2nd] [MATRX] [▶] [1] :det(

[2nd] [MATRX] [2] :[B] [)]

[ENTER]

Screen Display



Explanation

Choose the determinant option from the matrix menu.

Example 2 Find the reduced form of matrix $\begin{bmatrix} 2 & 1 & 5 & 1 \\ 3 & 2 & -1 & -5 \\ 0 & 8 & -3 & 10 \end{bmatrix}$.

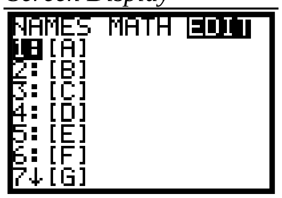
Solution:
There are two methods that can be used:

1. Use the row operations individually.
2. Use rref(from the MATRX MATH menu.

Method 1 Using row operations

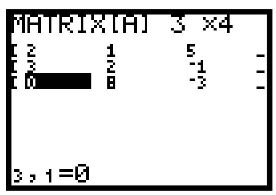
Keystrokes | *Screen Display* | *Explanation*

[2nd] [MATRX] [▶] [▶]



Enter the matrix mode and choose EDIT using the arrow keys. If there are numbers after the matrix name, this means that there are numbers already stored in the matrix. This does not matter. Continue as directed below.

[1] :[A]
[3] [ENTER] [4] [ENTER]
[2] [ENTER] [1] [ENTER]
[5] [ENTER] [1] [ENTER]
[3] [ENTER] [2] [ENTER] etc.

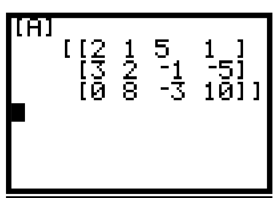


Choose the A matrix.
Store the dimensions of the matrix.
Enter the elements row by row.

[2nd] [QUIT]

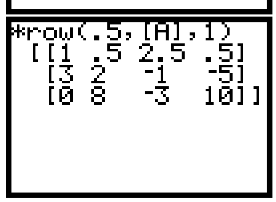
When all elements are entered, press [2nd] [QUIT] to get the Home Screen.

[2nd] [MATRX] [1] :[A] [ENTER]



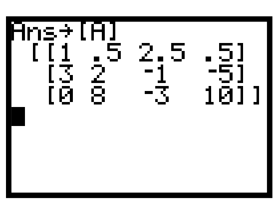
Display the matrix from the MATRX menu.

[2nd] [MATRX] [▶] [ALPHA]
[E] :*row([.5]
[,] [2nd] [MATRX] [1] :[A]
[,] [1] [)] [ENTER]



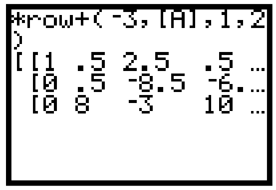
Multiply row 1 of matrix A by .5. Another way to say this that might help to remember the order of entries within the parentheses is to think:
.5 times matrix A row 1.

[STO▸] [2nd] [MATRX] [1] :[A]
[ENTER]



Store the result in matrix A location. It is a good idea to store the answer. You can always operate on the latest answer using [2nd] [ANS] .

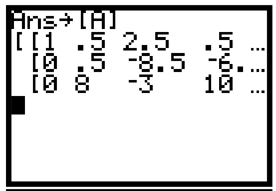
2nd MATRX ► ALPHA F :*row+((-) 3 , 2nd MATRX 1 :[A] , 1 , 2) ENTER



However, if you make a mistake and the new matrix is not stored, you will need to start over from the beginning.

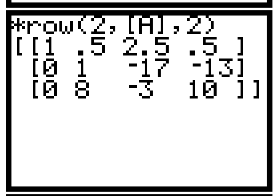
Multiply -3 times matrix A row 1 to add to row 2.

STO► 2nd MATRX 1 :[A] ENTER



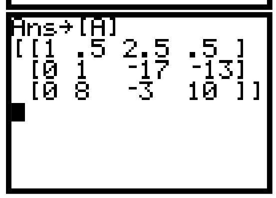
Store the result as matrix A.

2nd MATRX ► ALPHA E :*row(2 , 2nd MATRX 1 : [A] , 2) ENTER



2 times matrix A row 2.

STO► 2nd MATRX 1 :[A] ENTER



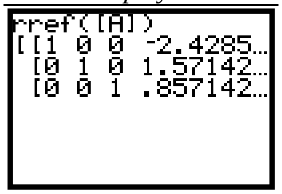
Store the result as matrix A.

Continue using row operations to arrive at the reduced form of $\begin{bmatrix} 1 & 0 & 0 & -2.428... \\ 0 & 1 & 0 & 1.571... \\ 0 & 0 & 1 & .857... \end{bmatrix}$.

To swap rows of a matrix use ALPHA C :rowSwap(from the MATRX ► menu.
To swap rows 2 and 3 in matrix [A] use rowSwap([A],2,3).
To add one row to another use ALPHA D :row+(from the MATRX ► menu.

Method 2 Using rref(from the MATRX MATH menu

Enter the elements in the matrix as done in Method 1.

Keystrokes	*Screen Display*	*Explanation*
[2nd] [MATRX] [▶] [ALPHA] [B] :rref([2nd] [MATRX] [1] :[A] [)] [ENTER]		Enter the matrix mode and choose MATH using the arrow keys. Select the rref(command and recall matrix A. This command will give the row-echelon form of matrix A, which has the identity matrix in the first three columns and constants as the fourth column.

Hence if a system of equations is

$$\begin{aligned} 2x_1 + x_2 + 5x_3 &= 1 \\ 3x_1 + 2x_2 - x_3 &= -5 \\ 8x_2 - 3x_3 &= 10 \end{aligned}$$

with augmented coefficient matrix

$$\begin{bmatrix} 2 & 1 & 5 & 1 \\ 3 & 2 & -1 & -5 \\ 0 & 8 & -3 & 10 \end{bmatrix}$$

the solution, rounded to two decimal places, of the system of equations is

$$\begin{aligned} x_1 &= -2.43 \\ x_2 &= 1.57 \\ x_3 &= .86 \end{aligned}$$

B-16 Graphing an Inequality

To graph an inequality:

- Change the inequality sign to an equals sign.
- Solve the equation for *y*.
- Enter this expression in the function list on the calculator. This is the boundary curve.
- Determine the half-plane by choosing a test point not on the boundary curve and substituting the test value into the original nequality. This can be done using paper and pencil.
- Graph the boundary curve using the lower shade option on the calculator to get a shaded graph.

<u>Example 1</u> Graph $3x + 4y \le 12$.

Solution:

Changing the inequality sign to an equals sign yields $3x + 4y = 12$. Solving this equation for y yields $y = (12 - 3x)/4$. Determine the correct half-plane by substituting the point (0,0) into the original inequality. We have $3(0) + 4(0) \le 12$, which is a true statement. Hence the point (0, 0) is in the solution set of the inequality.

Keystrokes

[Y=] [CLEAR] [(] [12]

[-] [3] [X,T,θ,*n*]

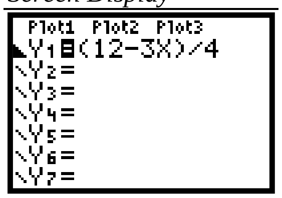
[)] [÷] [4]

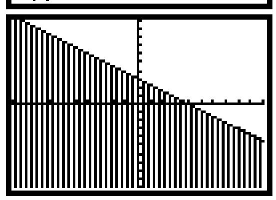
[◀] ... [◀]

[ENTER] [ENTER] [ENTER]

[ZOOM] [6] :ZStandard

Screen Display





Explanation

Clear any existing graphs. Turn all plots off.

Graph $3x+4y=12$ by first writing it as $y=(12-3x)/4$.

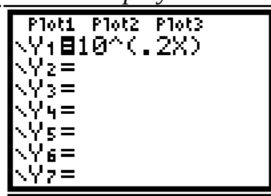
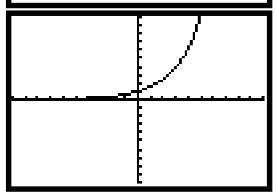
Determine the half-plane by choosing the point (0, 0) and substituting into the inequality **by hand** using paper and pencil. $3\cdot0+4\cdot0<12$ is a true statement. The inequality is true for this point. Hence, we want the lower half-plane.

Use the left arrow to move the cursor to the graph style icon. Press enter repeatedly until the lower half is shaded. Graph.

B-17 Exponential and Hyperbolic Functions

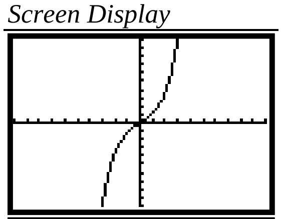
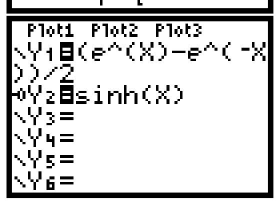
Example 1 Graph $y = 10^{0.2x}$

Solution:

Keystrokes	*Screen Display*	*Explanation*
Y= CLEAR 10 ^ (.2 X,T,θ,*n*) ZOOM 6 :ZStandard	 	Store the function and graph. Note the entire exponent needs to be in parentheses.

Example 2 Graph $y = \frac{e^{x} - e^{-x}}{2}$.

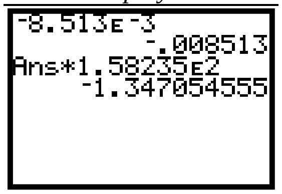
Solution:

Keystrokes	*Screen Display*	*Explanation*
Y= CLEAR (2nd e^x X,T,θ,*n*) - 2nd e^x (-) X,T,θ,*n*)) ÷ 2 ZOOM 6 :ZStandard		Store the function and graph.
Y= ▼ CLEAR 2nd CATALOG ▼ … ▼ ENTER X,T,θ,*n*) ◄ …◄ ENTER ENTER ENTER ENTER GRAPH		This is also the hyperbolic sine. So we could use sinh from the catalog list. Get the sinh from the catalog list. Enter X as the variable and graph. Store it as Y2 and use the graph style --0. Watch closely and you will see the --0 tracing the graph of Y1.

B-18 Scientific Notation, Significant Digits, and Fixed Number of Decimal Places

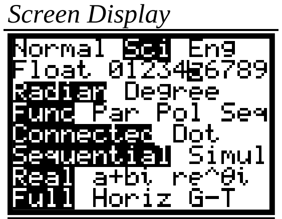
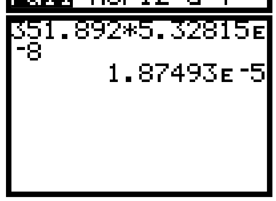
Example 1 Calculate $(-8.513\times10^{-3})(1.58235\times10^{2})$. Enter numbers in scientific notation.

Solution:

Keystrokes	*Screen Display*	*Explanation*
[(-)] [8.513] [2nd] [EE] [(-)] [3] [ENTER]		Enter the first number. The number displayed is not in scientific notation. (It is not necessary to press [ENTER] at this point. This is done here to show how the numbers are displayed on the screen.)
[×] [1.58235] [2nd] [EE] [2] [ENTER]		Multiply by the second number.

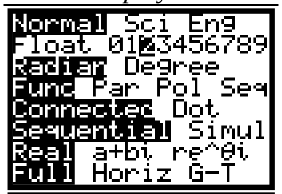
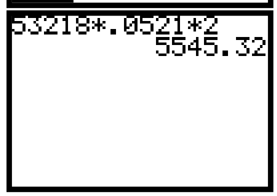
Example 2 Set the scientific notation to six significant digits and calculate $(351.892)(5.32815\times10^{-8})$.

Solution:

Keystrokes	*Screen Display*	*Explanation*
[MODE] [▶] [ENTER]		Select `Sci` using the arrow keys and press [ENTER] .
[▼] [▶] [▶] [▶] [▶] [▶] [▶] [ENTER]		Select 5 decimal places using the arrow keys and press [ENTER] . Five decimal places will give six significant digits in scientific mode.
[2nd] [QUIT]		Return to the Home Screen.
[351.892] [×] [5.32815]		Enter the numbers.
[2nd] [EE] [(-)] [8] [ENTER]		Note the result is displayed in scientific notation with six significant digits.

Example 3 Fix the number of decimal places at 2 and calculate the interest earned on $53,218.00 in two years when invested at 5.21% simple interest.

Solution:

Keystrokes	*Screen Display*	*Explanation*
[MODE] [ENTER]		Choose normal notation with 2 fixed decimal points.
[▼] [▶] [▶] [▶] [ENTER]		
[2nd] [QUIT]		Return to the Home Screen.
[53218] [×] [.0521] [×] [2] [ENTER]		Only two decimal places are shown in the answer. The interest is $5545.32.

Change the number of decimal places back to Float.

B-19 Angles and Trigonometric Functions

Example 1 Evaluate $f(x) = \sin x$ and $g(x) = \tan^{-1} x$ at $x = \frac{5\pi}{8}$.

Solution:

Keystrokes

[MODE] [▼] [ENTER]

[▼] [ENTER]

[2nd] [QUIT]

[5] [2nd] [π] [÷] [8]

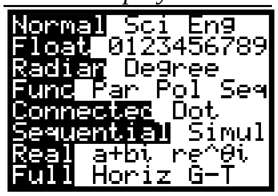
[STO▸] [X,T,θ,*n*] [ENTER]

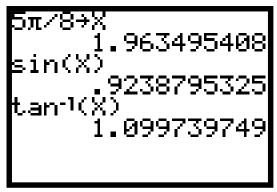
[SIN] [X,T,θ,*n*] [)] [ENTER]

[2nd] [TAN⁻¹] [X,T,θ,*n*] [)]

[ENTER]

Screen Display





Explanation

Set the mode to Float.
Since the angle measure is given in radians, set the calculator for radian measure before starting calculations.
Return to the Home screen.

Store $\frac{5\pi}{8}$ as *x*.

Get sine function and evaluate.

Get the inverse tangent function and evaluate.

Example 2 Evaluate $f(x) = \csc x$ at $x = 32° 5' 45''$.

Solution:

Keystrokes

[MODE] [▼] [ENTER]

[▼] [▶] [ENTER]

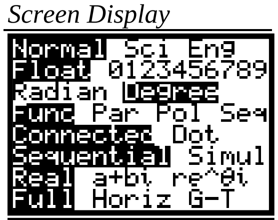
[2nd] [QUIT]

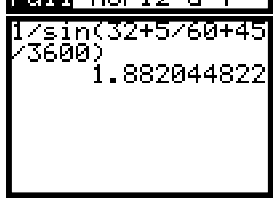
[1] [÷] [SIN] [32] [+]

[5] [÷] [60] [+] [45] [÷]

[3600] [)] [ENTER]

Screen Display





Explanation

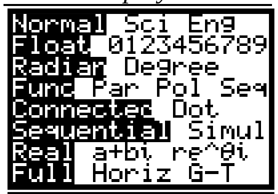
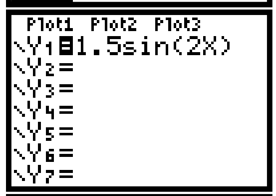
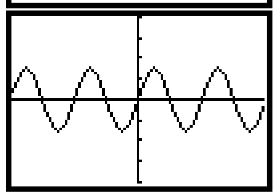
Set the mode to Float.
Since the angle measure is given in degrees, set the calculator for degree measure before starting calculations. Return to the Home Screen using.

Use $\frac{1}{\sin x}$ to evaluate csc *x*.

Change the minutes and seconds to decimal values while entering the angle measure.

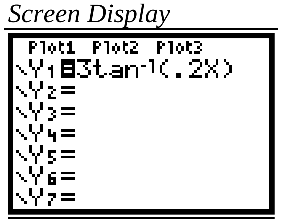
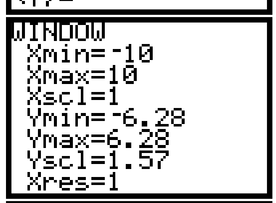
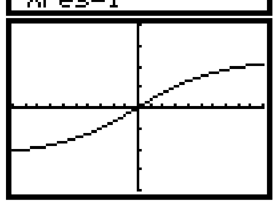
Example 3 Graph $f(x) = 1.5 \sin 2x$.

Solution:

Keystrokes	*Screen Display*	*Explanation*
MODE ▼ ▼ ENTER		Set MODE to Radian measure.
Y= CLEAR 1.5 SIN 2 X,T,θ,*n*)		Store *f*(*x*) as Y1.
ZOOM 7 :Trig		Use the trigonometric option on the ZOOM menu to get tick marks set at radian measures on the horizontal axis since the angle measure is in radians. Press WINDOW to see the WINDOW dimensions are set at [-6.15…, 6.15…]1.57… by [-4, 4]1.

Example 4 Graph $g(x) = 3\tan^{-1}(.2x)$.

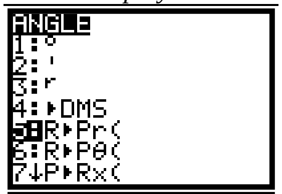
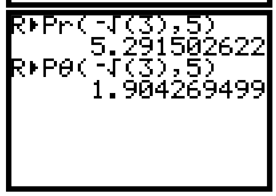
Solution:

Keystrokes	*Screen Display*	*Explanation*
Y= CLEAR 3 2nd TAN-1 .2 X,T,θ,*n*)		Store *g*(*x*) as Y1.
WINDOW (-) 10 ENTER 10 ENTER 1 ENTER (-) 6.28 ENTER 6.28 ENTER 1.57		Set the WINDOW dimensions to [-10, 10]1 by [-6.28, 6.28]1.57
GRAPH		Graph the function.

B-20 Polar Coordinates and Polar Graphs

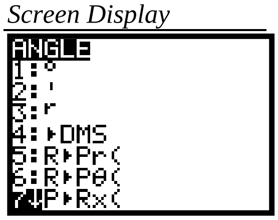
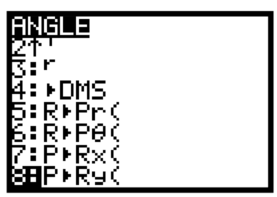
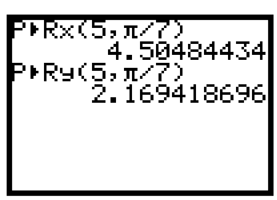
Example 1 Change the rectangular coordinates ($-\sqrt{3}$, 5) to polar form with $r \geq 0$ and $0 \leq \theta \leq 2\pi$.

Solution:

Keystrokes	*Screen Display*	*Explanation*
[2nd] [ANGLE] [5] :R▶Pr(		Get the angle menu. Choose rectangular to polar conversion that displays the *r* value.
[(-)] [2nd] [√] [3] [)] [,] [5] [)] [ENTER]		Enter the value of *x* and *y* coordinates. The displayed value is *r*.
[2nd] [ANGLE] [6] :R▶Pθ(		Get the angle menu again. Choose the rectangular to polar conversion that displays the value of *θ*.
[(-)] [2nd] [√] [3] [)] [,] [5] [)] [ENTER]		Enter the value of *x* and *y* coordinates. The displayed value is *θ*.

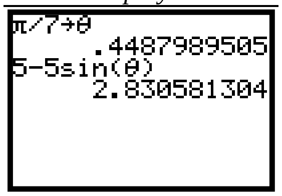
Example 2 Change the polar coordinates (5,□/7) to rectangular coordinates.

Solution:

Keystrokes	*Screen Display*	*Explanation*
[2nd] [ANGLE] [7] :P▶Rx(		Get the angle menu. Choose polar to rectangular conversion that displays the value of *x*.
[5] [,] [2nd] [π] [÷] [7] [)] [ENTER]		Enter the value of *r* and *θ*. The displayed value is *x*.
[2nd] [ANGLE] [8] :P▶Ry(		Get the angle menu again. Choose polar to rectangular conversion that displays the value of *y*.
[5] [,] [2nd] [π] [÷] [7] [)] [ENTER]		Enter the value of *r* and *θ*. The displayed value is *y*.

Example 3 Find the value of r for $r = 5 - 5\sin\theta$ at $\theta = \frac{\pi}{7}$.

Solution:

Keystrokes	*Screen Display*	*Explanation*
[2nd] [π] [÷] [7] [STO▶]		Store $\frac{\pi}{7}$ as θ .
[ALPHA] [θ] [ENTER]		θ is above the [3] .
[5] [-] [5] [SIN] [ALPHA] [θ] [)] [ENTER]		Enter $5 - 5\sin\theta$ and evaluate.

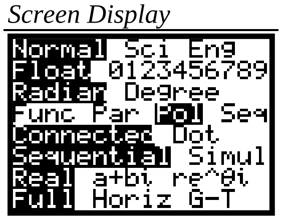
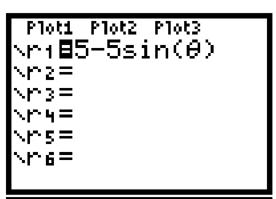
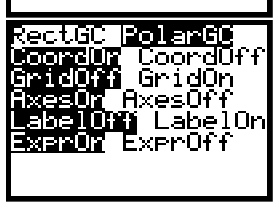
Example 4 Graph $r = 5 - 5\sin\theta$

Polar equations can be graphed by using the polar graphing mode of the calculator.

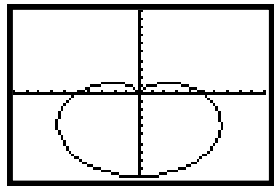
In general the steps to graph a polar function are:

Step 1 Set the calculator in polar graph mode.
Step 2 Enter the function in the Y= list (This list now has r= as the function names.)
Step 3 Set the WINDOW FORMAT to PolarGC
Step 4 Graph using the standard graph setting [ZOOM] [6] :ZStandard and then the square setting of the calculator [ZOOM] [5] :ZSquare to get a graph with equal spacing between the scale marks.
Step 5 Zoom in to get a larger graph if you wish.

Solution:

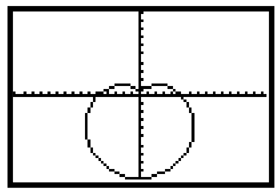
Keystrokes	*Screen Display*	*Explanation*
[MODE] [▼] [▼] [▼] [▶] [▶] [ENTER]		Select polar mode.
[2nd] [QUIT]		Return to the Home screen.
[Y=] [5] [-] [5] [SIN] [X,T,θ,n] [)]		Get the [Y=] list and enter the function as r1.
[2nd] [FORMAT] [▶] [ENTER]		Get the FORMAT menu on the [WINDOW] menu. Select PolarGC for polar graphs.

[ZOOM] [6] :Standard



Graph using the standard dimensions for the window. The graph on the standard screen is slightly distorted since the scale marks on the *y* axis are closer together than the scale marks on the *x* axis.

[ZOOM] [5] :Square



The square option on the Zoom Menu makes the scale marks the same distance apart on both axes.

Press [WINDOW] to see how the window dimensions are changed.