TI-92 GRAPHING CALCULATOR

BASIC OPERATIONS

by

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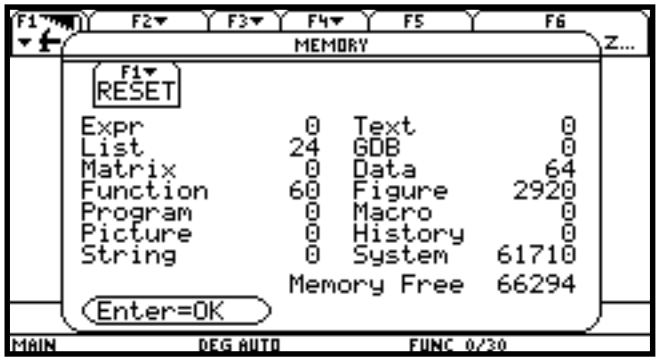
B-1 Getting Started

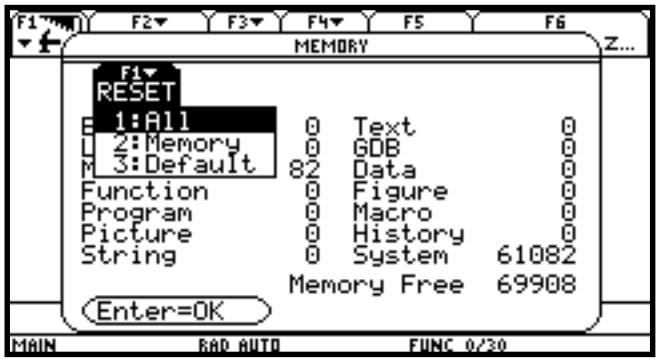
Press [ON] to turn on the calculator.

Press [2nd] [6] to get the MEMORY screen (shown at the right).



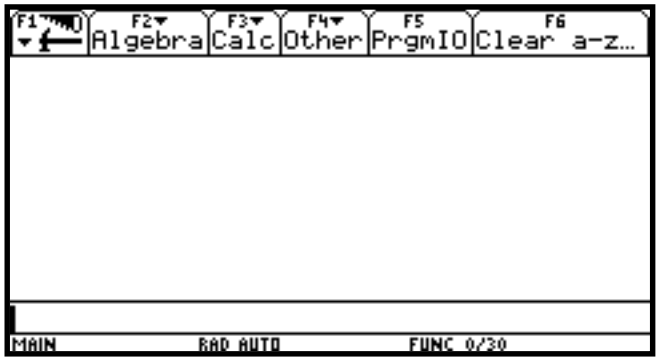
Press [F1] :RESET, press [1] :All and press [ENTER] .

The screen now has a toolbar across the top of the screen, two horizontal lines and some words at the bottom of the screen. The cursor should be flashing between the two horizontal lines at the bottom of the screen.



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

The contrast may be too light or too dark. Hold down the green diamond in a green square key [◆] and press the [-] key to make the display lighter, or the [+] key to make the display darker.



Press [◆] [-] to make the display lighter.

Press [◆] [+] to make the display darker.

B-2 Home Screen, Toolbar, Special Keys, and Menus

Home Screen

The screen on which calculations are done and commands are entered is called the Home Screen. The toolbar is across the top of the screen. Access the tool bar by pressing the blue function keys directly to the left of the screen.

You can always get to this screen (aborting any calculations in progress) by pressing
QUIT
2nd ESC . From here on, this will be referred to as 2nd QUIT in this manual.

> Clear the home screen by pressing F1 8 .
>
> Quit any calculations by pressing 2nd QUIT .
>
> Clear the Entry Line by pressing CLEAR .

The line where the cursor is flashing is called the Entry Line.
The words at the bottom of the screen is called the Status Line. This shows the current state of the calculator.

ENTER Keys

There are three ENTER keys. All three keys do the same thing. There are three only for your convenience.

Eight Directional Arrow Key

The large arrow key located on the upper righthand corner of the calculator is an eight-directional arrow key. The up, down, right, and left directions are used for the functions in this document. They will be indicated by:

◄ or ► Moves the cursor to the left or right one position.

▲ or ▼ Moves the cursor up or down one line.

2nd

This key must be pressed to access the operation above a key printed in yellow. 2nd will appear at the bottom of the screen when this 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.

◆

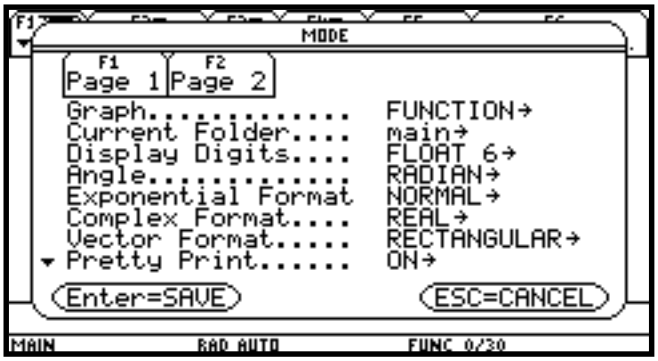
This key must be pressed to access the operation above and to the right of a key. These operations are printed in green on the face of the calculator.

ESC

If the calculator displays a menu, this key allows you to exit the menu.

MODE

Press MODE . The items listed is the current setting. Use the up or down arrow key to select the item you wish to change and press the right arrow key to get a menu. Use the up or down arrow key to select the menu item and press ENTER to activate the selection, or press the number of the selection.



Press F1 or F2 to see the pages of this menu. Press ESC to cancel and exit the menu. Press ENTER to save the settings.

The settings shown above are the default settings. This manual will assume the calculator has these settings unless the example specifically states to change them with the exception of numbers containing a decimal point being expressed to ten decimal places.

Note that AUTO setting for number presentation will cause numbers having fractions, e, , or square roots to be expressed in symbolic form unless a number has been entered using a decimal point. A decimal point in the entry causes the answer to be expressed using a decimal point. The AUTO setting is on the MODE screen, page 2.

Note, also, that the default setting is floating point (decimal point) form with digits. To get six decimal places, change to FIX 6.

Menus

The TI-92 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. Use the arrow keys to highlight the selection and then press [ENTER] .
2. Press 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 [◆] [GRAPH] menu [F2] [1] :ZoomBox refers to the first item on this menu.

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, the [♦] , [2nd] [INS] and/or [◆] [DEL] .

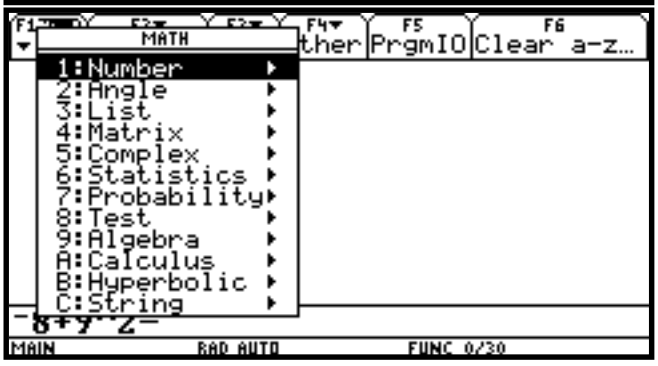
[◀] or [▶]	Moves the cursor to the left or right one position.
[▲]	Moves the cursor up one line or replays the last executed input.
[▼]	Moves the cursor down one line.
[◆] [DEL]	Deletes one character to the right of the cursor.
[2nd] [INS]	Inserts one or more characters to the left of the cursor position.

B-4 Calculation

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

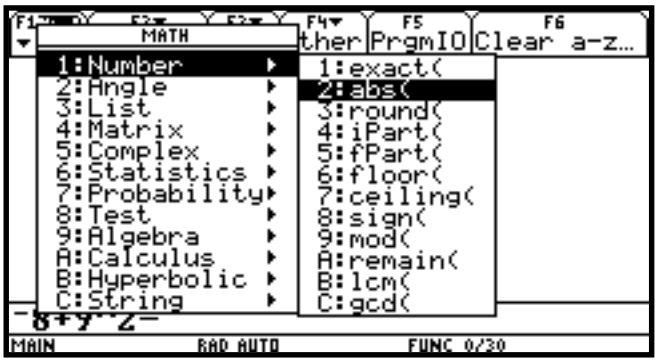
Turn the calculator on and press [2nd] [QUIT] to return to the Home Screen. Press [CLEAR] to clear the Home Screen. Now we are ready to do a new calculation.

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.

Keystrokes	Screen Display	Explanation
[F1] :Tools [8] :Clear Home [CLEAR] [MODE] [▼] [▼] [▶] [▲] ...[▲] [ENTER] [ENTER]		It is a good idea to clear the Home Screen before starting a calculation. Set the decimal display to fix 10 decimal places. Note that the default setting is FLOAT 6 which means six digits will be displayed in decimal notation. FIX 6 means that six decimal places will be displayed regardless of the number of digits.
[(-)] [8] [+] [9] [^] [2] [-] [2nd] [MATH]		

1 :Number

2 :abs(

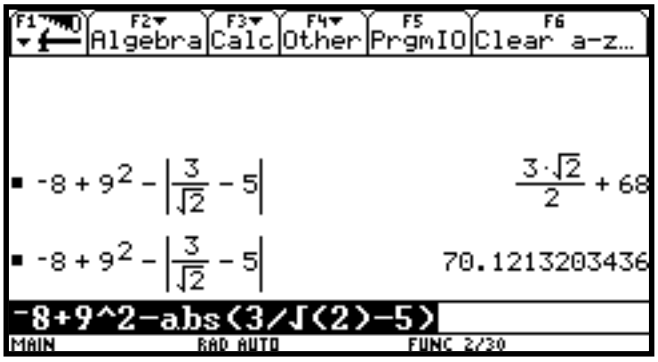


Watch for parentheses that are entered automatically with the operation.

3 ÷ 2nd √ 2) - 5)

ENTER

◆ ENTER



Notice that the solution is expressed in pretty print. This is the exact solution.

Temporarily override the pretty print setting to get the decimal approximation.

B-5 Evaluation of an Algebraic Expression

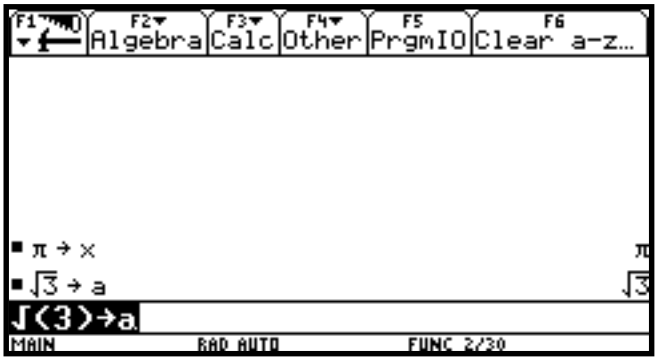
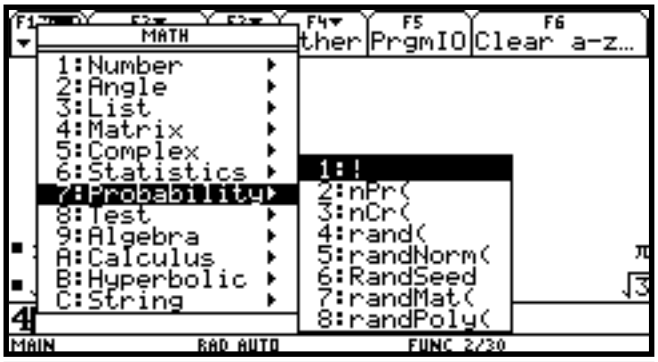
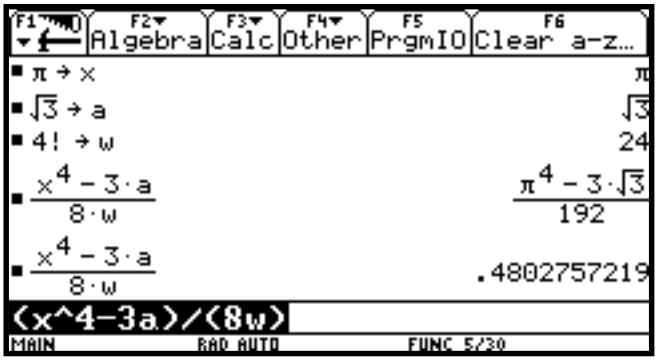
Example 1 Evaluate $\frac{x^4 - 3a}{8w}$ for $x = \pi$, $a = \sqrt{3}$, and $w = 4!$.

Two different methods can be used to evaluate algebraic expressions:

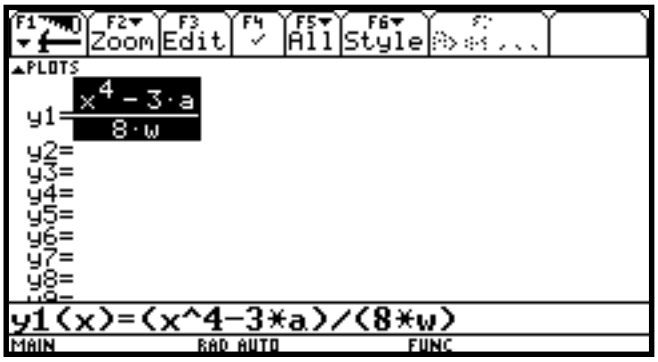
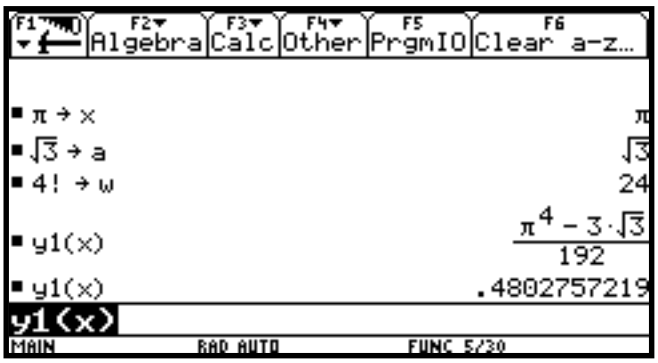
1. Store the values of the variable, enter the expression, and press ENTER to evaluate the expression for the stored values of the variables.
2. Store the expression and store the values of the variables. Recall the expression and press ENTER to evaluate the expression for the stored values of the variables.

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

Method 1

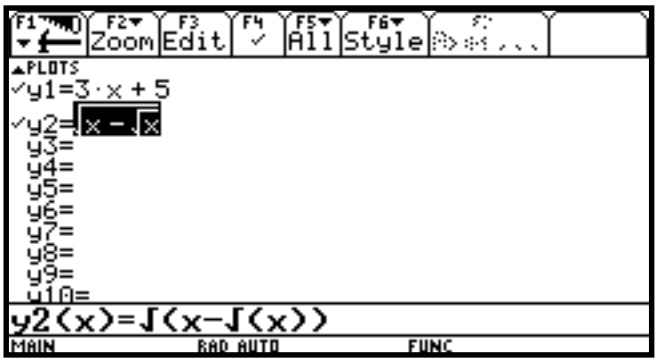
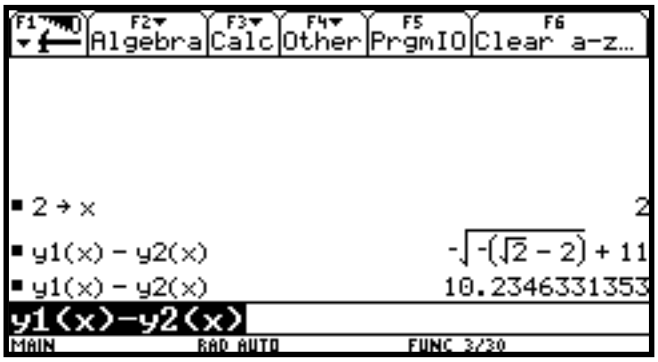
Keystrokes	Screen Display	Explanation
F1 :Tools 8 :Clear Home		Clear the Home Screen.
CLEAR 2nd • STO▸ X ENTER 2nd √ 3) STO▸ A ENTER		Store the values as variables.
4 2nd MATH 7 :Probability 1 :! STO▸ W ENTER		
(X ^ 4 - 3 A) ÷ (8 W) ENTER ◆ ENTER		Enter the expression and evaluate. Change the pretty print to decimal approximation.

Method 2

Keystrokes	Screen Display	Explanation
F1 :Tools 8 :Clear Home CLEAR ◆ Y= CLEAR (X ^ 4 - 3 A) ÷ (8 W) ENTER ▲ F4 :√		Clear the Home Screen. Enter the expression in the Y= list. Deselect y1 so that it will not graph. You can still evaluate the expression.
2nd QUIT 2nd • STO▸ X ENTER 2nd √ 3) STO▸ A ENTER 4 2nd MATH 7 :Probability 1 :! STO▸ W ENTER Y 1 (X) ENTER ◆ ENTER		Return to the Home Screen. Store the values as variables. Recall the expression and evaluate. Change the pretty print to decimal approximation .

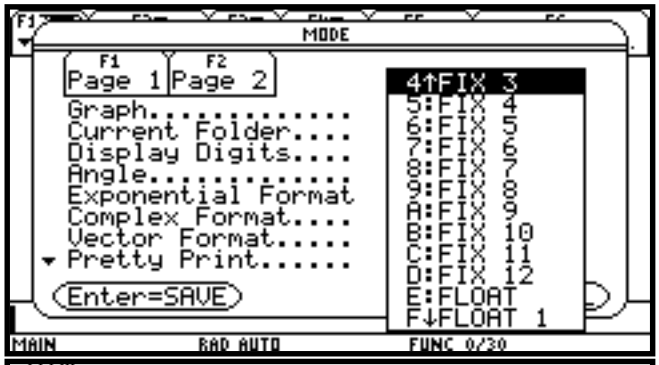
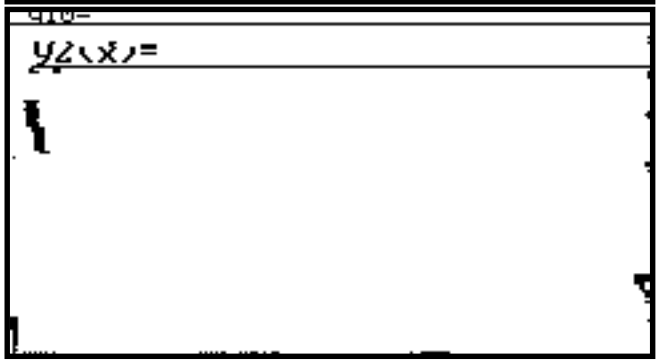
Example 2 For $f(x) = 3x+5$ and $g(x) = \sqrt{x - \sqrt{x}}$ find $f(2) - g(2)$.

(Using Method 2 above.)

Keystrokes	Screen Display	Explanation
F1 :Tools 8 :Clear Home CLEAR ◆ Y= CLEAR 3 X + 5 ENTER CLEAR 2nd √ X - 2nd √ X)) ENTER		Clear the Home Screen. Clear y1 and store $f(x)$ as y1. Clear y2 and store $g(x)$ as y2.
2nd QUIT 2 STO▸ X ENTER Y 1 (X) - Y 2 (X) ENTER ◆ ENTER		Return to the Home Screen. Store 2 as X. 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
F1 :Tools		Clear the Home Screen.
8 :Clear Home		
CLEAR		
MODE ▼ ▼		Change the mode to fixed three decimal places. Return to the Home screen.
▶ 4 :FIX 3		
ENTER		
◆ Y= CLEAR		Clear all entries on the Y= list using the arrow keys and CLEAR .
▼ CLEAR …		
2nd √ X -		Store the expression as y1.
2nd √		
X)) ENTER		
2nd QUIT		Return to the Home Screen.

2nd { 1.900

, 1.990 ,

1.999 , 2.001

, 2.010 ,

2.100 2nd }

STO▸ X

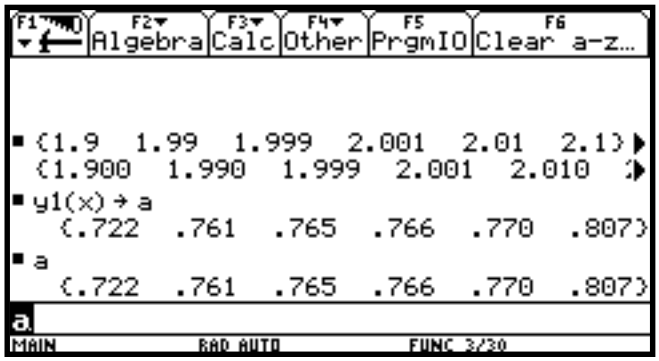
ENTER

Y 1 (X)

STO▸

A ENTER

A ENTER



Store the values of x in the list X.

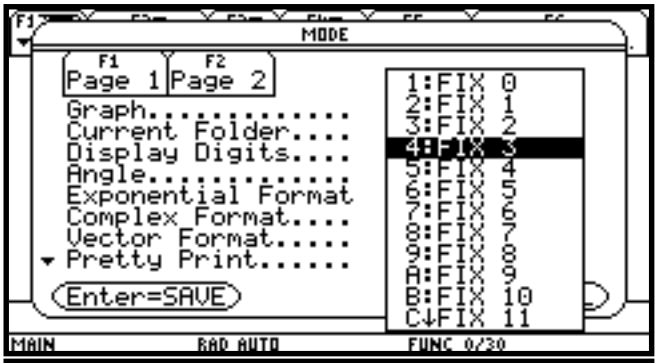
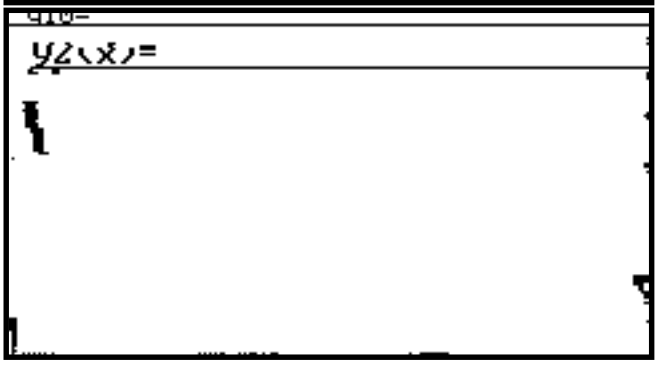
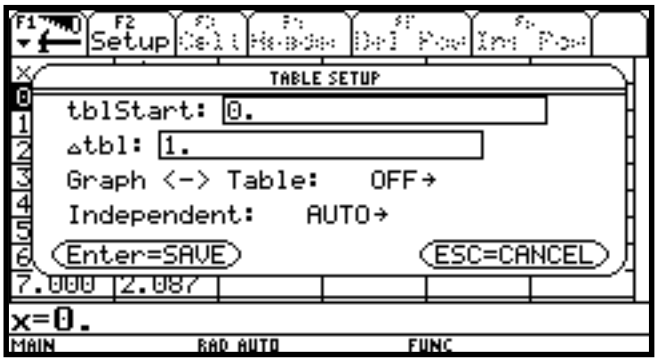
Calculate the value of the expression stored as y1 for the values of x in list X and store as A. To view the results, use the ◀ and ▶ keys.

To recall A, press A . The results are 0.722, 0.761, 0.765, 0.766, 0.770, and 0.807.

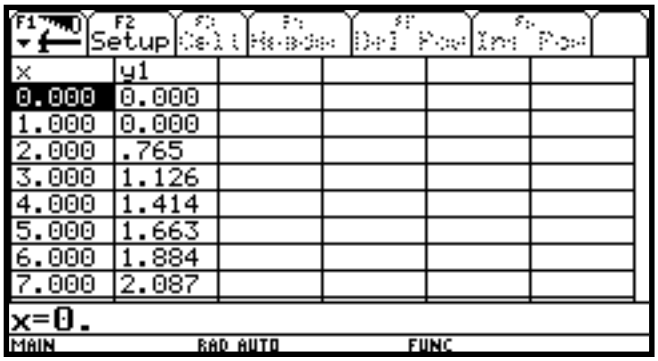
Example 4

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.

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
[F1] :Tools [8] :Clear Home [CLEAR] [MODE] [▼] [▼] [▶] [4] :FIX 3		Clear the Home Screen. Change the mode for fixed decimal places to three decimal places. Return to the Home Screen.
[ENTER]		Clear any existing expressions in the [Y=] list.
[◆] [Y=] [CLEAR] [▼] [CLEAR] … [2nd] [√] [X] [-] [2nd] [√] [X] [)] [)] [ENTER]		Store the expression as y1. Return to the Home Screen.
[2nd] [QUIT] [◆] [TblSet] [0] [ENTER] [▼] [1] [ENTER] [▼] [▼]		Set the table to begin evaluating the expression at x = 0 with a step size of 1. Set the calculator to AUTO to automatically display values of x and y1.
[ENTER]		Return to the Home Screen.

◆ TABLE ▼ ... ▼



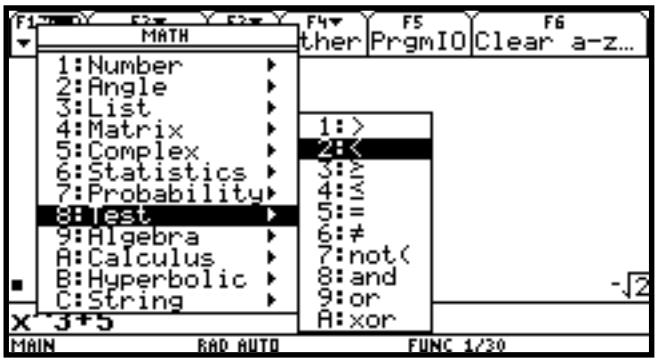
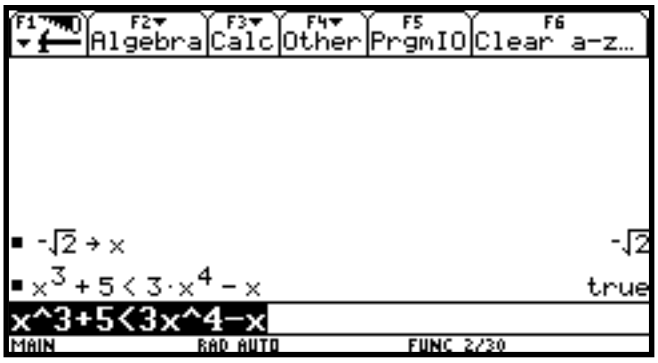
Get the table. Arrow down to see more of the table. The highlighted value will appear at the bottom of the table.

2nd QUIT

Return to the Home Screen.

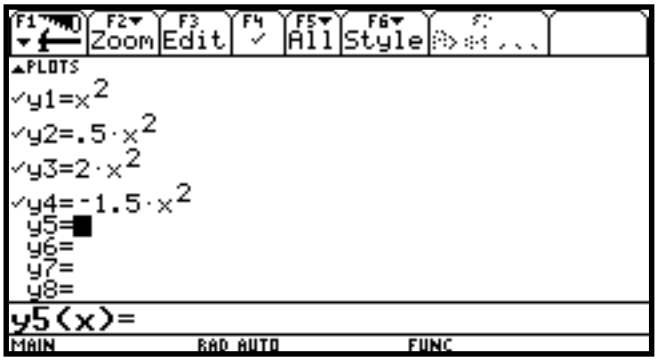
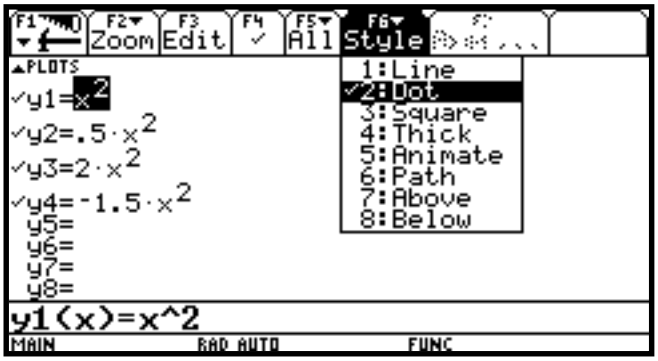
B-6 Testing Inequalities in One Variable

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

Keystrokes	Screen Display	Explanation
2nd QUIT		Return to the Home Screen and clear it.
F1 :Tools		
8 :Clear Home		
CLEAR		
MODE ▼ ▼ ▶		Set the mode to FIX 10.
B :FIX 10 ENTER		
(-) 2nd		Store the value for x.
√ 2) STO▸		
X ENTER		
X ^ 3 + 5		Enter the expression.
2nd MATH 8 :Test		
2 :< 3 X ^ 4		
- X ENTER		The result of true indicates the expression is true for this value of x.

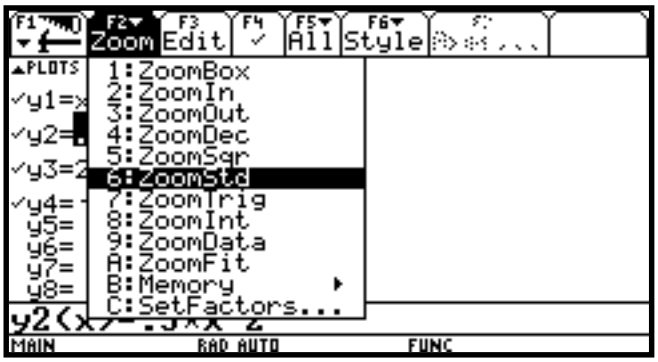
B-7 Graphing, the ZoomStd Graphing Screen, and Style of Graph

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, the fourth function with a thin line.

Keystrokes	Screen Display	Explanation
2nd QUIT		Return to the Home Screen and clear.
F1 :Tools		
8 :Clear Home		
CLEAR ◆ Y=		Clear the existing function and store the first function as y1.
CLEAR X		
^ 2 ENTER		Clear and store the second function as y2.
CLEAR .5		
X ^ 2 ENTER		Clear and store the third function as y3.
CLEAR 2 X		
^ 2 ENTER		Clear and store the fourth function as y4.
CLEAR		
(-) 1.5 X ^ 2		
ENTER		
▲ ▲ ▲ ▲		Get the graph style menu. Change the style for y1 to a dotted line. Change the style for y2 to a thin line. Change the style for y3 to a thick line. Change the style for y4 to a thin line.
F6 :Style 2 :Dot		
▼ F6 1 :Line		
▼ F6 4 :Thick		
▼ F6 1 :Line		

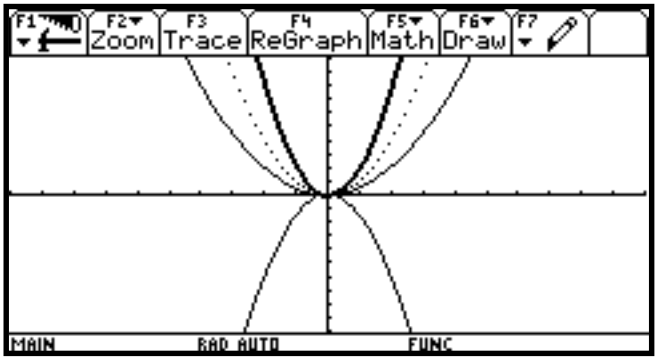
F2 :Zoom

6 :ZoomStd

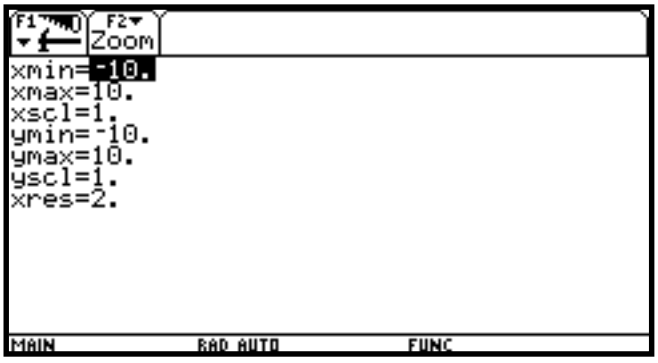


Get the zoom menu.
Press 6 to get the ZoomStd option and graph the functions.

Note the ZoomStd option automatically sets the graph screen dimentions at -10 x 10 and -10 y 10.



◆ WINDOW



Get the window display to check this.

The ZoomStd 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.
If there is more than one function graphed, the up ▲ and down ▼ arrow keys allow you to move between the graphs displayed when tracing.

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

[F3] :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.

[F2] :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:

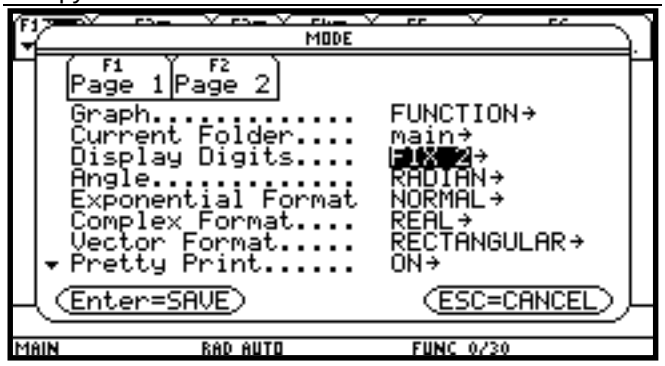
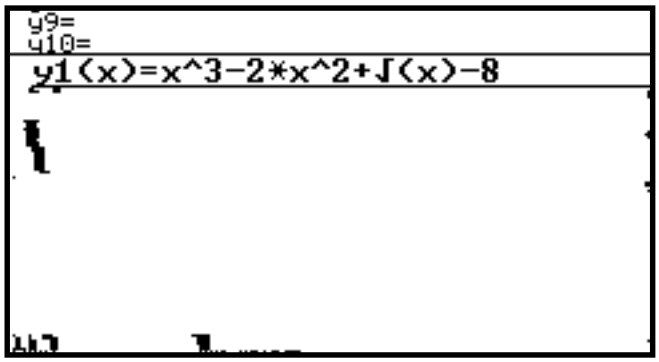
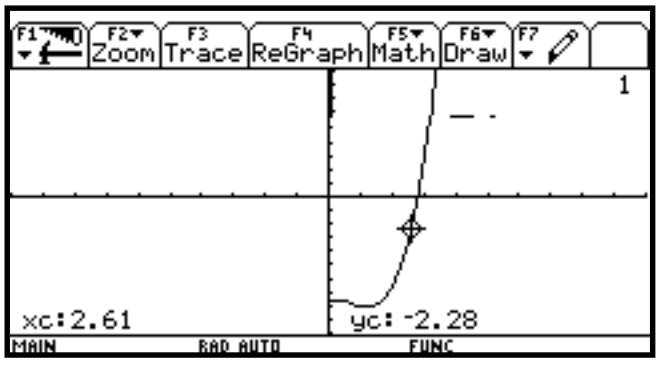
1. Zoom in by changing the WINDOW dimensions.
2. Zoom in by setting the Zoom Factors and using Zoom In from the ZOOM menu.
3. Zoom in by using the Zoom Box feature of the calculator.
4. Use the Zero feature of the calculator.
5. Use the Intersect feature of the calculator.
6. Use the Solver feature of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

Three methods to zoom in are:

1. Change the WINDOW dimensions using [◆] [WINDOW] .
2. Use the [2] :Zoom In option on the [F2] :Zoom menu in conjunction with [F2] :Zoom [C] :Set Factors.
3. Use the [1] :ZoomBox option on the [F2] :Zoom menu.

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

Method 1 Change the WINDOW dimensions.

Keystrokes	Screen Display	Explanation
2nd QUIT F1 :Tools 8 :Clear Home CLEAR MODE ▼ ▼ ▶ 3 :FIX 2 ENTER		Clear the Home Screen and change the number of decimal places to FIX 2. Return to the Home Screen.
◆ Y= CLEAR X ^ 3 - 2 X ^ 2 + 2nd √ X) - 8		Clear all functions in the Y= list. Enter the function as y1. Use the up arrow to highlight the function so you can see how it was entered on the Entry Line.
ENTER ▲ F2 :Zoom 6 :ZoomStd F3 :Trace ▶ …▶		Graph using the standard window. Get the TRACE function and press the right arrow repeatedly until the new type of cursor gives a y value close to -1.58. The closest point is (2.61, -2.28).

◆ WINDOW

2 ENTER 3

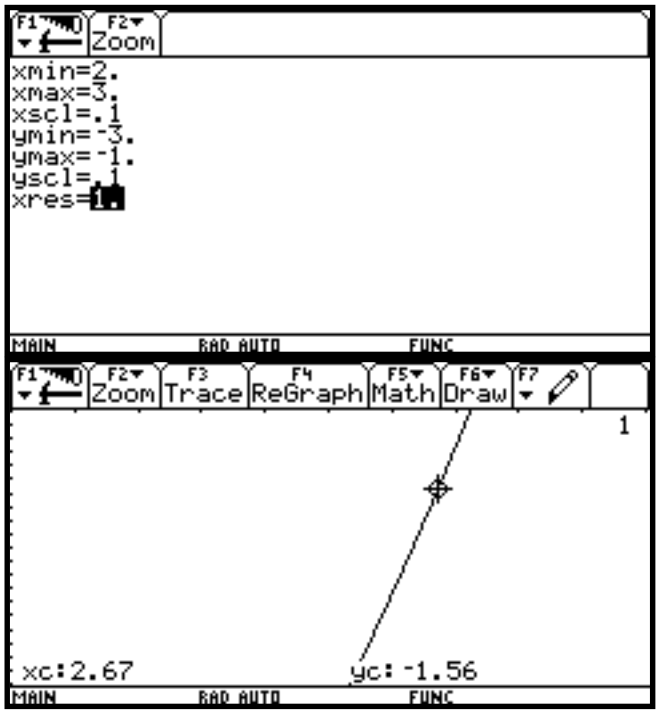
ENTER .1

ENTER

(-) 3 ENTER

(-) 1 ENTER

.1 ENTER 1



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.

◆ GRAPH

F3 :Trace

▶ …▶

Get the TRACE function and press the right arrow repeatedly until the new type of cursor gives a y value close to -1.58. The closest point is (2.67, -1.56).

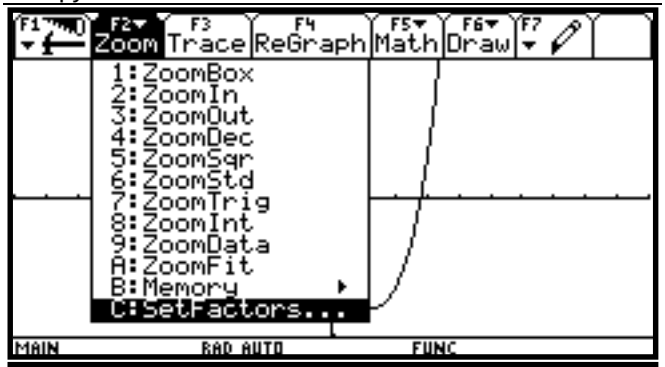
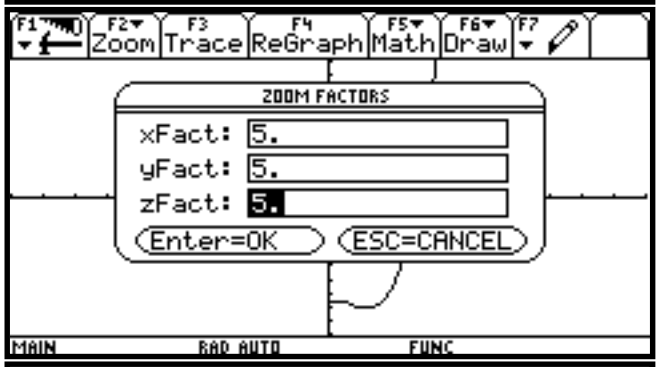
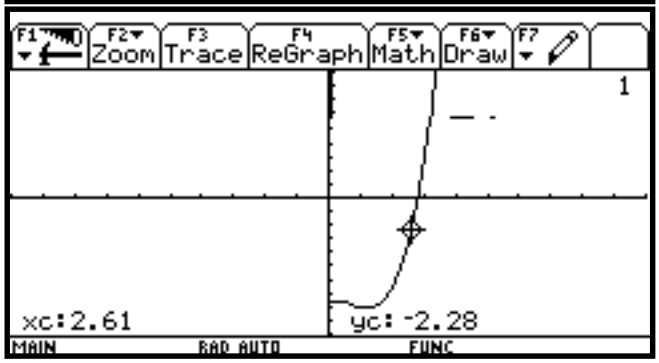
Repeat the process of changing the graphing window dimensions until you get the approximation for x as 2.67 for y = -1.58. Hence the desired value for x is approximately 2.67.

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 the word BUSY in the lower righthand corner. This means the calculator is working. Wait until BUSY disappears before continuing.

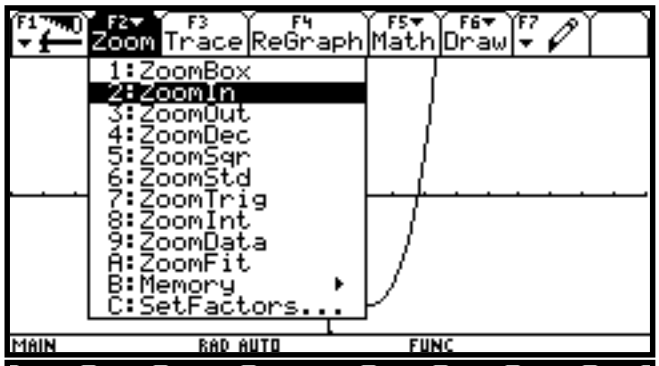
Method 2 Use the 2 :Zoom In option on the F2 :Zoom menu.

Return to the Home Screen, Clear, enter the function in the Y= list (see Method 1 of this example).

Keystrokes	Screen Display	Explanation
◆ WINDOW F2 :Zoom 6 :ZoomStd F2 :Zoom C :SetFactors…		Graph the function using the standard graphing screen. Magnification factors need to be set.
5 ▼ 5 ▼ 5 ENTER		For this example let us set them at 5 for both horizontal and vertical directions.
ENTER F3 :Trace ▶ …▶		Get the TRACE function and move the cursor using the arrow keys to the point (2.61, -2.28).

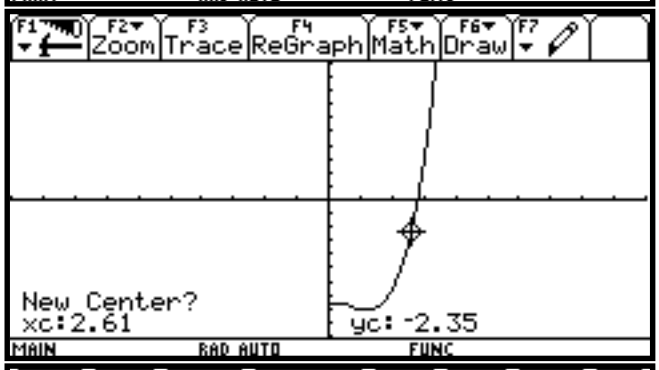
F2 :Zoom

2 :ZoomIn



▶ …▶

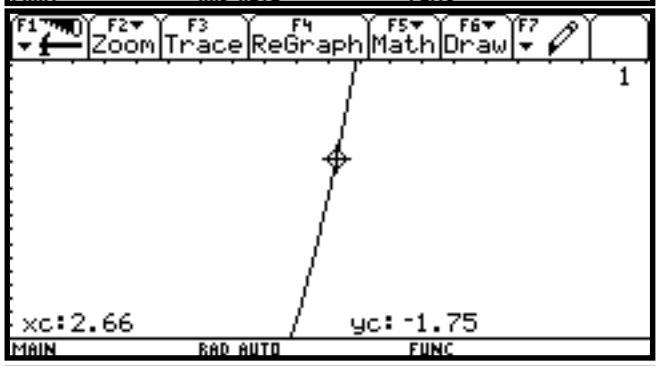
ENTER



Press 2 :ZoomIn and move the cursor to (2.61, -2.35) for the center. Press ENTER .

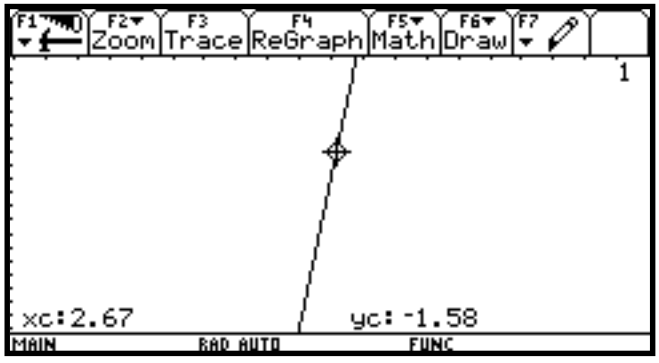
F3 :Trace

▶ …▶



Use TRACE again to get a new estimate for x. The new estimate is 2.66.

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

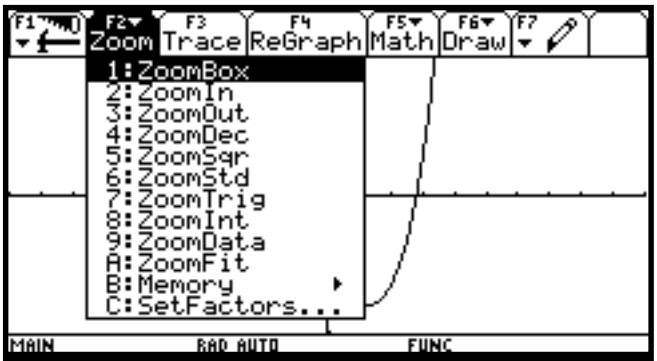
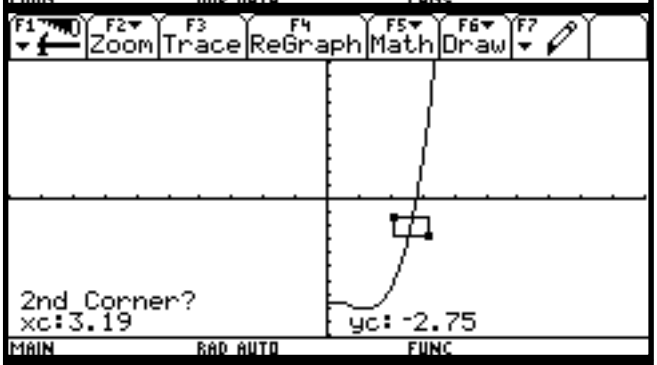
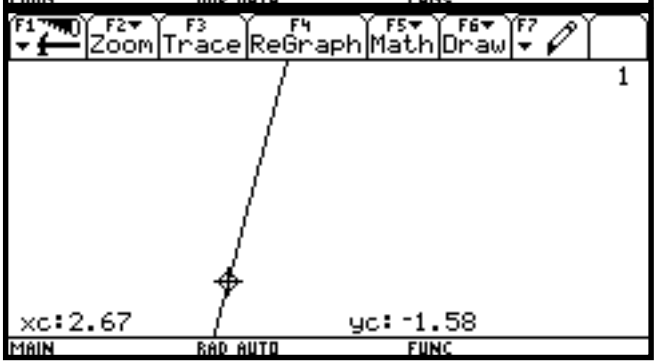


After several zooms you should have a screen similar to the one shown at the left.

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

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

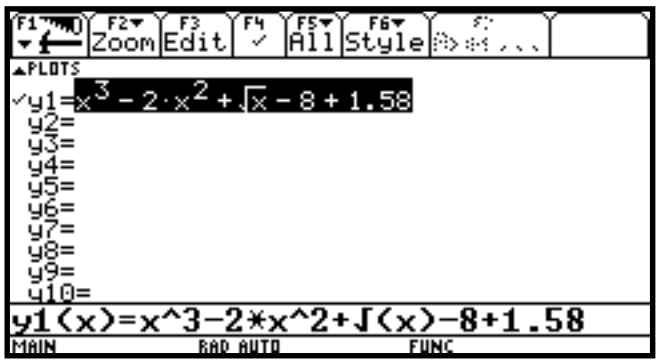
Return to the Home Screen, clear, enter the function in the Y= list (see Method 1 of this example).

Key	Screen Display	Explanation
◆ WINDOW F2 :Zoom 6 :ZoomStd		Graph the function using the standard graphing screen. Get the ZoomBox feature.
F2 Zoom 1 :ZoomBox		
▶ … ▼ ENTER ▼ … ▶ 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 (2.10, -1.37). Press [ENTER]. This anchors the upper left corner of the box.
F3 :Trace ▶ … ▼ ENTER		Now use the arrow keys to locate the lower right corner of the box, say at (3.19, -2.75). 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. This point is (2.67, -1.58).

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.

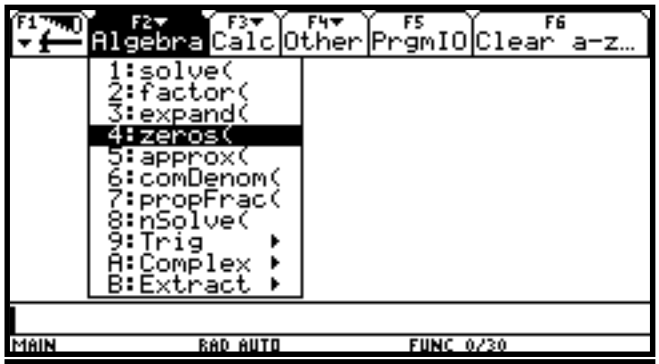
Method 4 Use the zeros(feature of the calculator.

Keystrokes	Screen Display	Explanation
2nd QUIT		Clear the Home Screen.
F1 :Tools		
8 :Clear Home		
CLEAR		Algebraically set the expression involving x equal to -1.58, the value of y. $x^3 - 2x^2 + \sqrt{x} - 8 = -1.58$
◆ Y= CLEAR		Now change the equation so it is equal to zero. $x^3 - 2x^2 + \sqrt{x} - 8 + 1.58 = 0$.
X ^ 3 -		
2 X ^		
2 + 2nd		
√ X) - 8		
+ 1.58		Enter the left side of the equation into the function list.
ENTER ▲		
2nd QUIT		Return to the Home Screen.



[F2] :Algebra

[4] :zeros(



Get the zeros(feature.

[Y] [1] [(] [X] [)]

[,] [X] [)] [ENTER]

The expression itself or the place where the expression is stored, can be used.

or

[F2] :Algebra

[4] :zeros(

[X] [^] [3]

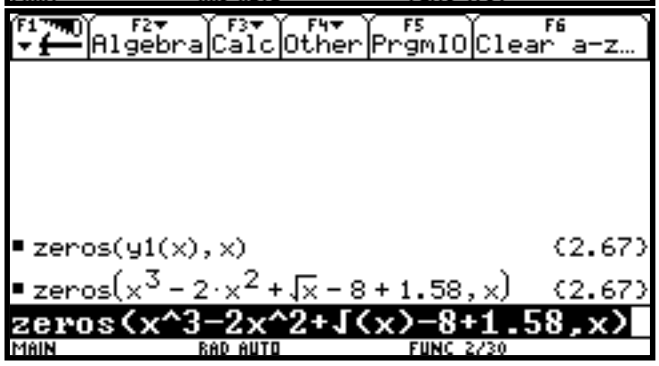
[-] [2] [X] [^] [2]

[+] [2nd] [√] [X]

[)] [-] [8] [+] [1.58]

[,] [X] [)]

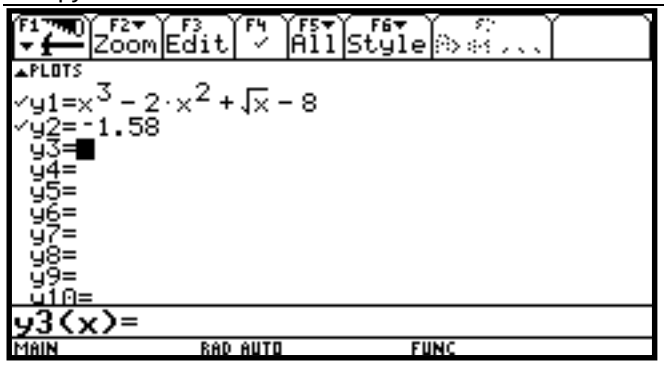
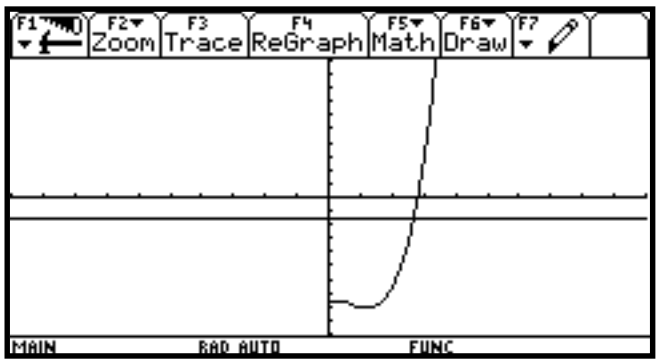
[ENTER]



The solution is x = 2.67.

Method 5 Use the Intersection feature of the calculator.

Return to the Home Screen, clear, enter the function in the [Y=] list (see Method 1 of this example).

Keystrokes	Screen Display	Explanation
[(-)] [1.58]		Enter the function as y1 and enter -1.58 as y2 in the function list.
[F2] :Zoom [6] :Zoom Std		Graph the function using the standard graphing screen.

F5 :Math 5 :Intersection

◀ or ▶

ENTER

◀ or ▶

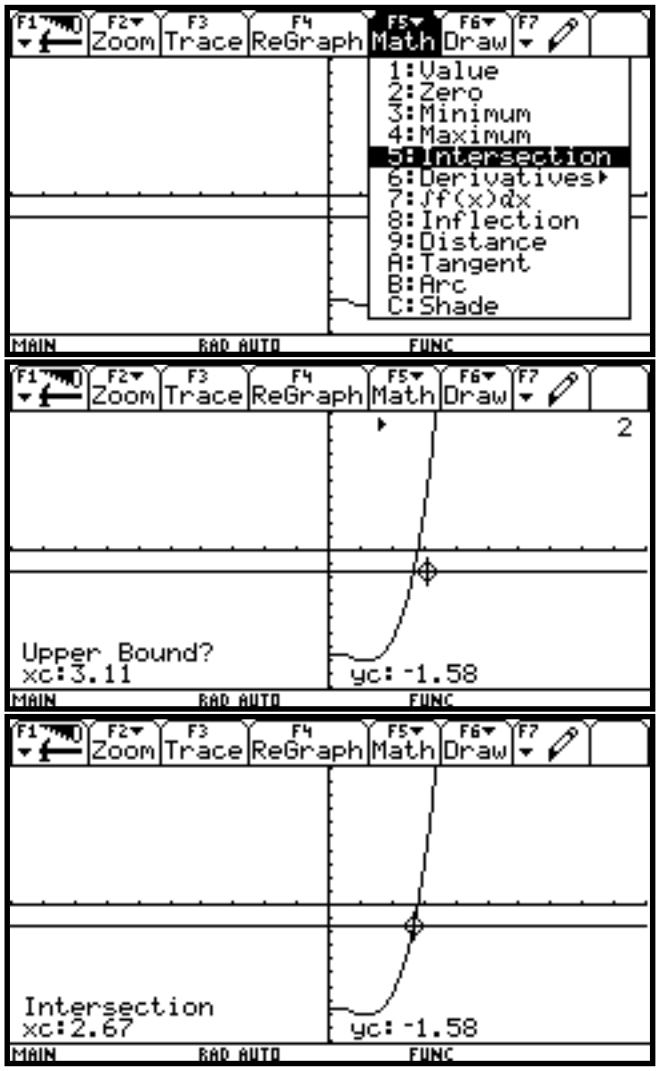
ENTER

◀ …▶

ENTER

◀ or ▶

ENTER



Get the intersect feature.

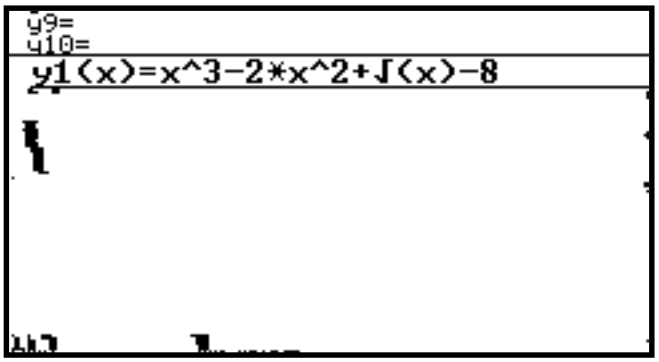
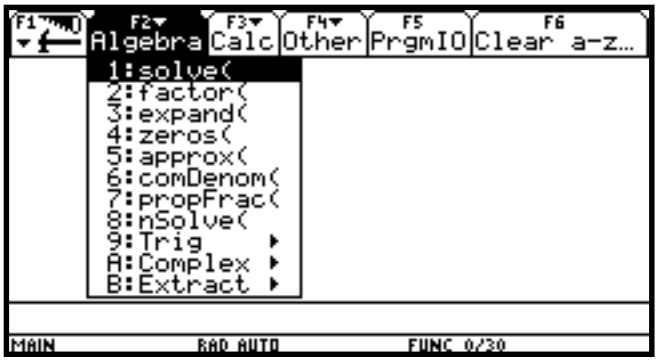
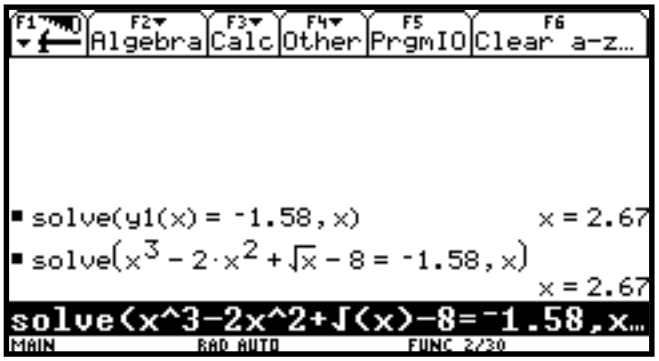
Place the cursor at a point on the first graph near the point of intersection and press ENTER .

Place the cursor at a point on the second graph near the intersection point and press ENTER .

Move the cursor to a value of x less than the intersection point and press ENTER for the Lower Bound on x. Move the cursor to a value of x greater than the x coordinate of the intersection point and press ENTER for the Upper Bound on x.

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

Method 6 Use the solve(feature of the calculator

Keystrokes	Screen Display	Explanation
2nd QUIT		Return to the Home Screen and clear it.
F1 :Tools		
8 :Clear Home		
CLEAR		
◆ Y= CLEAR		Clear all expressions in the Y= list.
X ^ 3 -		Enter the function as y1. Use the up arrow to highlight the function so you can see how it was entered on the Entry Line.
2 X ^ 2 +		
2nd √		
X) - 8		
ENTER ▲		
2nd QUIT		Return to the Home Screen
F2 :Algebra		Get the solve(from the Algebra list.
1 :solve(		
Y 1 (X) =		Recall y1 from the function list and set it equal to -1.58.
(-) 1.58 , X		
) ENTER		
or		Note that the expression itself could have been entered in the solve(expression. Both methods are shown to the left.
2nd QUIT		
F2 :Algebra		
1 :solve(		
X ^ 3 - 2		
X ^ 2 +		
2nd √ X)		
- 8 = (-)		The desired value for x is approximately 2.67.
1.58 , X)		
ENTER		

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.

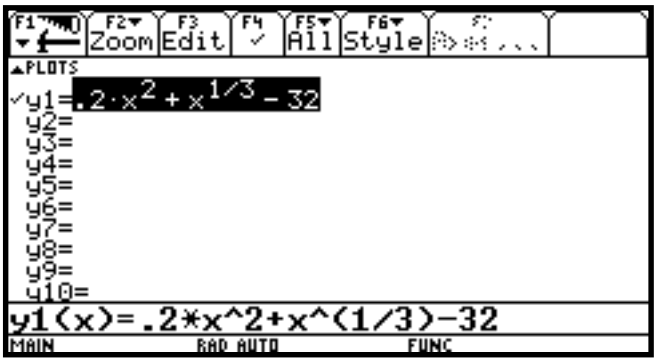
2. Evaluate the function for several values of x. Make a first estimate of the window dimensions based on these values.

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 (30-(-30))/20 or 3.

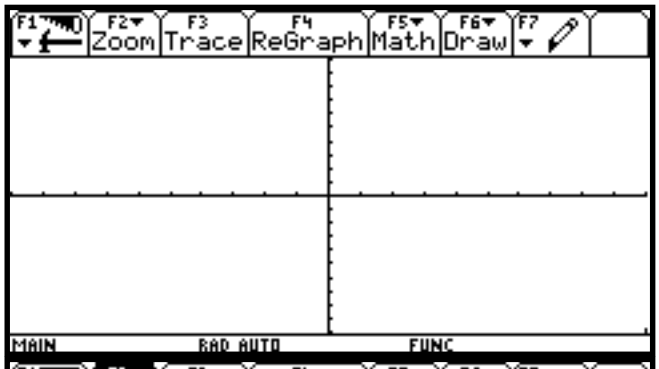
Example 1 Graph the function $f(x)= .2x^2 + \sqrt[3]{x} - 32$.

Method 1 Use the default setting and zoom out.

Keystrokes	Screen Display	Explanation
2nd QUIT		
F1 :Tools		Return to the Home Screen and clear it.
8 :Clear Home		
CLEAR		
◆ Y= CLEAR		Clear all expressions in the Y= list.
.2 X ^ 2 +		
X ^ (1 ÷		Enter the function as y1 in the function list.
3) - 32		
ENTER ▲		Use the up arrow to highlight the function and to view it in the Entry Line.

F2 :Zoom

6 :ZoomStd



Nothing is seen on the graph screen because no part of this curve is in this WINDOW.

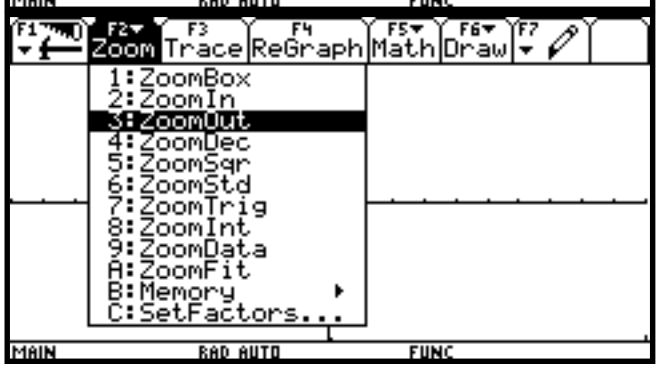
F2 :Zoom

C :SetFactors...

4 ▼ 4 ▼ 4

ENTER

ENTER

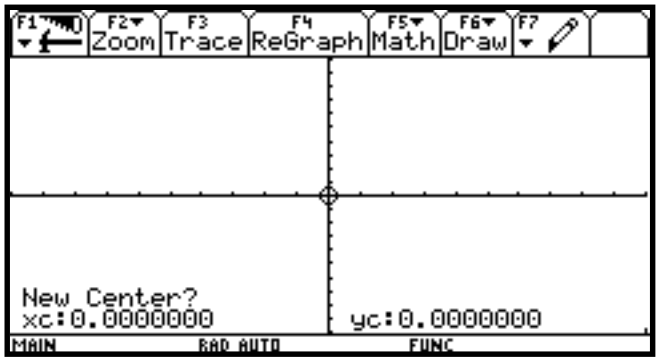


Set the zoom factors to 4. See Section 8, Example 1, Method 2, in this document.

F2 :Zoom

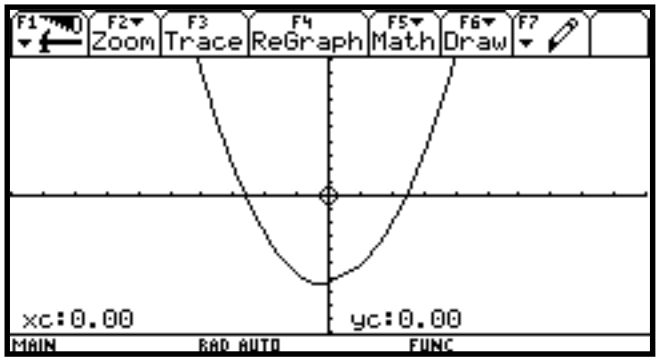
3 :Zoom Out

▼ …▶



Then get the ZoomOut option 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 circle with a + sign in it.

ENTER



Zooming out shows a parabolic shaped curve.

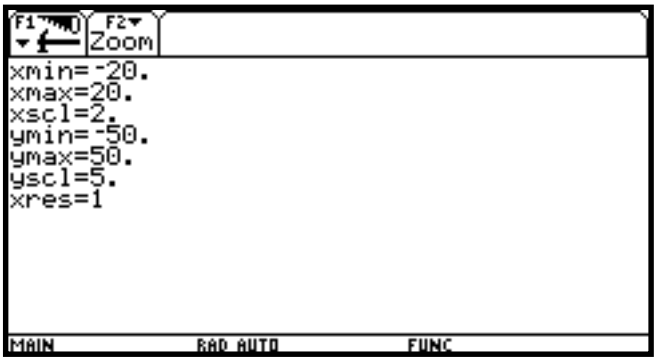
Method 2 Enter the function and evaluate the function for several values of x. (See Section B-5 on how to evaluate a function at given values of x.)

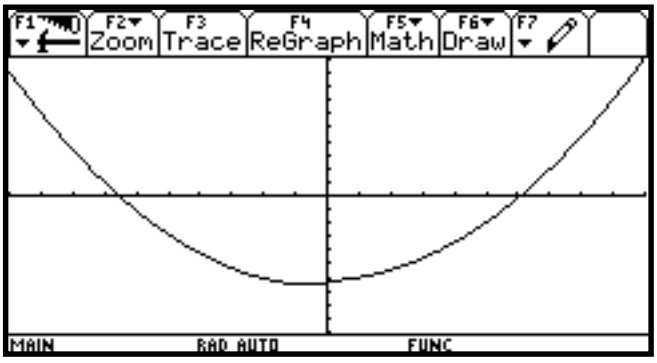
x	f(x)
-20	45.3
-10	-14.2 || 0	-32.0
10	-9.8
20	50.7

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 $\frac{50-(-50)}{20} = 5$.

Keystrokes	Screen Display	Explanation
2nd QUIT		Return to the Home Screen and clear it.
F1 8 :Clear Home		
CLEAR ◆ Y=		Clear all expressions in the Y= list.
CLEAR .2 X ^		
2 + X ^		Enter the function as y1 in the function list.
(1 ÷		
3) - 32		
◆ WINDOW		Set the window dimensions to [-20, 20]2 by [-50, 50]5 with a resolution of 1.
(-) 20 ENTER		
20 ENTER		
2 ENTER		
(-) 50 ENTER		
50 ENTER		
5 ENTER		
1 ENTER		
◆ GRAPH		Graph the function.





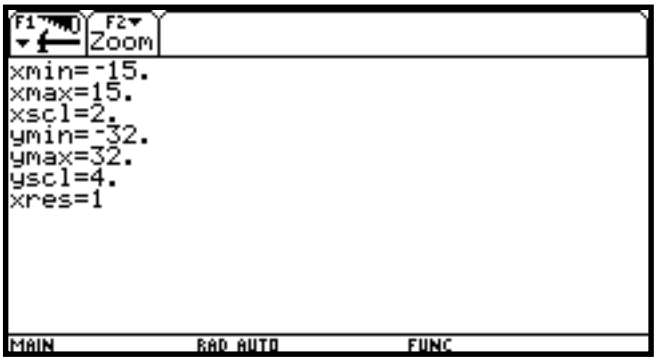
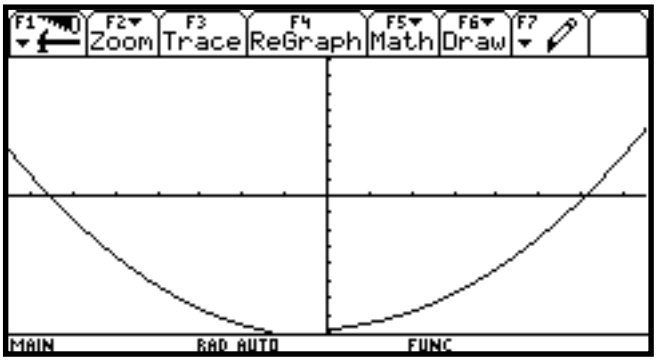
Method 3 Analyze the leading coefficient and constant terms.

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 $\frac{\text{Xmax - Xmin}}{20} = \frac{15-(-15)}{20}$ = 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 $\frac{\text{Ymax - Ymin}}{20} = \frac{32-(-32)}{20}$ = 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.

Keystrokes	Screen Display	Explanation
2nd QUIT		Return to the Home Screen and clear it.
F1 :Tools		
8 :Clear Home		
CLEAR		Clear all expressions in the Y= list.
◆ Y= CLEAR		
.2 X ^ 2 +		Enter the function as y1 in the function list.
X ^ (1 ÷		
3) - 32		
◆ WINDOW		Set the window dimensions to [-15, 15]2 by [-32, 32]5 with a resolution of 1.
(-) 15 ENTER		
15 ENTER		
2 ENTER		
(-) 32 ENTER		
32 ENTER		
4 ENTER		
1 ENTER		
◆ GRAPH		Graph the function.

A good choice for the **scale** is so that about 20 marks appear along the axis.
This is $\frac{\text{xmax - xmin}}{20}$ (rounded up to the next integer) for the x axis and
$\frac{\text{ymax - ymin}}{20}$ (rounded up to the next integer) for the y axis.

B-10 Piecewise-Defined Functions and Conditional Statements

There are two methods to graph piecewise-defined functions:

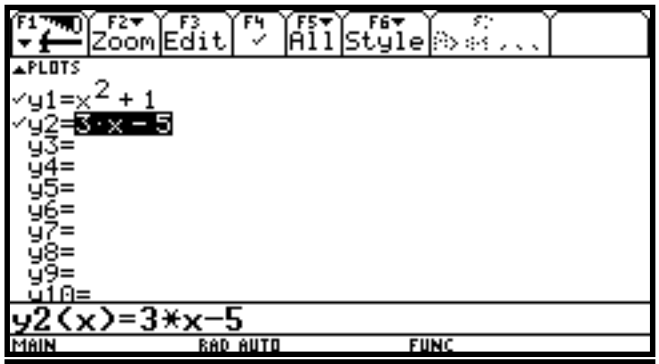
1. Graph each piece of the function separately as an entire function on the same coordinate axes. Use Trace and Zoom to locate the partition value on each of the graphs.

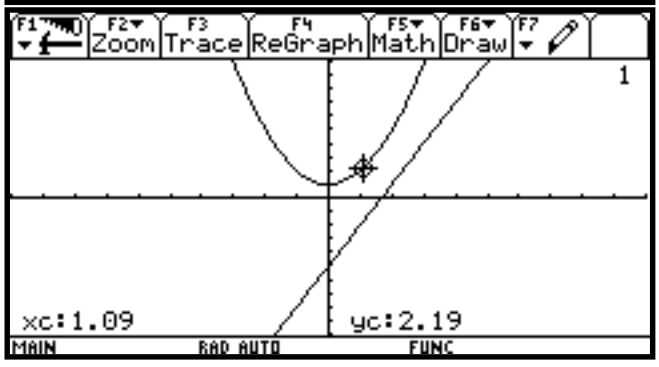
2. Store each piece of the function separately but include a conditional statement following the expression which will restrict the values of x at which the function will be graphed. Then graph all pieces on the same coordinate axes.

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

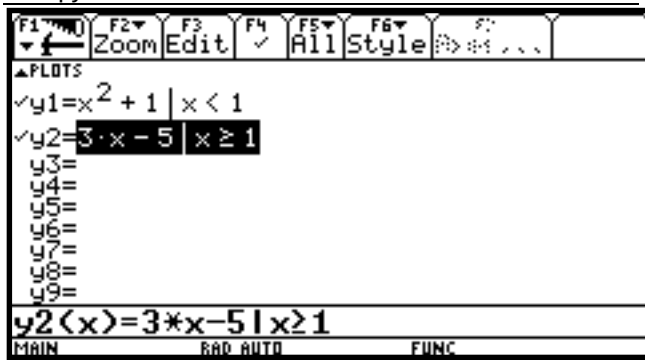
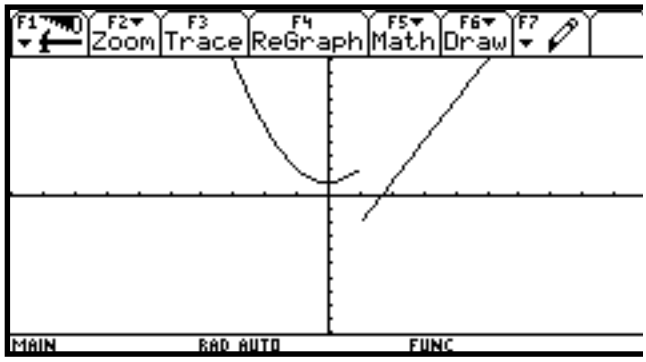
Method 1

Keystrokes	Screen Display	Explanation
2nd QUIT		Return to the Home Screen and clear it.
F1 :Tools		
8 :Clear Home		
CLEAR		Clear all expressions in the Y= list.
◆ Y=		
CLEAR		
X ^ 2 + 1		Store the functions as y1 and y2. Graph. Both functions will be displayed. Use Trace and Zoom to find the point on the graphs where x=1. A close value to one is x = 1.09.
ENTER		
CLEAR 3 X		
- 5		
ENTER ▲		
F2 :Zoom 6 :ZoomStd		When drawing this curve on paper, place an open circle 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.
F3 :Trace		
▶ ▶ ▶ ▶		





Method 2

Keystrokes	Screen Display	Explanation
◆ Y= CLEAR		Return to the Home Screen and clear it. Clear all expressions in the Y= list.
X ^ 2 + 1		
2nd | X		Store the functions as y1 and y2 each with a condition.
2nd MATH		
8 :Test 2 :<		
1 ENTER		
CLEAR 3 X		
- 5 2nd		
| X 2nd MATH		
8 :Test 3 :≥		
1 ENTER		
F2 :Zoom 6 :ZoomStd		Graph using the ZoomStd. When drawing this curve on paper, place an open circle 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.

B-11 Solving Equations in One Variable

There are four 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 any of the methods described in Section B-8 of this document. The intersect feature can be used by storing 0 as y2. The solve(feature of the calculator is shown below.

2. 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 any of the methods described in Section B-8 of this document. The intersect feature can be used by storing 0 as y2. The zeros((x intercept) feature of the calculator is shown below.

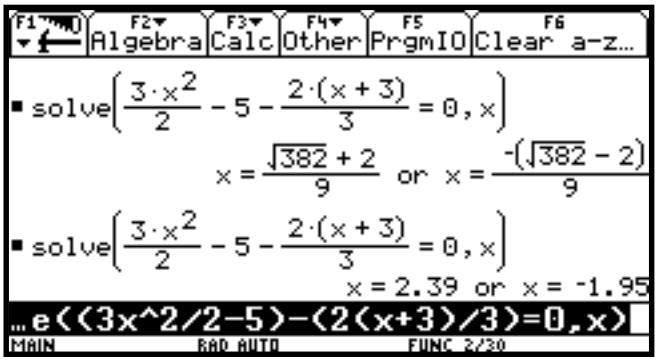
3. Graph y1=(left side of the equation) and y2=(right side of the equation) on the same coordinate axes. The x coordinate of the points of intersection are the solutions to the equation. The x coordinate of the point of intersection can be done using the solve(.

4. 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. The point of intersection can be done using the intersect feature of the calculator.

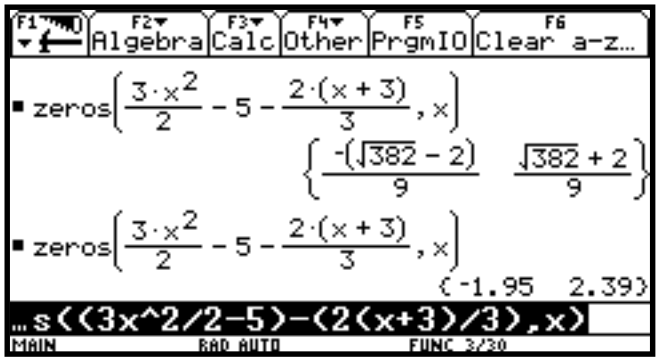
Example 1 Solve, to two decimal places, $\frac{3x^2}{2} - 5 = \frac{2(x+3)}{3}$.

[illegible]

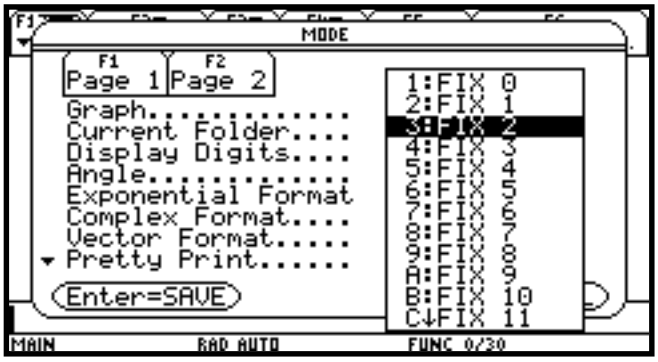
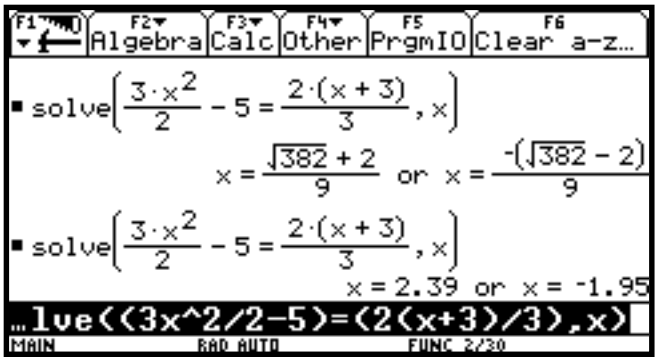
Method 1 Using solve(

Keystrokes	Screen Display	Explanation
2nd QUIT F1 :Tools 8 :Clear Home CLEAR MODE ▼ ▼ ▶ 3 :FIX 2 ENTER		Clear the Home Screen and change the number of decimal places to 2.
F2 :Algebra 1 :solve((3 X ^ 2 ÷ 2 - 5) - (2 (X + 3) ÷ 3) = 0 , X) ENTER		The keystrokes given require the function to be entered in the solve(command. You could store the left and right side of the equation as y1 and y2 and put y1-y2 as the left side in this command.
◆ ENTER		The calculator expresses the answer as pretty print (exact answer) since the calculator is set in AUTO mode. Temporarily override the AUTO mode to get the decimal approximation. The approximate solutions to this equation are -1.95 and 2.39, rounded to two decimal places.

Method 2 Using zeros((x intercept)

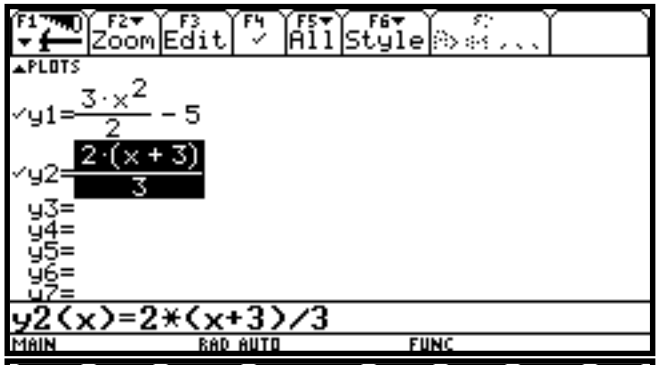
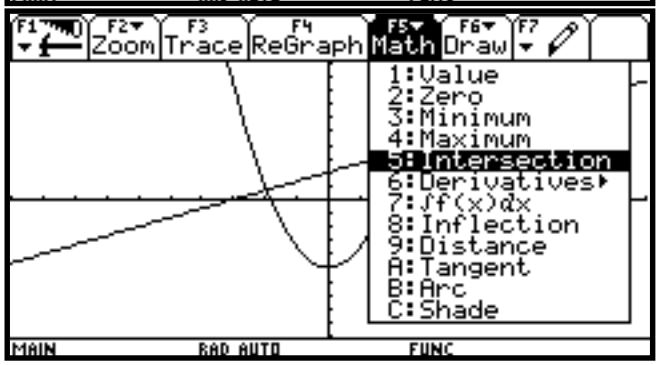
Keystrokes	Screen Display	Explanation
2nd QUIT		Clear the Home Screen and change the number of decimal places to 2.
F1 :Tools		
8 :Clear Home		
CLEAR		
MODE ▼ ▼		
▶		
3 :FIX 2		
ENTER		
F2 :Algebra 4 :zeros(		The keystrokes given require the function to be entered in the solve(command. You could store the left and right side of the equation as y1 and y2 and put y1-y2 as the left side in this command.
(3 X ^ 2		
÷ 2 - 5)		
- (2 (X		
+ 3) ÷		
3) , X)		
ENTER		The calculator expresses the answer as pretty print (exact answer) since the calculator is set in AUTO mode.
◆ ENTER		Temporarily override the AUTO mode to get the decimal approximation.
		The approximate solutions to this equation are -1.95 and 2.39, rounded to two decimal places.

Method 3 Using solve(

Keystrokes	Screen Display	Explanation
2nd QUIT		Clear the Home Screen and change the number of decimal places to 2.
F1 :Tools		
8 :Clear Home		
CLEAR		
MODE ▼ ▼		
▶ 3 :FIX 2		
ENTER		
F2 :Algebra		The keystrokes given require the function to be entered in the solve(command. You could store the left and right side of the equation as y1 and y2 and put y1=y2 in this command.
1 :solve(		
(3 X ^ 2 ÷		
2 - 5) = (		
2 (X + 3)		
÷ 3) , X)		
ENTER		The calculator expresses the answer as pretty print (exact answer) since the calculator is set in AUTO mode.
◆ ENTER		Temporarily override the AUTO mode to get the decimal approximation.
		The approximate solutions to this equation are -1.95 and 2.39, rounded to two decimal places.

Method 4 Using Intersection

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.

Key	Screen Display	Explanation
2nd QUIT F1 :Tools 8 :Clear Home		Clear the Home Screen and change the number of decimal places to 2.
CLEAR		Clear all expressions stored in the Y= list.
MODE ▼ ▼ ▶ 3 :FIX 2 ENTER		
◆ Y= CLEAR 3 X ^ 2 ÷ 2 - 5 ENTER 2 (X + 3) ÷ 3 ENTER		Enter the expressions as y1 and y2 in the Y= list.
F2 :Zoom 6 :ZoomStd F5 :Math 5 :Intersection		Get the Intersection feature from the Math menu. Press ENTER to select y1 as the first curve. Press ENTER to select y2 as the second curve.

ENTER

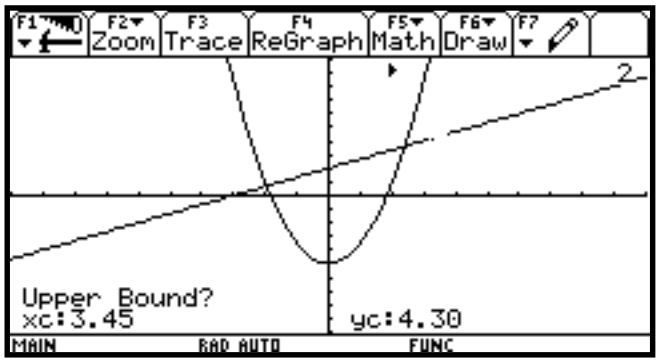
ENTER

▶ ... ▶

ENTER

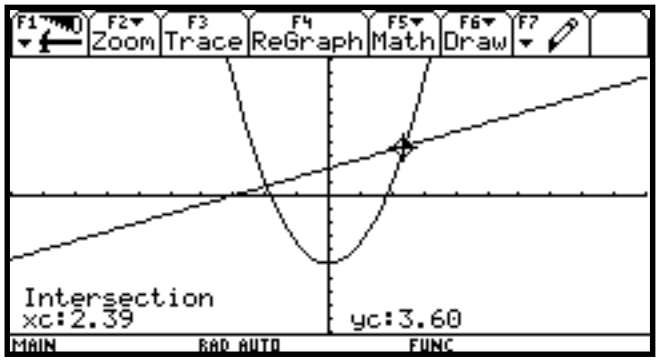
▶ ... ▶

ENTER



Move the cursor to the left of the intersection point and press ENTER to select the Lower Bound for x.

Move the cursor to the right of the intersection point and press ENTER to select the Upper Bound for x and to get the intersection point.



The intersection point is (2.39, 3.60). Hence one solution to the equation is 2.39.

Repeat to get the other intersection point.

The two solutions to the equation are 2.39 and -1.95. to two decimal place accuracy.

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 the solve(or zero(feature of the calculator. See Section B-11 of this document.

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 solve(or using the intersect feature of the calculator.

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

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-11, Example 1, Method 3 using zeros(of this document.

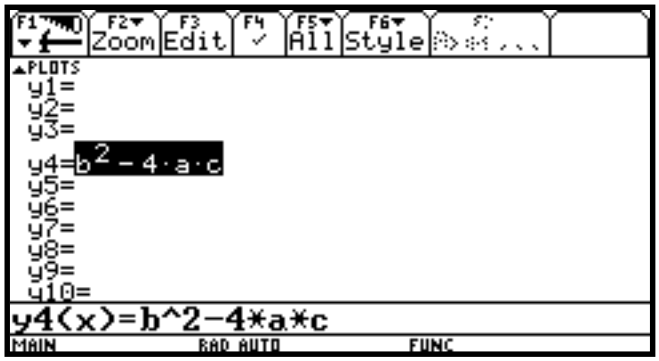
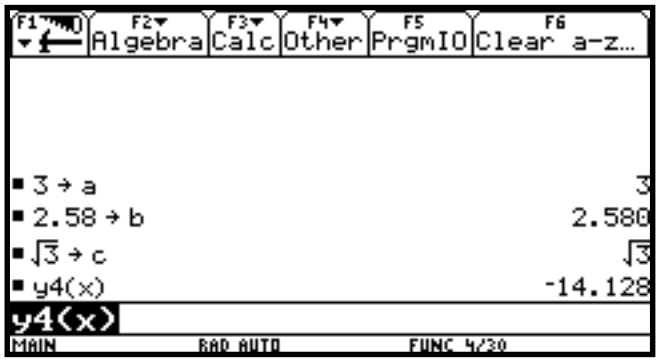
The x intercepts are -1.95 and 2.39. The solution to the inequality is the interval on x for which the graph is below the x axis. The solution is $-1.95 \le x \le 2.39$.

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-11, Example 1, Method 2 Using Intersection of this document. The x coordinate of the points of intersections are -1.95 and 2.39. We see that the parabola is below the 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 "false" answer which means the inequality is not true for this value of x. (See Section B-6 of this document.) Repeat the testing using 0 and 3. We see that the inequality is true for x=0 and false 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, to three decimal places, this expression for A = 3, B = 2.58, and C = $\sqrt{3}$.

Keystrokes	Screen Display	Explanation
2nd QUIT		Clear the Home Screen and change the number of decimal places to FIX 3.
F1 :Tools		
8 :Clear Home		
CLEAR		
MODE ▼ ▼		Clear all expressions from the Y= list.
▶ 4 :FIX 3		
ENTER		
◆ Y= CLEAR		Select y4. Enter the expression.
▼ ▼ ▼		
B ^ 2 - 4		
A x C		
ENTER ▲		Return to the Home Screen and clear the Entry Line.
F4 : ENTER		
2nd QUIT		
CLEAR		
3 STO▸ A		Store the value of the variables.
ENTER		
2.58 STO▸ B		
ENTER		
2nd √ 3)		Recall the function from the function list. The value of the expression is -14.128 rounded to three decimal places.
STO▸ C		
ENTER		
Y 4 (X)		
ENTER		

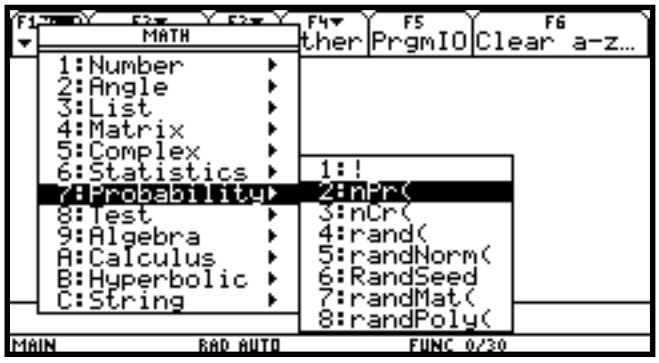
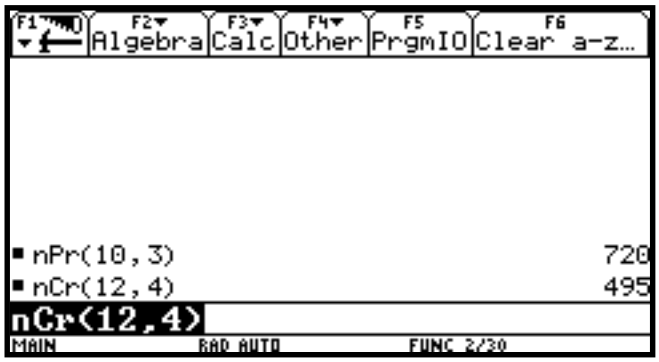
B-14 Permutations and Combinations

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

(A) and (B):

The quantity $P_{10,3}$ can be found by using the definition $\frac{10!}{7!}$ or using the built-in function nPr(.

Similarly for $C_{12,4}$ or $\binom{12}{4}$.

Keystroke	Screen Display	Explanation
2nd QUIT		Return to the Home Screen and clear.
F1 :Tools		
8 :Clear Home		
CLEAR		
2nd MATH		Choose nPr(and press ENTER .
7 :Probability		
		Enter the numbers separated by a comma and press ENTER .
2 :nPr(		Repeat for nCr(.
10 , 3)		The results are:
ENTER		$P_{10,3}$ = 720
2nd MATH		$C_{12,4}$ = 495
7 :Probability		
3 :nCr(		
12 , 4)		
ENTER		

B-15 Matrices

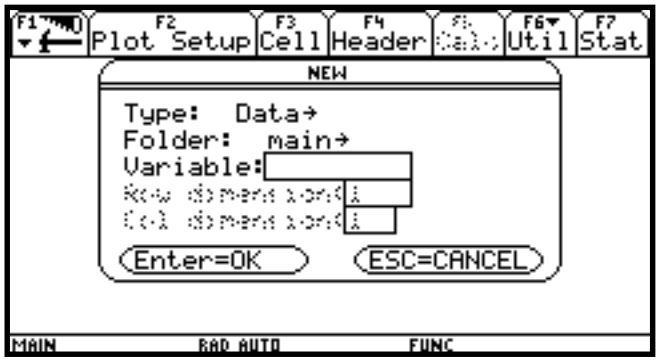
Example 1 Given the matrices

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

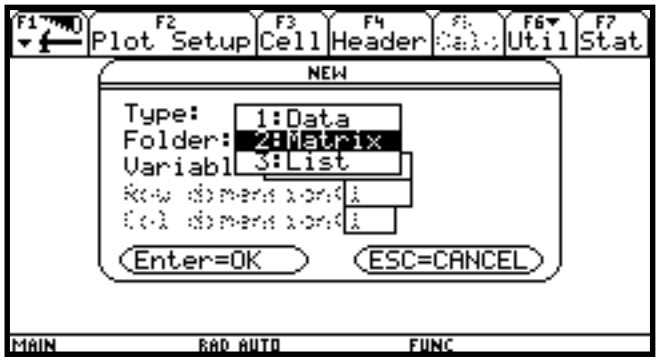
Find (A) $-3BC$ (B) B^{-1} (C) A^T (D) det B
Use three decimal place accuracy.

Solution

Keystrokes	Screen Display	Explanation
2nd [QUIT]		Return to the Home Screen.
2nd [MEM]		Clear the memory so new variables can be defined.
F1 :RESET		
1 :All		
ENTER :YES		Adjust the contrast using ◆ - or ◆ + .
MODE ▼ ▼		
▶ 4 :FIX 3		Change the number of decimal places to FIX 3 and return to the Home Screen.
ENTER		
APPS		Get the APPS menu and select Data/Matrix Editor by pressing 6. Select New by pressing 3.
6 :Data/Matrix Editor		
3 :New...		



▶ 2 :Matrix

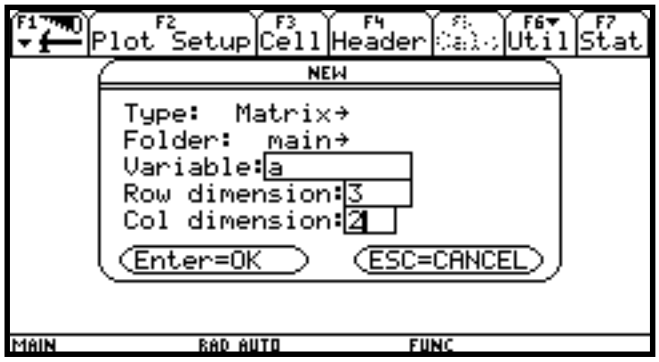


Select Matrix from the Type menu.

▼ ▼ A

▼ 3 ▼ 2

ENTER ENTER



We will store in the main folder. Name the matrix A.

If you get an error message, begin again by resetting the memory. Usually the problem is that the variable A is already in use.

1 ENTER

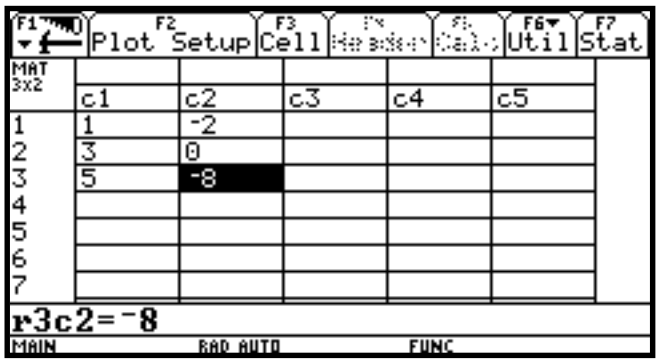
(-) 2 ENTER

3 ENTER

0 ENTER

5 ENTER

(-) 8 ENTER



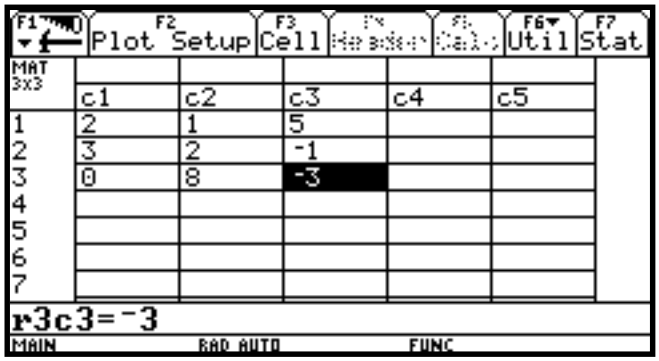
Matrix A will have 3 rows and 2 columns.

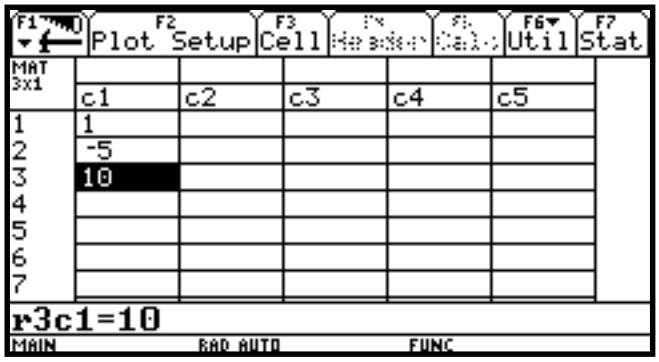
Enter the elements of the matrix A.

2nd QUIT

Return to the Home Screen.

Get the matrix menu again and and repeat the procedure to enter matrices B and C.





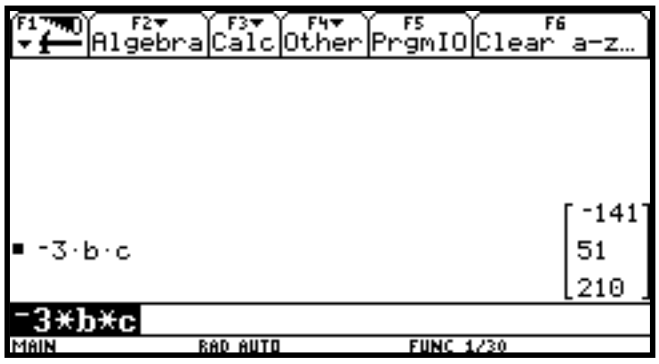
2nd QUIT

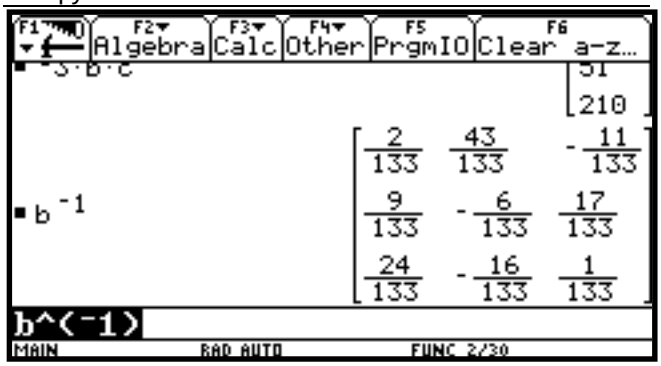
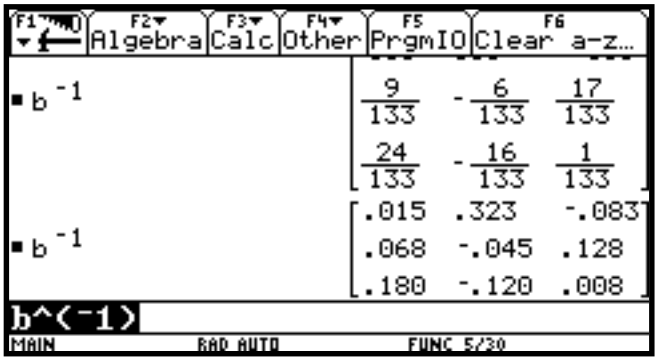
(-) 3 x B

x C ENTER

Return to the home screen to do calculations.

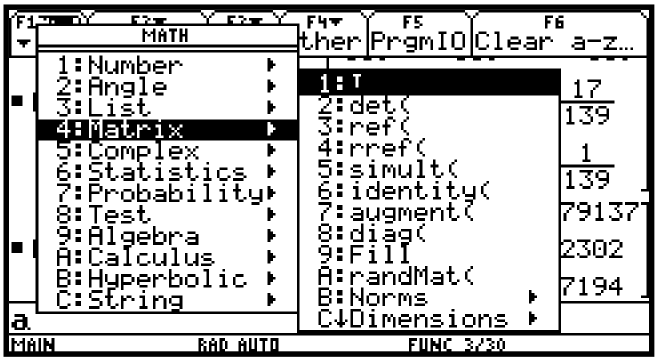
Operations are entered as usual.

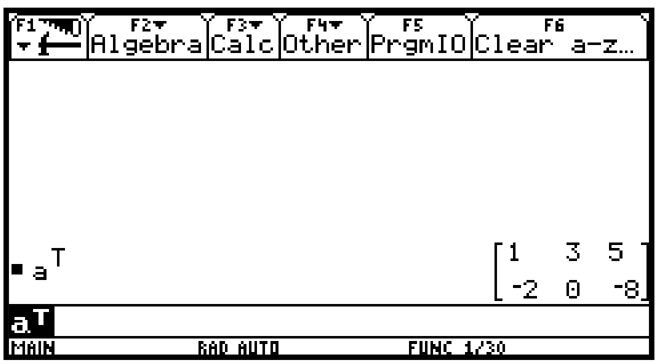


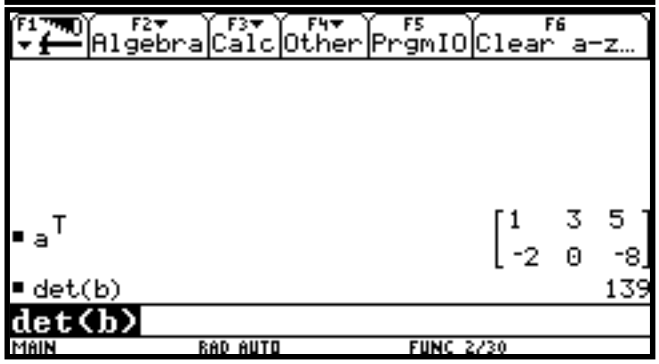
Keystrokes	Screen Display	Explanation
2nd QUIT F1 :Tools 8 :Clear Home CLEAR B ^ ((-) 1) ENTER		Get the Home Screen and clear the Entry Line. Notice the way inverses are found. The rest of the matrix can be seen using the right arrow keys.
◆ ENTER		The solution is given in pretty print form. Override the pretty print to get solution as 3 decimal places.

[illegible]

K[illegible]	Sc[illegible]D[illegible]y	E[illegible]
2nd QUIT		Clear the Entry Line.
F1 :Tools		Get the Matrix operations list from the MATH menu.
8 :Clear Home		
CLEAR		
A 2nd MATH		
4 :Matrix		Choose the transpose from the MATH Matrix menu.
1 :T ENTER		





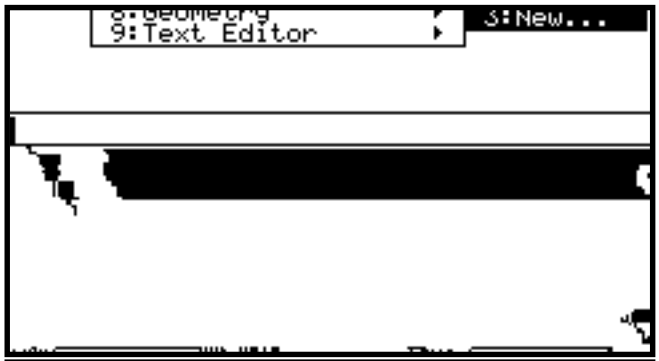
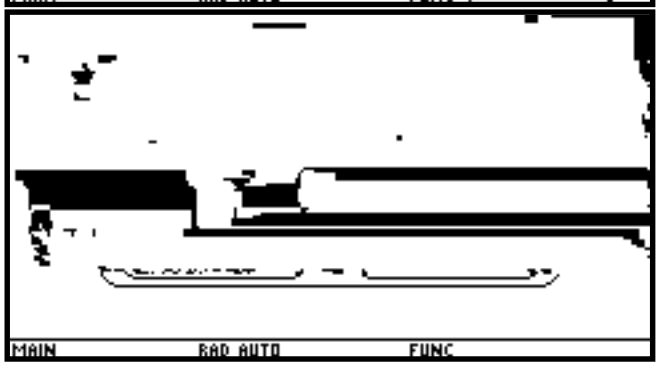
Keystrokes	Screen Display	Explanation
2nd QUIT F1 :Tools 8 :Clear Home CLEAR 2nd MATH 4 :Matrix		Get the Home Screen and clear the Entry Line. Get the Matrix operations list from the MATH menu.
2 :det(B) ENTER		Choose the determinant from the MATH Matrix menu. The determinant of matrix B is 139.

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

There are two methods that can be used:

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

Method 1 Using row operations

Key	Screen Display	Explanation
2nd QUIT		Clear the memory so new variables can be defined. Reset the contrast if necessary.
2nd MEM F1 :RESET 1 :All ENTER :YES		
MODE ▼ ▼ ▶ 4 :FIX 3 ENTER		Change the number of decimal places to 3 and return to the Home Screen.
APPS 6 :Data/Matrix Editor 3 :New...		Get the APPS menu and select Data/Matrix Editor by pressing 6. Select New by pressing 3.
▶ 2 :Matrix ▼ ▼ A ▼ 3 ▼ 4 ENTER ENTER		Select Matrix and enter A for the matrix name with dimensions 3×4.

2 ENTER

1 ENTER

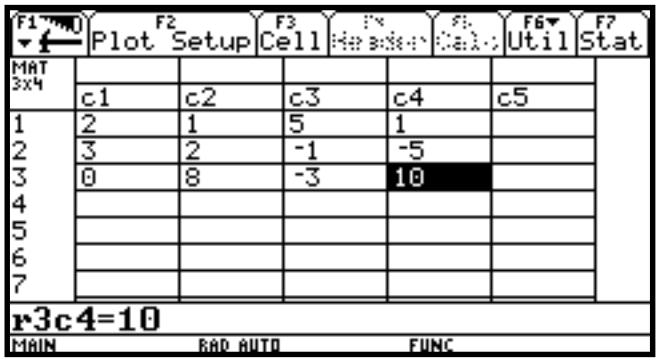
5 ENTER

1 ENTER

3 ENTER

2 ENTER

etc.



Enter the elements row by row.

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

2nd QUIT

2nd MATH

4 :Matrix

D :Row ops

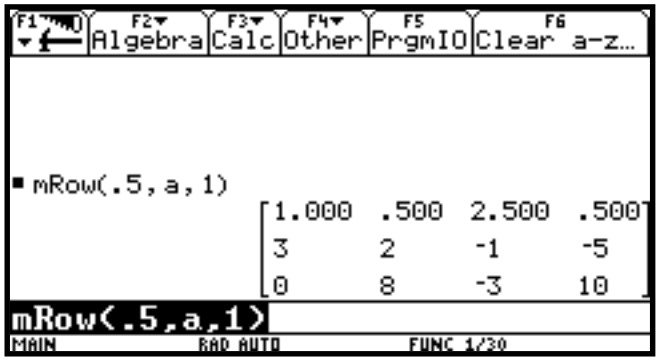
3 :mRow(

Get the MATH Matrix menu.

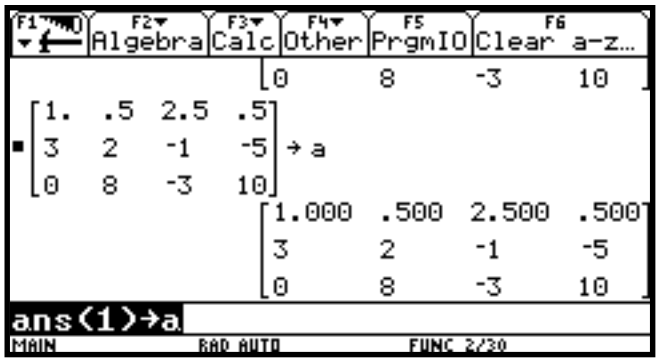
Select Row ops.

.5 , 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.



Store the result in matrix A location. It is a good idea to store the answer.

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

STO▸ A

ENTER

A ENTER

Look at matrix A. Note that it now has a 1 in row 1 col 1.

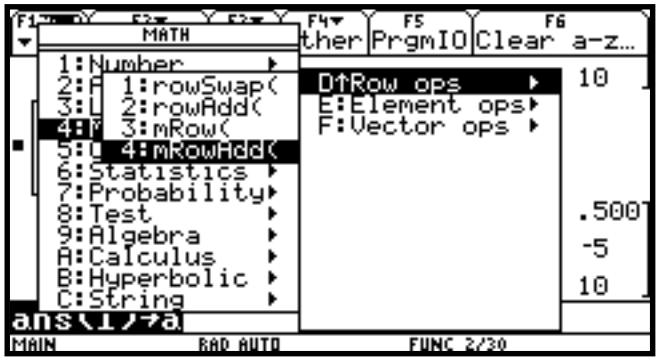
2nd MATH

4 :Matrix

D :Row ops

4 :mRowAdd(

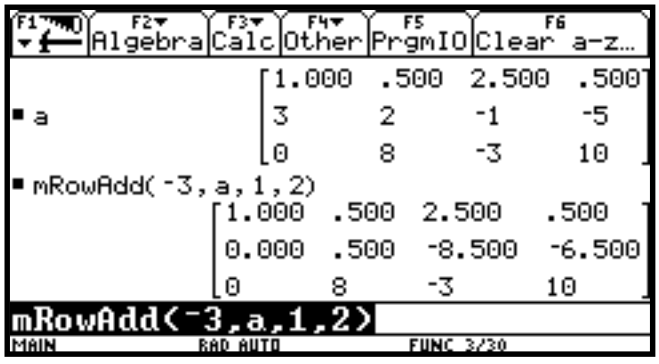
Multiply -3 times matrix A row 1 to add to row 2 and place the result in row 2.



(-) 3 , A ,

1 , 2)

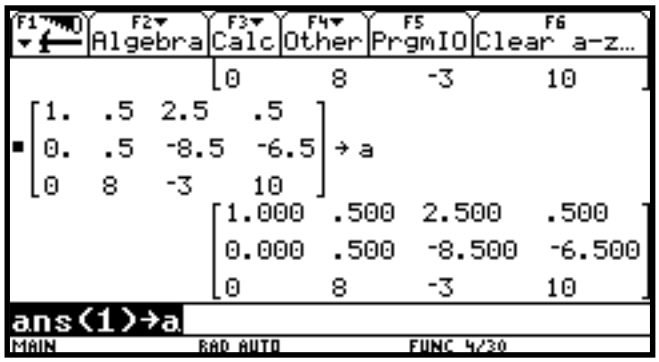
ENTER



STO▸ A

ENTER

Store the result as matrix A.



2nd MATH

4 :Matrix

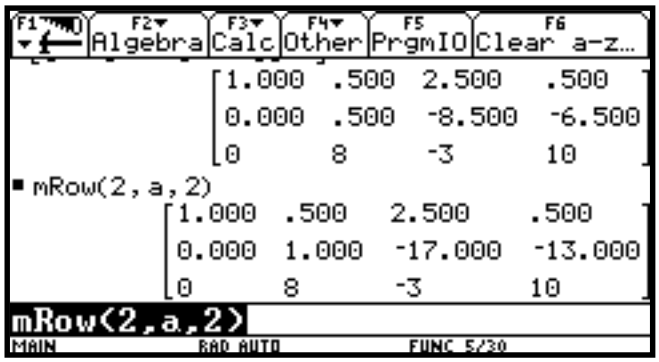
D :Row ops

3 :mRow(

2 , A ,

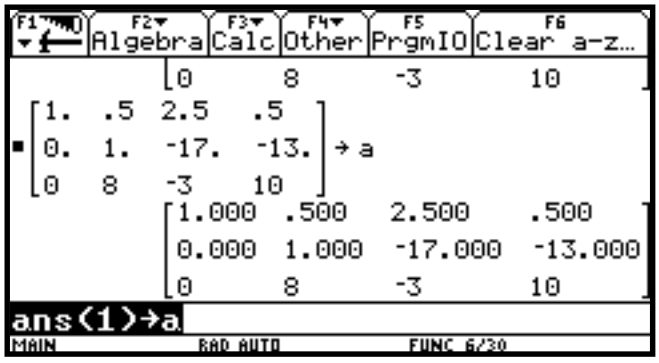
2) ENTER

2 times matrix A row 2.



STO▸ A

ENTER



Continue using row operations to arrive at the reduced form of

$$\begin{bmatrix} 1.000 & 0.000 & 0.000 & -2.429 \\ 0.000 & 1.000 & 0.000 & 1.571 \\ 0.000 & 0.000 & 1.000 & 0.857 \end{bmatrix}.$$

Thus the solution, to three decimal places, of the system of equations is $x = -2.429$, $y = 1.571$, and $z = 0.857$.

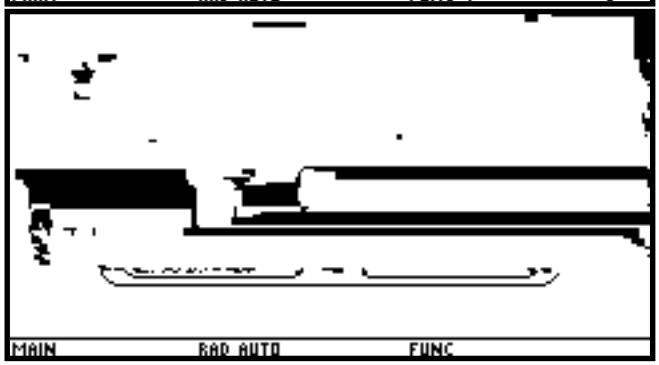
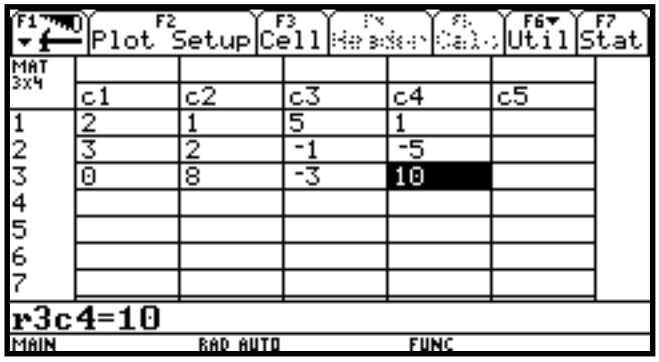
NOTE:

To swap rows of a matrix use [2nd] [MATH] [4] :Matrix [D] :Row ops [1] :rowSwap(.
To swap rows 2 and 3 in matrix A use rowSwap(A,2,3).

To add one row to another use [2nd] [MATH] [4] :Matrix [D] :Row ops [2] :rowAdd(.
To add rows 2 and 3 in matrix A and place the result in row 3 use rowAdd(A,2,3).

Method 2 Using rref(from the MATH Matrix menu

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

Keystrokes	Screen Display	Explanation
[APPS] [6] :Data/Matrix Editor [3] :New [▶] [2] :Matrix [▼] [▼] [A] [▼] [3] [▼] [4] [ENTER] [ENTER] [2] [ENTER] [1] [ENTER] [5] [ENTER] [1] [ENTER] [3] [ENTER] [2] [ENTER] etc. [2nd] [QUIT]	  	Enter the matrix mode and enter the elements of the matrix. If you already have a matrix A stored in the calculator, you will get an error message if you choose New. Choose Current instead and change the matrix elements as needed.

2nd MATH

4 :Matrix

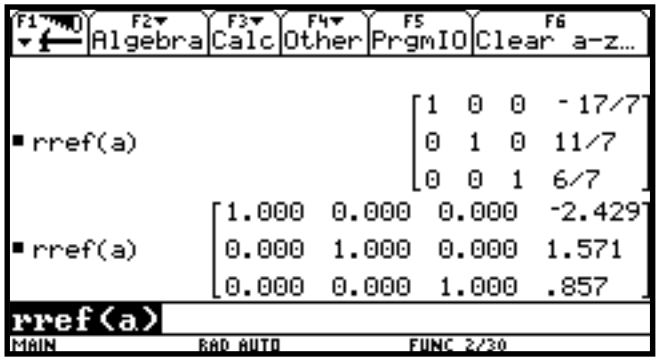
4 :rref(

A) ENTER

Select the rref(command.

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.

◆ ENTER



The solution is given in pretty print form.

Override the pretty print to get solution as FIX 3 decimal places.

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 three decimal places, of the system of equations is

$$\begin{aligned} x_1 &= -2.429 \\ x_2 &= 1.571 \\ x_3 &= .857 \end{aligned}$$

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 inequality. This can be done using paper and pencil.
- Graph the boundary curve using the appropriate shade option on the calculator to get a shaded graph.

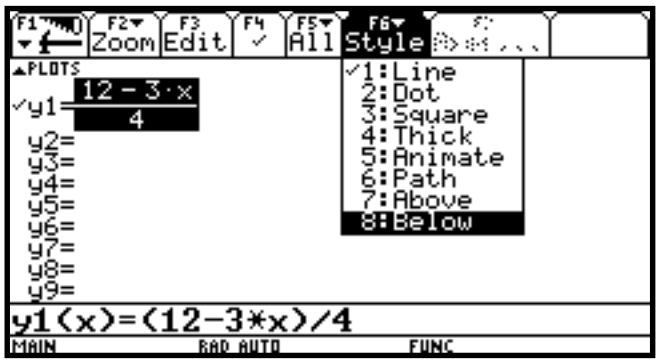
Example 1 Graph $3x + 4y \leq 12$.

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.

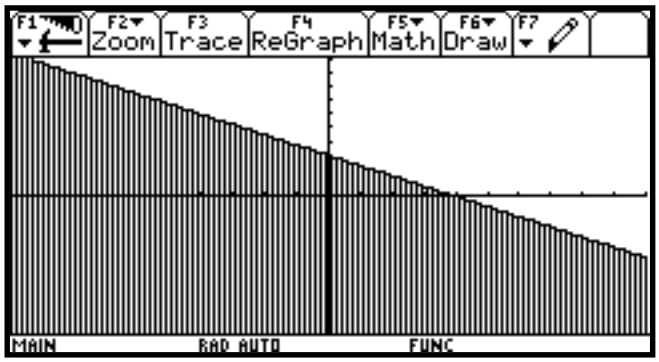
We have $3(0) + 4(0) \leq 12$, which is a true statement. Hence the point (0, 0) is in the solution set of the inequality. Since (0, 0) is in the lower half plane, the solution set is the lower half-plane plus the line.

Keystrokes	Screen Display	Explanation
2nd QUIT		Return to the Home Screen.
2nd MEM		Reset the memory.
F1 :RESET		
1 :All		
ENTER :YES		Adjust the contrast using ◆ - or ◆ + .
◆ Y= CLEAR		
(12 - 3 X		First write 3x+4y=12 as y=(12-3x)/4.
) ÷ 4		
ENTER ▲		Store the expression in the Y= list after clearing any existing expressions.
F6 :Style		Use the style selection to shade the lower part of the graph.
8 :Below		



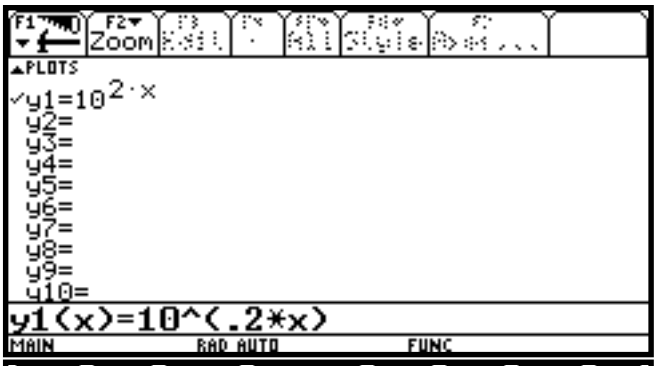
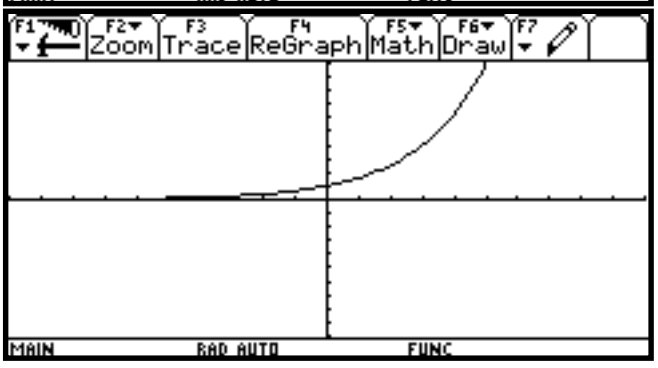
F2 :Zoom

6 :ZoomStd

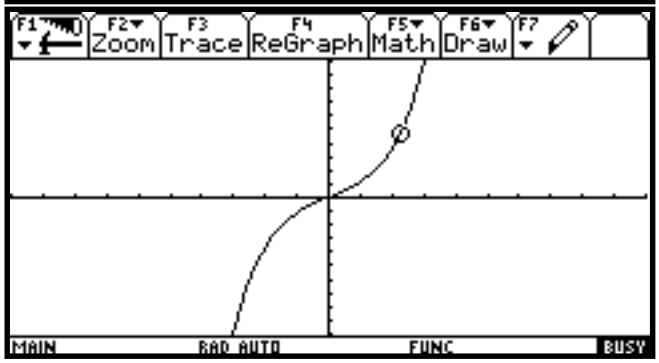


B-17 Exponential and Hyperbolic Functions

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

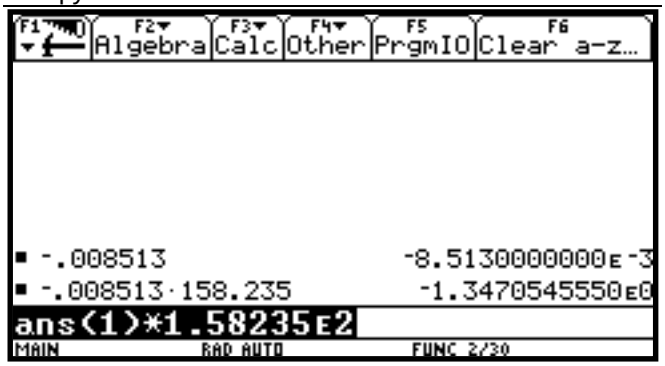
Keystrokes	Screen Display	Explanation
2nd QUIT F1 :Tools 8 :Clear Home CLEAR		Return to the Home Screen and clear.
◆ Y= CLEAR 10 ^ (.2 X) ENTER ▲		Store the function in the Y= list and graph. Use the up arrow to highlight the function. Now the entry line will also be displayed.
F2 :Zoom 6 :ZoomStd		Graph the function.

Example 2 Graph $y = \frac{e^{x} - e^{-x}}{2}$. [NOTE: This is the hyperbolic sine, sinh x.]

Keystrokes	Screen Display	Explanation
2nd QUIT		Return to the Home Screen and clear.
F1 :Tools		
8 :Clear Home		
CLEAR		
◆ Y= CLEAR		Store the function and graph.
(2nd e^{x} X)		This is also the hyperbolic sine. So we could use sinh from the catalog list.
- 2nd e^{x}		
(-) X))		
÷ 2 ENTER		Get the sinh from the MATH Hyperbolic list. Store it as y2. Enter X as the variable. Change the style to Animate.
2nd MATH		
B :Hyperbolic		
1 :sinh(X)		
ENTER ▲		
F6 :Style		
5 :Animate		
F2 :Zoom		Watch very closely and you will see the O tracing the graph of y1.
6 :ZoomStd		

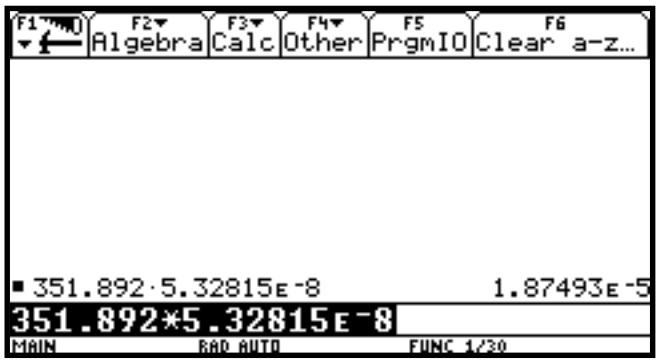
B-18 Scientific Notation, Significant Digits, and Fixed Number of Decimal Places

Example 1 Calculate, to ten decimal places, $(-8.513\times10^{-3})(1.58235\times10^{2})$. Enter numbers in scientific notation. Express your answer in scientific notation.

Keystrokes	Screen Display	Explanation
2nd QUIT F1 :Tools 8 :Clear Home CLEAR MODE ▼ ▼ ▶ B :FIX 10 ▼ ▼ ▶ 2 :SCIENTIFIC ENTER		
(-) 8.513 ENTER		Enter the first number. The number displayed is not in scientific notation. (It is not necessary to press ENTER after the entry of the first number. This is done here to show how the numbers are displayed on the screen.)
2nd EE (-) 3 ENTER		
× 1.58235 ENTER		Multiply by the second number.
		The answer is -1.3470545550, to ten decimal places.

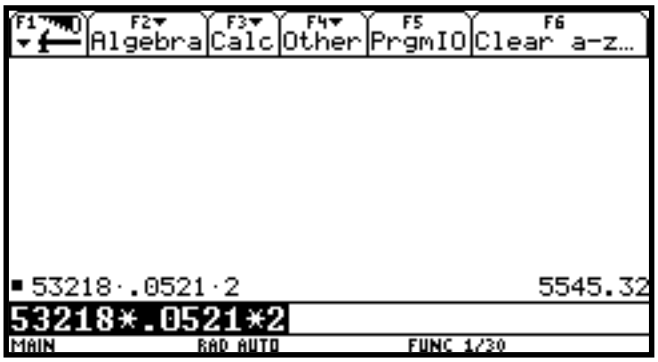
Example 2 Set the scientific notation to six significant digits and calculate $(351.892)(5.32815\times10^{-8})$.

Solution

Keystrokes	Screen Display	Explanation
2nd QUIT		Clear the Home Screen.
F1 :Tools		
8 :Clear Home		
CLEAR		
MODE ▼ ▼		Select Float 6 and Scientific notation.
▶ K :FLOAT 6		
▼ ▼ ▶		
2 :SCIENTIFIC		
ENTER		Enter the numbers.
351.892		
× 5.32815		Note the result is displayed in scientific notation with six significant digits.
2nd EE (-) 8		
ENTER		

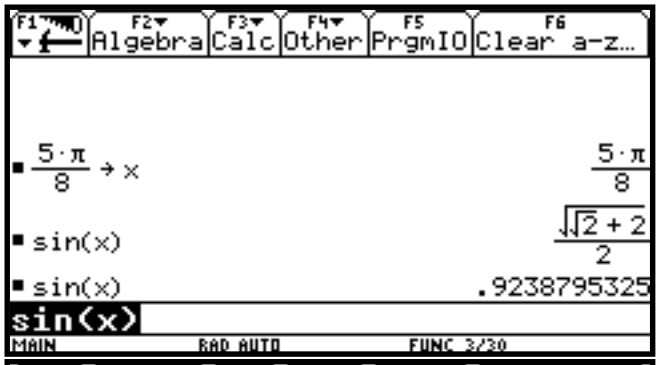
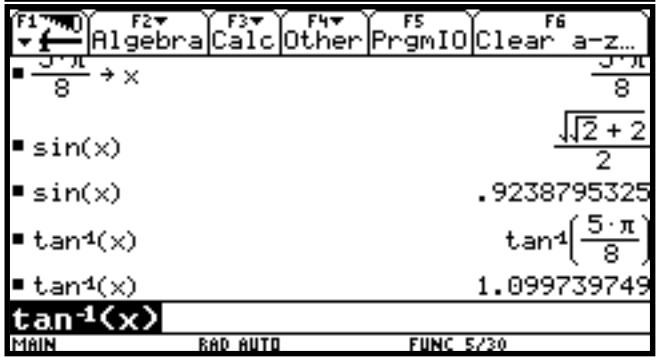
Example 3 Fix the number of decimal places at 2 and calculate the interest earned on $53,218.00 in two years when invested at 5.21% simple interest.

Keystrokes	Screen Display	Explanation
2nd QUIT		
F1 :Tools 8 :Clear Home		
CLEAR MODE		Choose NORMAL notation with 2 fixed decimal points.
▼ ▼ ▶		
3 :FIX 2		Return to the Home Screen.
▼ ▼ ▶		
1 :NORMAL		Only two decimal places are shown in the answer. The interest is $5545.32.
ENTER		
53218 × .0521		
× 2 ENTER		

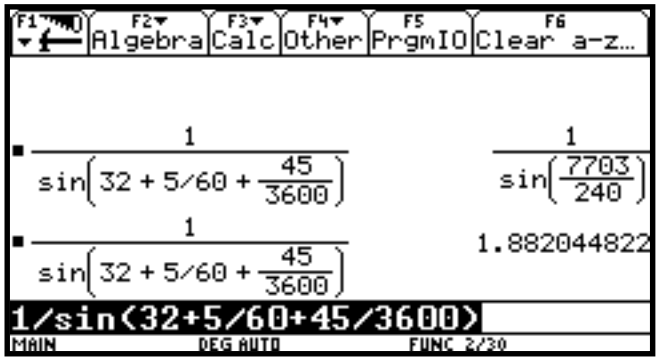


B-19 Angles and Trigonometric Functions

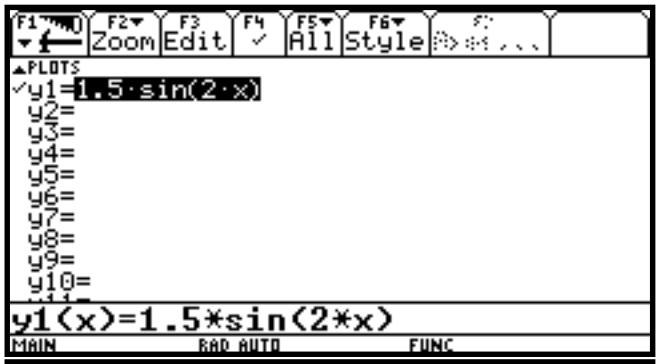
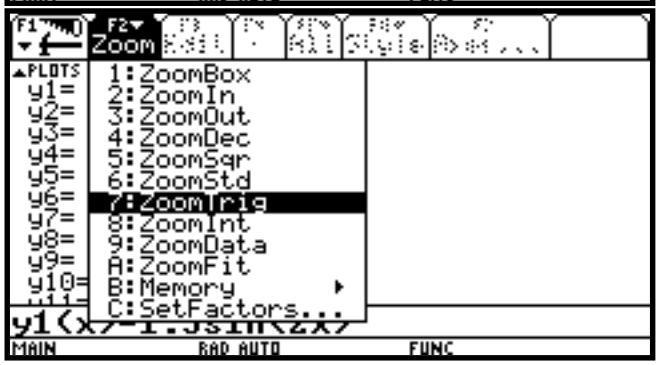
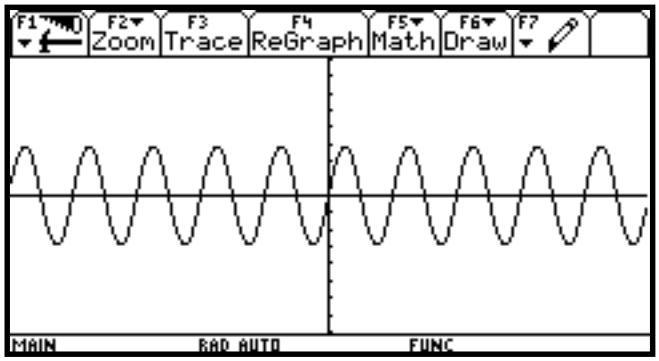
Example 1 Evaluate $f(x) = \sin x$ and $g(x) = \tan^{-1} x$ at $x = \frac{5\pi}{8}$. Use 10 significant digits.

Keystrokes	Screen Display	Explanation
2nd [QUIT]		
[F1] :Tools [8] :Clear Home		
[CLEAR]		
[MODE] [▼] [▼] [▶] [O] :FLOAT 10 [▼] [▶] [1] :RADIAN [▼] [▶] [1] :NORMAL		Set the mode to Float 10 to get 10 significant digits. Since the angle measure is given in radians, set the calculator for radian measure before starting calculations.
[ENTER]		Store $\frac{5\pi}{8}$ as x. Get the sine function and evaluate.
5 [2nd] [π] [÷] [8] [STO▸] [X] [ENTER]		
[SIN] [X] [)] [ENTER]		
[◆] [ENTER]		Override the pretty print to get the decimal approximation.
[2nd] [TAN^{-1}] [X] [)] [ENTER]		Get the inverse tangent function and evaluate.
[◆] [ENTER]		

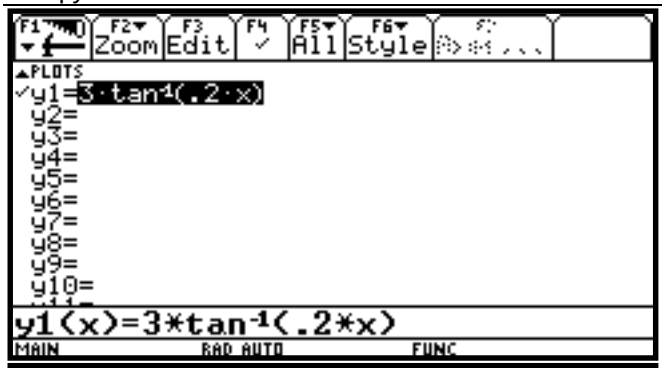
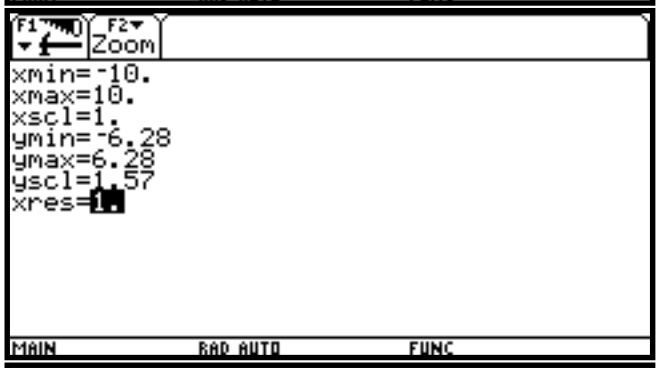
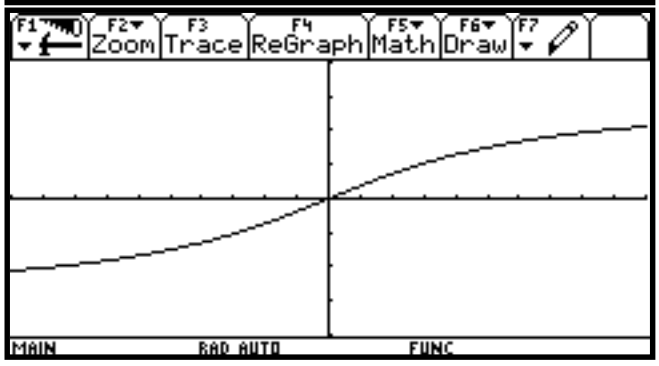
Example 2 Evaluate f(x) = csc x at x = 32° 5' 45". Express answer using 10 significant digits.

Keystrokes	Screen Display	Explanation
2nd QUIT		Set the mode to Float 10. Since the angle measure is given in degrees, set the calculator for degree measure before starting calculations.
F1 :Tools 8 :Clear Home		
CLEAR		Return to the Home Screen.
MODE ▼ ▼ ▶ O :FLOAT 10 ▼ ▶ 2 :DEGREE ▼ ▶ 1 :NORMAL ENTER		
1 ÷ SIN 32 + 5 ÷ 60 + 45 ÷ 3600) ENTER		Use $\frac{1}{\sin x}$ to evaluate csc x.
◆ ENTER		Change the minutes and seconds to decimal values while entering the angle measure.
		Override the pretty print format to get the decimal approximation.

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

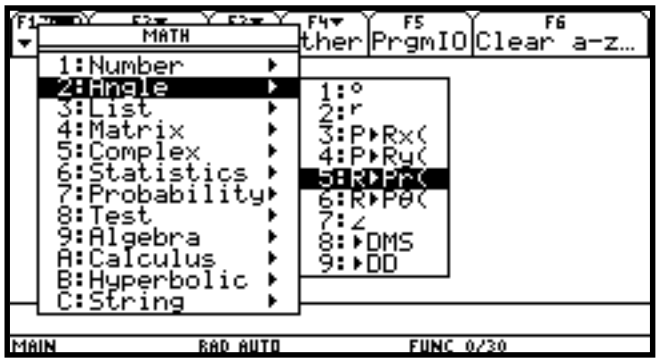
Keystrokes	Screen Display	Explanation
2nd QUIT		Set MODE to RADIAN measure.
F1 :Tools		
8 :Clear Home		
CLEAR		
MODE ▼ ▼		
▼ ▶		
1 :RADIAN		
ENTER		
◆ Y= CLEAR		Clear all expressions stored in the Y= list.
1.5 SIN 2		Store f(x) as y1.
X)		
F2 :Zoom 7 :ZoomTrig		Use the trigonometric option on the ZOOM menu to get tick marks set at radian measures on the horizontal axis since the angle measure is in radians.
		Press ◆ WINDOW to see that the WINDOW dimensions are [-15.577…, 15.577…]1.571… by [-4, 4].5 with xres=2.

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

Keystrokes	Screen Display	Explanation
2nd QUIT F1 :Tools 8 :Clear Home CLEAR		Return to the Home Screen and clear.
◆ Y= CLEAR 3 2nd TAN^{-1} .2 X) ◆ WINDOW (-) 10 ENTER 10 ENTER 1 ENTER (-) 6.28 ENTER 6.28 ENTER 1.57 ENTER 1 ENTER		Store $g(x)$ as y1.
		Set the WINDOW dimensions to [-10, 10]1 by [-6.28, 6.28]1.57.
◆ GRAPH		Graph the function.

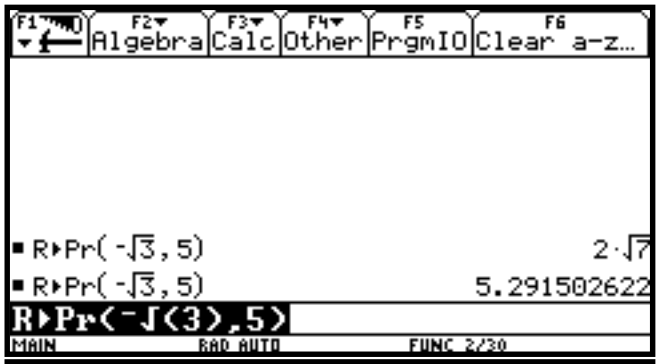
B-20 Polar Coordinates and Polar Graphs

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

Keystrokes	Screen Display	Explanation
2nd QUIT		Return to the Home Screen and clear.
F1 :Tools 8 :Clear Home		
CLEAR		
2nd MATH		Get the Angle option from the MATH menu.
2 :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.

◆ ENTER

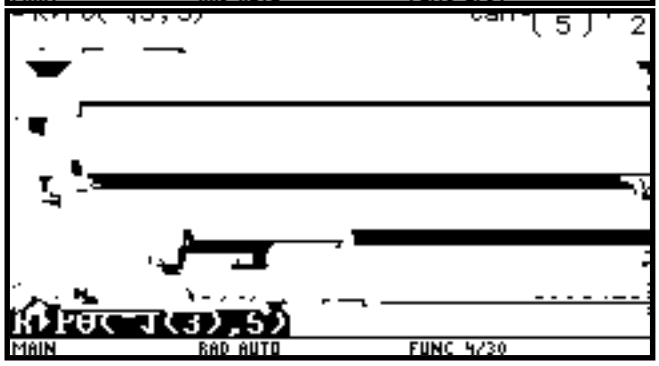
2nd MATH

2 :Angle

6 :R▸Pθ(

(-) 2nd √ 3) , 5)

ENTER



Get the angle menu again.

Choose the rectangular to polar conversion that displays the value of θ.
Enter the value of x and y coordinates. The displayed value is θ.

◆ ENTER

The polar coordinates, to two decimal places, are (5.29, 1.90).

F2