BASIC OPERATIONS for TI-83 and TI-83+ GRAPHING CALCULATORS by

Carolyn Meitler
Concordia University Wisconsin

1 Getting Started

Press ON to turn on the calculator.

Press 2nd + to get the MEMORY screen.

Use the down arrow ▼ to select 5:Reset... on the TI-83 or 7:Reset... on the TI-83+.

TI-83

TI-83+

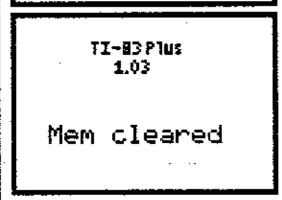
Press ENTER.

On the TI-83 select 1:All Memory... and press ENTER.

On the TI-83+ use the right arrow to select 1:All Memory... and press ENTER.

Use the down arrow ▼ to choose 2:Reset and press ENTER.

The screen should now indicate that the memory 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 ▲ key depressed until you see the display in the middle of the screen. Now the contrast will be dark enough for you to see the screen display.

If the contrast is too dark, press [2nd] and hold the [▼] depressed until the screen is the contrast you want.

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.

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 [↑] 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.

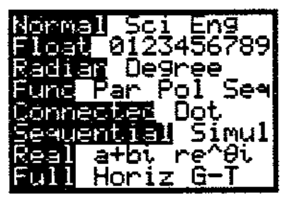
[A-LOCK]

[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.

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 to highlight the selection and then 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.

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.

4 Calculation

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

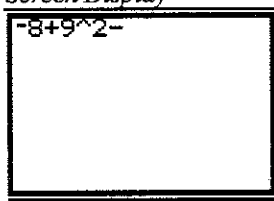
Turn the calculator on and press [2nd] [QUIT] to return to the Home Screen. Press [CLEAR] to clear the Home Screen. Now we are ready to do a new calculation.

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:

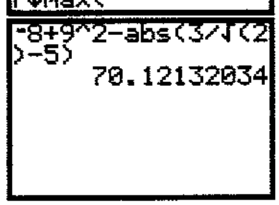
Keystrokes / *Screen Display* / *Explanation*

[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.

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:

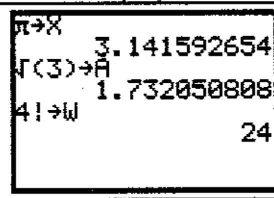
1. Store the values of the variable, enter the expression, and press [ENTER] to evaluate the expression for the stored values of the variables.
2. Store the expression and store the values of the variables. Recall the expression and press [ENTER] to evaluate the expression for the stored values of the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

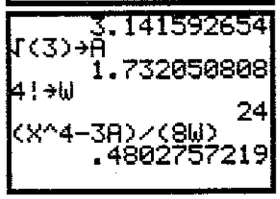
The advantage of the second method is that the expression can be easily evaluated for several different values of the variables.

Solution:

Method 1

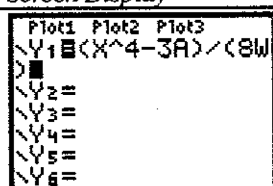
Keystrokes	*Screen Display*
[2nd] [QUIT] [CLEAR]	
[2nd] [π] [STO▸] [X,T,θ,n] [ENTER]	
[2nd] [√] [3] [)] [STO▸] [ALPHA] [A] [ENTER]	
[4] [MATH] [▶] [▶] [▶] [4] :! [STO▸] [ALPHA] [W] [ENTER]	
NOTE: In this document the notation [4] :! refers to the fourth menu item.	
[(] [X,T,θ,n] [^] [4] [-] [3] [ALPHA]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

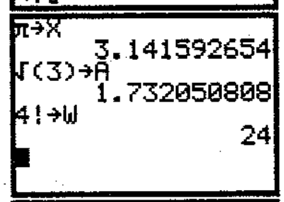


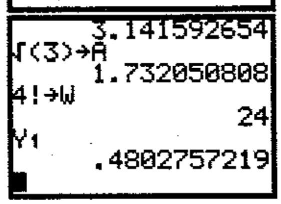


Method 2

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]	





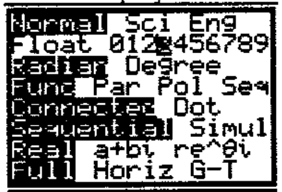


Example 2 Evaluate the function $g(x) = \sqrt{x - \sqrt{x}}$ to three decimal places for x = 1.900, 1.990, 1.999, 2.001, 2.010, and 2.100 using a list.

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] ...

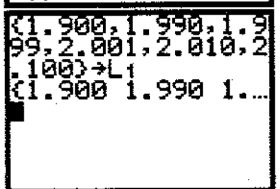


Change the mode to three decimal places. Return to the home screen.
Clear any existing expressions in the in the Y= list by clearing or deselecting them.

[2nd] [√] [X,T,θ,n] [–]
[2nd] [√] [X,T,θ,n] [)] [)]
[2nd] [QUIT]

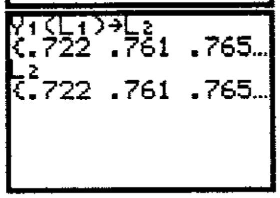
Store the expression as Y1 and return to the home screen.

[2nd] [{] [1.900] [,] [1.990] [,] [1.999] [,] [2.001]
[,] [2.010] [,] [2.100] [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.

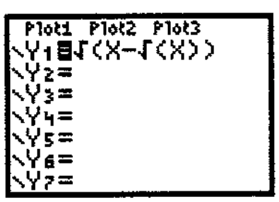
Solution: First store the expression in the Y= list. Set the table parameters to begin at $x = 0$ and to have an increment of 1. Get the table.

Keystrokes | *Screen Display* | *Explanation*

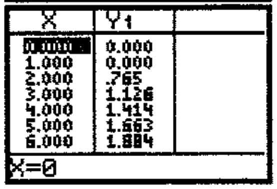
[MODE] [▼] [►] [►] [►] [►]
[ENTER] [2nd] [QUIT]
[Y=] [CLEAR] [▼] [CLEAR] ...

Change the mode for numbers 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]



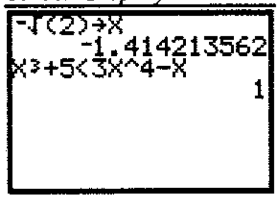
Store the expression as Y1 and return to the home screen.

Keystrokes	Screen Display	Explanation
2nd TblSet 0 ENTER 1 ENTER ▼ ENTER		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 ▼ ... ▼		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.

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 2 of this document.

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

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 (–) 1.5 X,T,θ,n

x²

▲ ▲ ▲ ▲ ◄ ◄ ENTER

ENTER ENTER ENTER

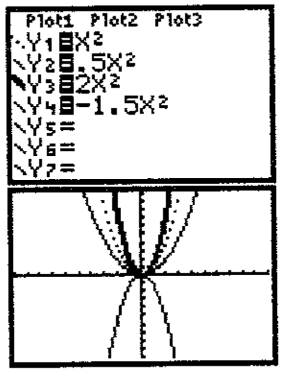
ENTER ENTER

▼

▼ ENTER

▼

ZOOM 6 :ZStandard



Clear and store the third function as Y3.
Clear and store the fourth function as Y4.

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).

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).

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.

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:

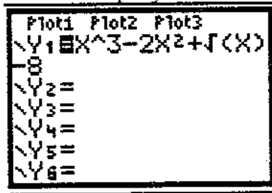
Method 1 Change the WINDOW dimensions.

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

Keystrokes

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

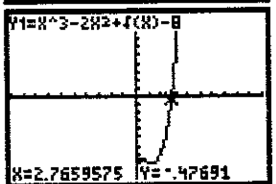
Screen Display



Explanation

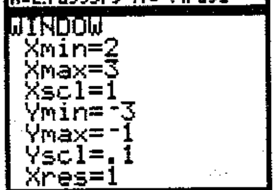
Enter the function as Y1.

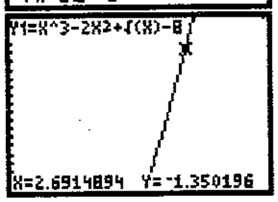
TRACE ► ... ►



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.

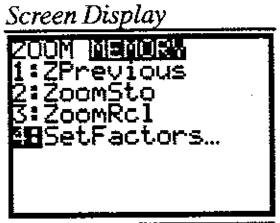
Method 2 Use the 2 :Zoom In option on the ZOOM menu.

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

Keystrokes

ZOOM 6 :ZStandard
ZOOM ► 4 :Set Factors

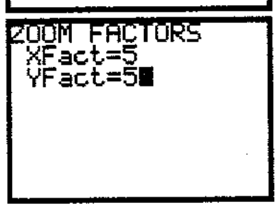
Screen Display



Explanation

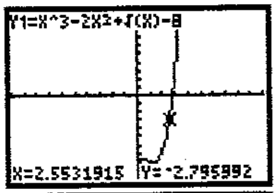
Graph the function using the standard graphing screen.
Magnification factors need to be set.

5 ENTER 5



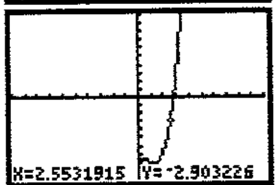
For this example let us set them at 5 for both horizontal and vertical directions.

TRACE ► … ►



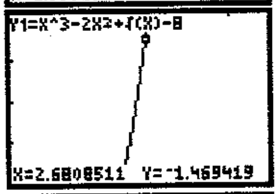
Get the TRACE function and move the cursor using the arrow keys to the point (2.5531915, –2.795992).

ZOOM 2 :Zoom In ENTER

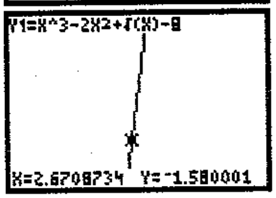


Press 2 :Zoom In from the ZOOM menu. Move the cursor to (2.5531915, -2.903226) and press ENTER.

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).



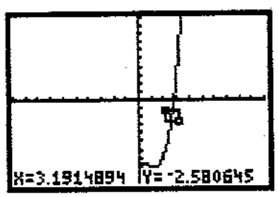
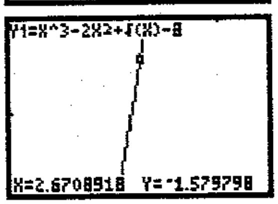
Repeat the trace and zoom procedure until you get a value for the x coordinate accurate to two decimal places for $y = -1.58$.

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.

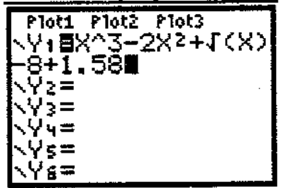
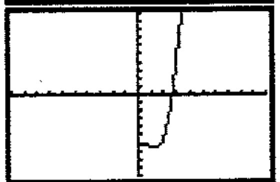
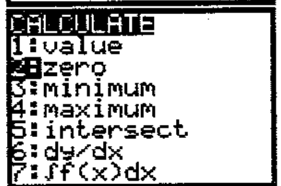
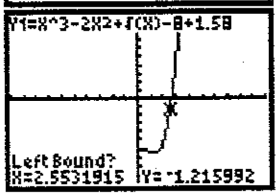
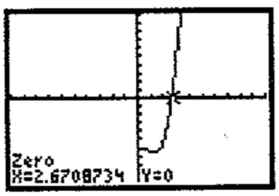
Method 3 Use the 1 :Box option on the ZOOM menu.

Graph the function using the ZStandard Graphing Screen. (See Section 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.

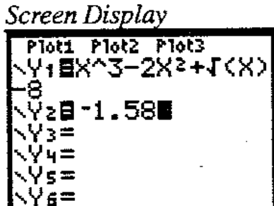
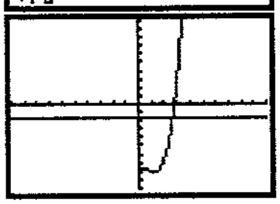
Repeat using trace and zoom box until you get a value for the y coordinate accurate to two decimal places. The point has coordinates (2.67, -1.58). Hence the desired value for x is approximately 2.67.

Method 4 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. $$x^3-2x^2+\sqrt{x}-8=-1.58$$ Now change the equation so it is equal to zero. $$x^3-2x^2+\sqrt{x}-8+1.58=0.$$
ZOOM 6 :ZStandard		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.

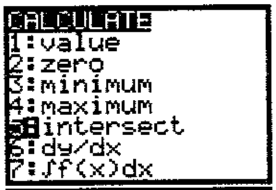
Method 5 Use the Intersect feature of the calculator.

Graph the function using the ZStandard Graphing Screen. (See Section 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.

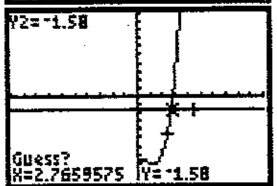
2nd CALC 5 :intersect

◄ … ► ENTER



Get the intersect feature.

◄ or ► ENTER

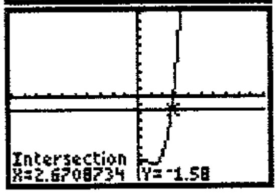


Place the cursor at a point on the first graph near the point of intersection and press ENTER.

◄ or ► ENTER

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

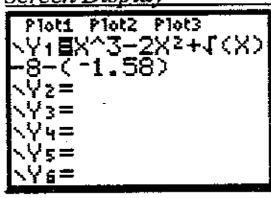
Move the cursor and press enter for the guess.



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*

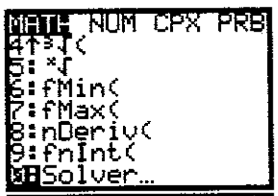


Write the function as

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

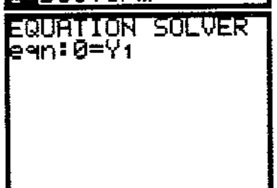
Enter this as Y1 in the function list.

MATH 0 :Solver…

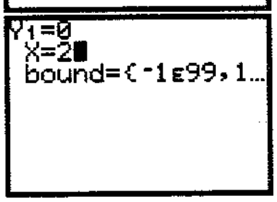


Get the EQUATION SOLVER. Recall Y1 from the function list.

VARS ► 1 :Function



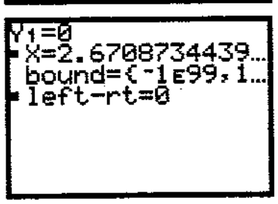
ENTER ENTER 2



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

SOLVE is above the ENTER key.

ALPHA SOLVE



Hence the desired value for x is approximately 2.67.

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

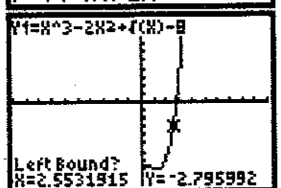
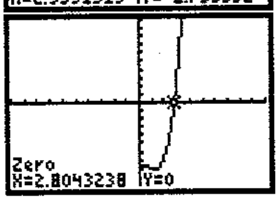
1. Change the [WINDOW] dimensions.
2. Set the Zoom Factors and zoom in.
3. Use the Zoom Box feature of the calculator.
4. Use the Zero feature of the calculator.
5. Use the Intersect feature of the calculator.
6. Use the Solver feature of the calculator.

<u>Method 1</u> Change the [WINDOW] dimensions.
This method is described in Section 8 Example 1 Method 1 of this document.

<u>Method 2</u> Set the Zoom Factors and zoom in.
This method is described in Section 8 Example 1 Method 2 of this document.

<u>Method 3</u> Use the Zoom Box feature of the calculator.
This method is described in Section 8 Example 1 Method 3 of this document.

<u>Method 4</u> 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.

<u>Method 5</u> Use the Intersect feature of the calculator.
This method is described in Section 8 Example 1 Method 4 of this document

<u>Method 6</u> Use the Solver feature of the calculator
This method is described in Section 8 Example 1 Method 5 of this document.

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:

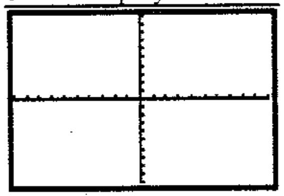
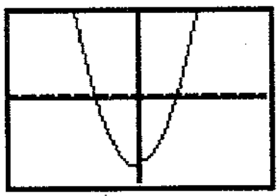
1. Graph using the default setting of the calculator and zoom out. The disadvantage of this method is that often the function cannot be seen at either the default settings or the zoomed out settings of the [WINDOW].
2. Evaluate the function for several values of x. Make a first estimate of the window 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 $f(x)= .2x^2 + \sqrt[3]{x} - 32$.

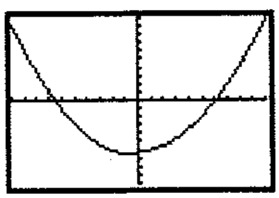
Solution:

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

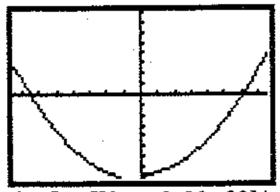
Method 3 Analyze the leading coefficient and constant terms.

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 \f(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 $\frac{\text{Ymax}-\text{Ymin}}{20}$ $= \frac{32-(-32)}{20} = 3.2$ (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.

10 Piecewise-Defined Functions

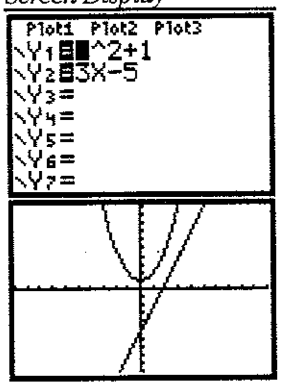
There are two methods to graph piecewise-defined functions:

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

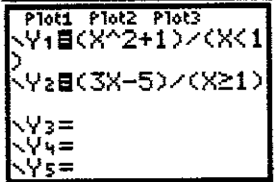
Keystrokes	*Screen Display*	*Explanation*
[Y=] [CLEAR] [X,T,θ,n] [^] [2] [+] [1] [ENTER] [CLEAR] [3] [X,T,θ,n] [–] [5] [ZOOM] [6] :ZStandard		Store the functions. Graph. Both functions will be displayed. Use trace and zoom to find the point on the graphs where x=1. When drawing this curve on paper, place 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.

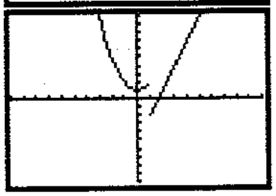
Method 2

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 $x\geq 1$. The function will not graph when it is divided by 0. Similarly for the logical statement $x\geq 1$ 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.

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 TRACE and ZOOM or using the Solver from the MATH menu. See Section 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.

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

Solution:

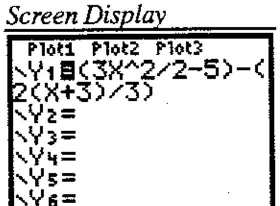
Method 1 Using TRACE and ZOOM

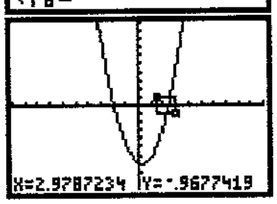
Write the equation as $\left(\frac{3x^2}{2} - 5\right) - \left(\frac{2(x+3)}{3}\right) = 0$. Graph $y = \left(\frac{3x^2}{2} - 5\right) - \left(\frac{2(x+3)}{3}\right)$. Now we want to find the x value where the graph crosses the x axis. This is the x intercept.

Keystrokes

Y= CLEAR (3
X,T,θ,n ^ 2 ÷ 2
− 5) − (2
(X,T,θ,n + 3)
÷ 3) ZOOM 6 :ZStandard

Screen Display





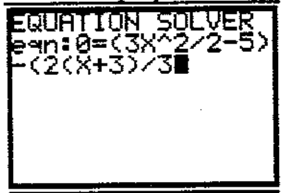
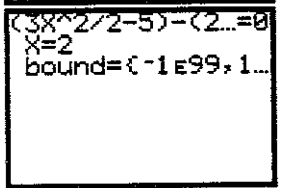
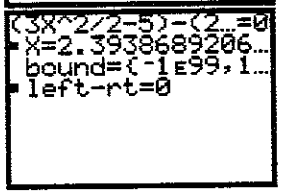
Explanation

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 $x \approx 2.39$.

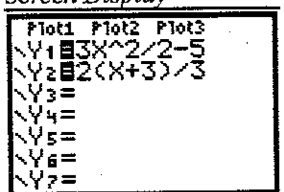
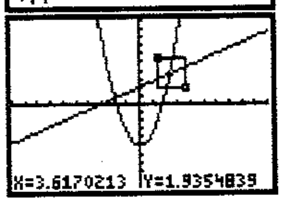
A typical zoom box is shown on the graph at the left. (See Section 8 Method 3 of this document.)

Method 1 Using Solver

Keystrokes	*Screen Display*	*Explanation*
MATH 0 :Solver ▲ (3 X,T,θ,*n* ^ 2 ÷ 2 - 5) - (2 (X,T,θ,*n* + 3) ÷ 3) ENTER		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.
2		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		

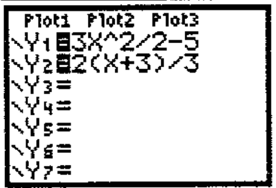
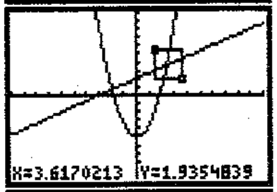
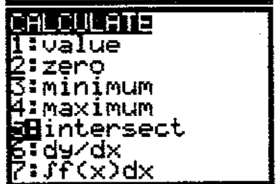
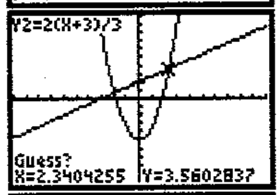
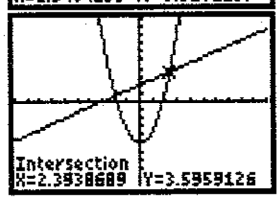
Method 2 Using TRACE and ZOOM

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		Select intersect from the CALC menu.
ENTER		Select the first curve. Look in the upper right corner for the function number.
ENTER 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.

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 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 $-1.95 \le x \le 2.39$.

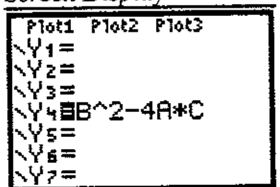
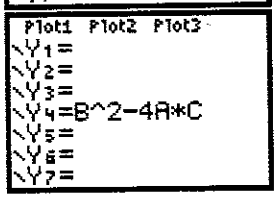
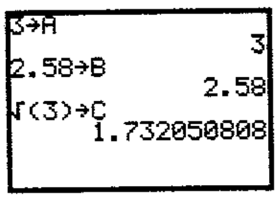
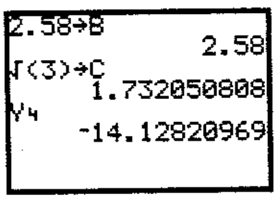
Method 2 Graph $y = \frac{3x^2}{2} - 5$ and $y = \frac{2(x+3)}{3}$ on the same coordinate axes and find the x coordinate of their points of intersection. See Section 10 Example 1 Method 2. The x coordinate of the points of intersections are -1.95 and 2.39. We see that the parabola is below the x line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

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:

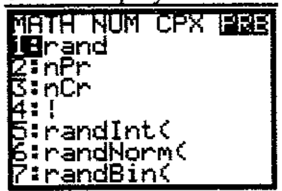
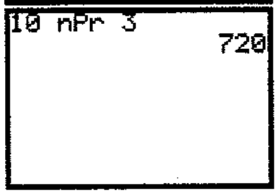
Keystrokes	*Screen Display*	*Explanation*
[Y=] [▼] [▼] [▼] [CLEAR] [ALPHA] [B] [^] [2] [-] [4] [ALPHA] [A] [x] [ALPHA] [C]		Choose Y4 using the arrow keys. (Any of Y1, Y2, Y3, ... could be used.) Store the expression.
[◄] ... [◄] [ENTER] [2nd] [QUIT]		Use the left arrow repeatedly until the cursor is 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.

14 Permutations and Combinations

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

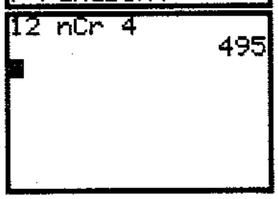
Solution (A):

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.

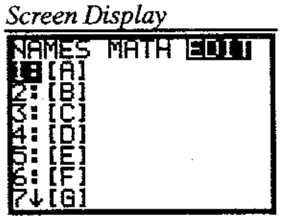
15 Matrices (Note the TI-83 does not need the 2nd key pressed before pressing MATRX.

Example 1 Given the matrices

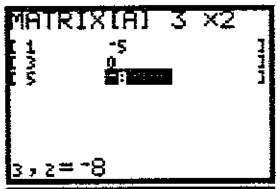
$$A = \begin{bmatrix} 1 & -2 \\ 3 & 0 \\ 5 & -8 \end{bmatrix} \quad B = \begin{bmatrix} 2 & 1 & 5 \\ 3 & 2 & -1 \\ 0 & 8 & -3 \end{bmatrix} \quad C = \begin{bmatrix} 1 \\ -5 \\ 10 \end{bmatrix}$$

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

Solution (A):

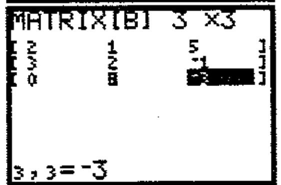
Keystrokes	Screen Display	Explanation
2nd MATRX ► ►		Enter the matrix mode.
		Choose **EDIT** using the arrow keys.
1 :[A]		Choose the A matrix.
3 ENTER 2 ENTER		Enter the dimensions of the matrix.

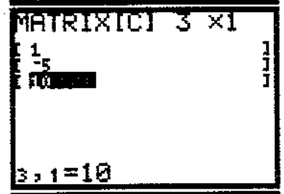
1 ENTER (-) 2 ENTER
3 ENTER 0 ENTER
5 ENTER (-) 8 ENTER



Enter the matrix elements.

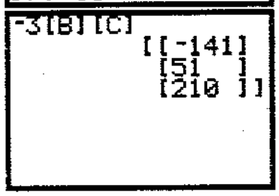
2nd MATRX ► ► etc.





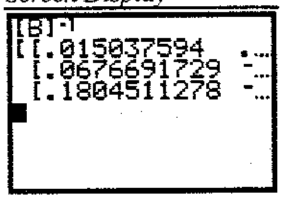
Return to the matrix menu and repeat the procedure to enter matrix B and C.

2nd QUIT CLEAR
(-) 3 2nd MATRX 2 :[B]
2nd MATRX 3 :[C]

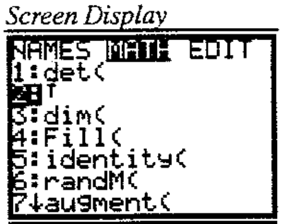
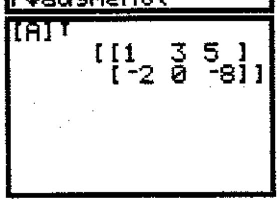


Return to the home screen to do calculations. Operations are entered as usual except use the matrix symbols from the MATRX NAMES menu.

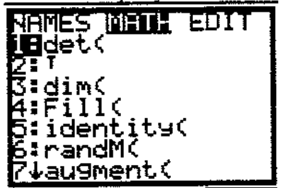
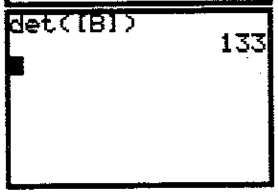
Solution (B):

Keystrokes	*Screen Display*	*Explanation*
2nd MATRX 2 :[B] x-1 ENTER		Notice the way inverses are found. The rest of the matrix can be seen using the right arrow keys.

Solution (C):

Keystrokes	*Screen Display*	*Explanation*
2nd MATRX 1 :[A]		Get the matrix from the NAMES menu.
2nd MATRX ► 2 :T ENTER	 	Choose the transpose from the MATRX MATH menu.

Solution (D):

Keystrokes	*Screen Display*	*Explanation*
2nd MATRX ▶ 1 :det(		Choose the determinant option from the matrix menu.
2nd MATRX 2 :[B]) ENTER		

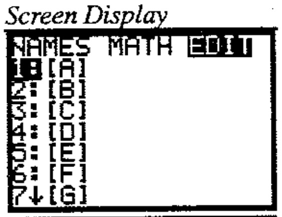
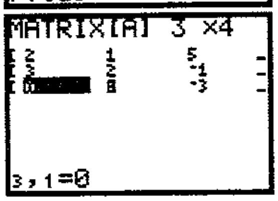
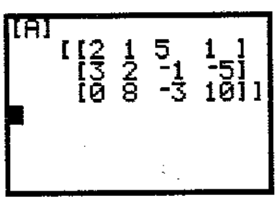
Example 2 Find the reduced form of matrix $\begin{bmatrix} 2 & 1 & 5 & 1 \\ 3 & 2 & -1 & -5 \\ 0 & 8 & -3 & 10 \end{bmatrix}$.

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]

```
*row(.5,[A],1)
 [[1 .5 2.5 .5]
  [3 2  -1  -5]
  [0 8  -3  10]]
```

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]

```
Ans→[A]
 [[1 .5 2.5 .5]
  [3 2  -1  -5]
  [0 8  -3  10]]
```

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]

```
*row+(-3,[A],1,2
)
[[1 .5 2.5  .5 ...
 [0 .5 -8.5 -6....
 [0 8  -3   10 ...
```

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]

```
Ans→[A]
[[1 .5 2.5  .5 ...
 [0 .5 -8.5 -6....
 [0 8  -3   10 ...
```

Store the result as matrix A.

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

```
*row(2,[A],2)
[[1 .5 2.5 .5 ]
 [0 1  -17 -13]
 [0 8  -3  10 ]]
```

2 times matrix A row 2.

[STO▸] [2nd] [MATRX]
[1] :[A] [ENTER]

```
Ans→[A]
[[1 .5 2.5 .5 ]
 [0 1  -17 -13]
 [0 8  -3  10 ]]
```

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]	rref([A]) [[1 0 0 -2.4285... [0 1 0 1.57142... [0 0 1 .857142...	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

$$x_1 = -2.43$$
$$x_2 = 1.57$$
$$x_3 = .86$$

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.

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

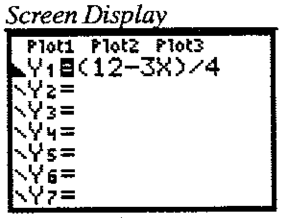
Solution:

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 | *Screen Display* | *Explanation*

Keystrokes: Y= CLEAR (12 - 3 X,T,θ,n) ÷ 4

Screen Display:

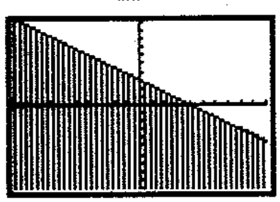


Explanation: Clear any existing graphs. Turn all plots off.

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

Keystrokes: ◄ ... ◄ ENTER ENTER ENTER ZOOM 6 :ZStandard

Screen Display:



Explanation: Determine the half-plane by choosing the point (0, 0) and substituting into the inequality **by hand** using paper and pencil. $3 \cdot 0+4 \cdot 0<12$ 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.

17 Scientific Notation, Significant Digits, and Fixed Number of Decimal Places

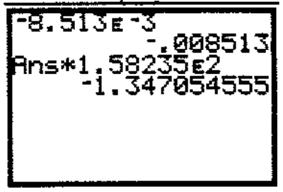
Example 1 Calculate $(-8.513\times10^{-3})(1.58235\times10^{2})$. Enter numbers in scientific notation.

Solution:

Keystrokes

[(-)] [8.513] [2nd] [EE] [(-)] [3]
[ENTER]
[×] [1.58235] [2nd] [EE] [2]
[ENTER]

Screen Display



Explanation

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.)
Multiply by the second number.

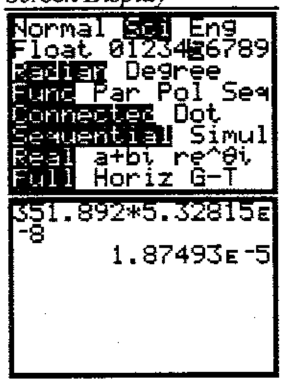
Example 2 Set the scientific notation to six significant digits and calculate $(351.892)(5.32815\times10^{-8})$.

Solution:

Keystrokes

[MODE] [►] [ENTER]
[▼] [►] [►] [►] [►] [►] [►]
[ENTER]
[2nd] [QUIT]
[351.892] [×] [5.32815]
[2nd] [EE] [(-)] [8] [ENTER]

Screen Display



Explanation

Select Sci using the arrow keys and press [ENTER].
Select 5 decimal places using the arrow keys and press [ENTER]. Five decimal places will give six significant digits in scientific mode.
Return to the Home Screen.
Enter the numbers.
Note the result is displayed in scientific notation with six significant digits.

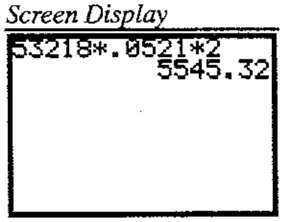
Example 3 Fix the number of decimal places at 2 and calculate the interest earned on $53,218.00 in two years when invested at 5.21% simple interest.

Solution:

Keystrokes

[MODE] [ENTER] [▼] [►] [►] [►]
[ENTER] [2nd] [QUIT]
[53218] [×] [.0521] [×] [2] [ENTER]

Screen Display



Explanation

Choose normal notation with 2 fixed decimal points.
Return to the Home Screen.
Only two decimal places are shown in the answer. The interest is $5545.32.

Change the number of decimal places back to Float.

18 One-Sample Statistics

Example 1 Given the following data find:

(A) The sample mean.
(B) The sample standard deviation .
(C) The first quartile.
(D) An histogram with first class beginning at 0 and width 4.
(E) Repeat Parts A and B after deleting the data value 92 from the list.
How did eliminating this outlier effect the mean and standard deviation?
(F) Use the sample statistics found in Part (E). Calculate the z value of an x score of 60.

26	22	22	15	92	55	48	76	43	60	42
41	59	24	18	40	45	54	41	57	63	

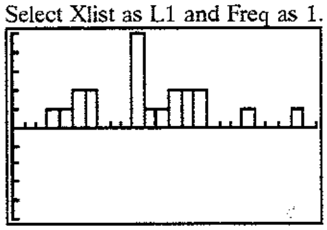
Use one decimal place in answers.

Solution (A), (B) and (C):

STAT 4 <ClrList>	Clear the list named L1.
2nd L1 ENTER	
STAT 1 <Edit>	Get the data entry menu.
26 ENTER 22 ENTER Etc.	Enter the data in the L1 list. Enter all data. There are 21 values. If you make a mistake, use the arrow keys to highlight the number and type it in again. To remove a data value, use the arrow keys to highlight number and press DEL.
2nd QUIT	Exit the data entry screen.
STAT ► <CALC> 1 <1-Var Stats> 2nd L1 ENTER	Get the statistics menu again. Press 1 to get the one variable statistics. Since each piece of data was entered individually, we need only to list L1 after 1-Var Stats. The calculator will use 1 as the frequency for each number in the L1 list. The mean is 44.90 and the sample standard deviation is 19.28. The first quartile is 25.

Solution (D):

WINDOW 0 ENTER 100 ENTER 4 ENTER (-) 5 ENTER 5 ENTER 1	The smallest value is 15 so let xMin=0. The greatest value is 92. Let us set Xmax=100. Let Xscl=4 since this is the class width. Let Ymin=-5 to get some room below the histogram. We do not know the frequencies yet so let Ymax=5 for a first try. Let yScl=1.
Y= CLEAR ...	Clear all functions on the function list.
2nd DRAW 1 <ClrDraw> ENTER	Clear all drawings from the display.
2nd STAT PLOT 1 <Plot1...OFF> ENTER ▼ <Type:> ► ► < ⊔ > ENTER ▼ <Xlist:> ENTER ▼ ENTER GRAPH	Select Plot1. Set Plot1 to ON. Select Type as Histogram. Select Xlist as L1 and Freq as 1. Graph the histogram.



Solution (E):

STAT 1 ▼ ▼ ... ▼ ▼ DEL	Get the data list and arrow down to the 92. Press DEL.
STAT ► <CALC> 1 <1-Var Stats> 2nd L1 ENTER	Get the statistics menu and the one variable sample statistics. The mean is now 42.6 and the sample standard deviation is 17.0. Notice how much influence an outlier has!

Example 2 Given the ungrouped frequency data, shown at the right: (A) Find the mean. (B) Find the sample standard deviation. (C) Draw a boxplot.

x	*f*
2.4	4
3.5	6
4.9	8
5.3	5
6.8	2

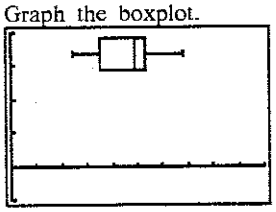
Solution (A) & (B):

STAT 4 <ClrList>	Clear the lists named L1 and L2.
2nd L1 , 2nd L2	
ENTER	
STAT 1 <Edit>	Get the data entry menu.
2.4 ENTER 3.5 ENTER Etc.	Enter the data in the L1 list. Enter all data. If you make a mistake, use the arrow keys to highlight the number and type it in again.
	To remove a data value, use the arrow keys to highlight number and press DEL.

► 4 ENTER 6 ENTER	Enter the frequencies in the L2 list.
Etc.	
2nd QUIT	Exit the data entry screen.
STAT ► <CALC> 1 <1-Var Stats>	Get the statistics menu again. Press 1 to get the one variable statistics. The calculator will use the L1 list for the values of x and the L2 as the frequency for each number in the L1 list. The mean is 4.40 and the sample standard deviation is 1.27, rounded to two decimal places.
2nd L1 , 2nd L2 ENTER	

Solution (C):

WINDOW ENTER 0 ENTER	The smallest value is 2.4 so let Xmin=0.
10 ENTER 1 ENTER	The greatest value is 6.8 so let Xmax=10. Let Xscl=1. Let Ymin=-1 to get some room below the graph. Let Ymax=4 and Yscl=1. Leave Xres at 1.
(-) 1 ENTER	
4 ENTER 1 ENTER 1	
Y= CLEAR ...	Clear all functions on the function list.
2nd DRAW 1 <ClrDraw> ENTER	Clear all drawings from the display.
2nd STAT PLOT 1 <Plot1...OFF>	Select Plot1
ENTER	Set Plot1 to ON.
▼ <Type:>	Select Type as Boxplot. Select Xlist as L1 and Freq as L2.
► ► ► ► < > ENTER	Graph the boxplot.
▼ <Xlist:> 2nd L1	
▼ 2nd L2	
GRAPH	



19 Two-Variable Statistics

Example 1 Given the following bivariate data: (A) Find the correlation coefficient and the equation of the least squares line. (B) Graph the scatter plot. (C) Graph the least squares line and the scatter plot on the same graph. (D) Sort the data on x and join the points using straight line segments. (E) Repeat (A) and (C) for the regression modela of LnReg, ExpReg, and PwrReg. (F) Predict the y value for the x = 15 using the exponential regression model. Use two decimal places.

x	4	7	9	29	15	22
y	5	4	8	15	8	18

Solution (A):

STAT 4 <ClrList> 2nd L1 ,	Clear list L1 and list L2.
2nd L2 ENTER	
STAT 1 <Edit>	Get the lists.
4 ENTER 7 ENTER 9	Enter the data in list L1.
ENTER 29 ENTER 15	
ENTER 22 ENTER	
► 5 ENTER 4 ENTER 8	Move to list L2. Enter the data in list L2. The data for y in L2 must correspond pairwise to the data for x in L1.
ENTER 15 ENTER 8 ENTER 18 ENTER	
STAT ► <CALC> 8 <LinReg(a+bx)>	
2nd L1 , 2nd L2 ENTER	

CATALOG ▼ ... ▼
ENTER ENTER

Arrow down to DiagnosticsOn
Press ENTER twice to turn the diagnostics on so the correlation coefficient will be displayed.

STAT ▶ <CALC> 8 <LinReg(a+bx)
2nd L1 , 2nd L2 ENTER

The equation of the line is $\hat{y} = 2.25+.52x$.
The linear correlation coefficient is r=.89.

Solution (B):

WINDOW 0 ENTER 30
ENTER 1 ENTER 0 ENTER
20 ENTER 1

Set the graph WINDOW. Observe the data to determine the WINDOW values. Set the y value lower than needed so if you trace, the coordinates at the bottom of the screen do not cover up the graph.

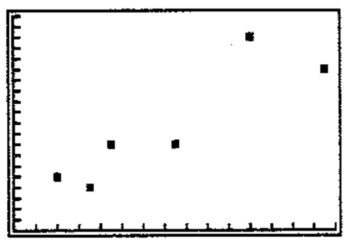
Y= CLEAR ...

Clear all functions on the function list.

2nd DRAW 1 <ClrDraw> ENTER

Clear all drawings from the display.

2nd STAT PLOT
4 <PlotsOff> ENTER
2nd STAT PLOT ENTER
ENTER ▼ ENTER ▼
2nd L1 ENTER
2nd L2 ENTER GRAPH



Solution (C):

Y= CLEAR VARS 5 ▶ ▶ <EQ>

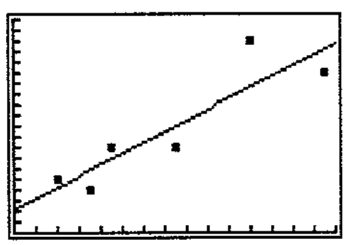
Clear or deselect any existing functions in the list. Clear Y1.

1 <RegEQ>

The least squares line equation will be put into the function list so you can graph it.

2nd STAT PLOT
4 <PlotsOff> ENTER
2nd STAT PLOT ENTER
ENTER ▼ ENTER ▼
2nd L1 ENTER
2nd L2 ENTER
GRAPH

Set up the calculator to get the scatter plot with the line.



Solution (D):

[Y=] [CLEAR] or [Y=] [◄] [ENTER]

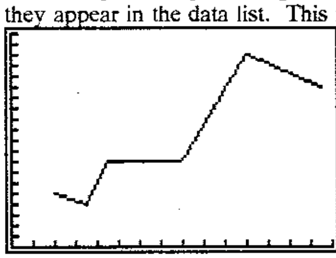
Clear the functions from the list or deselect them so they won't graph.

[STAT] [2] [2nd] [L1] [,] [2nd] [L2] [)]
[ENTER]

Sort the data on the x variable. The list L1 will be sorted in ascending order. The list L2 will sort along with L1 as pairs.

[2nd] [STAT PLOT] [1] <Plot 1> [ENTER]
[ENTER]
[▼] [►] [ENTER] [▼] [2nd] [L1] [ENTER]
[2nd] [L2]
[GRAPH]

Set the calculator to draw line segments joining the points.
This will join the points together with straight line segments in the order they appear in the data list. This is why we sorted the data on x first.



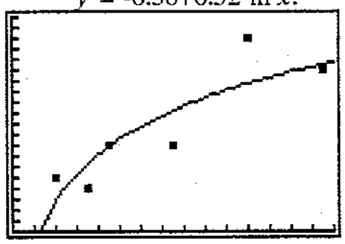
Solution (E):

[STAT] [►] [9] [ENTER]
[Y=] [CLEAR] [VARS] [5] [►] [►] <EQ>
[1] <RegEQ>

```
LnReg
 a=-6.299078393
 b=6.518485269
 r=.8646747069
```

The regression equation is

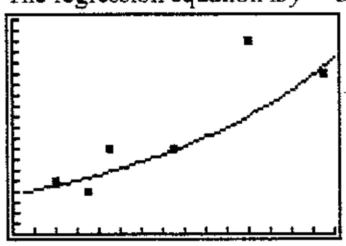
$$\hat{y} = -6.30+6.52 \ln x.$$



[STAT] [►] [0] [ENTER]
[Y=] [CLEAR] [VARS] [5] [►] [►] <EQ>
[1] <RegEQ>

```
ExpReg
 a=3.820867645
 b=1.05629705
 r=.8933839691
```

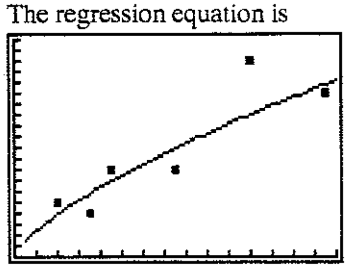
The regression equation is $\hat{y} = 3.82 \times 1.05^x$.



[STAT] [►] [ALPHA] [A] [ENTER]
[Y=] [CLEAR] [VARS] [5] [►] [►] <EQ>
[1] <RegEQ>

```
PwrReg
 a=1.497533687
 b=.7029292511
 r=.8863007345
```

The regression equation is $\hat{y} = 1.50 \times x^{.70}$.



Solution (F):

STAT ▶ 0 ENTER	Calculate the exponential regression equation
15 STO▸ X,T,θ,n ENTER	Store the value of 15 as x.
VARS 5 <Statistics> ▶ ▶ <EQ> ENTER	Recall the equation for the exponential model that you just calculated and evaluate it. The predicted y value for $x = 15$ is 8.69 to two decimal places.

20 The Normal Probability Distribution

Example 1 Display the normal distribution with $\mu = 35$ and $\sigma = 2$.

Solution:

Keystrokes	*Screen Display*	*Explanation*
Set the WINDOW dimensions to [28, 42]2 by [0, .25].1.		First set the viewing screen parameters.
Y= CLEAR 2nd DISTR ENTER X,T,θ,n , 35 , 2) ENTER GRAPH	`Y1=normalpdf(X,35,2 )`	Put the normal distribution function into the Y= list by getting the normal pdf from the DISTR menu. Graph.

Example 2 (A) Find the probability $P(30.2 < x < 36.8)$ for the normal distribution with $\mu = 35$ and $\sigma = 2$.
(B) If x is the weight distribution among a population of men is normally distributed with a mean of 180 pounds and a standard deviation of 3.5 pounds, what weight is exceeded by only 6% of the men (the 94th percentile)?

Solution (A):

Keystrokes	*Screen Display*	*Explanation*
2nd DISTR 2 :normalcdf(30.2 , 36.8 , 35 , 2) ENTER	`normalcdf(30.2,3 6.8,35,2)` `.8077423796`	Get the normal cumulative density function from the DISTR menu and enter the values.

Solution (B):

Keystrokes	*Screen Display*	*Explanation*
2nd DISTR 3 :invNorm(.94 , 180 , 3.5) ENTER	`invNorm(.94,180, 3.5)` `185.4417076`	Get the inverse normal cumulative density function from the DISTR menu and enter the values.

Example 3 Display the normal distribution with $\mu = 35$ and $\sigma = 2$ shaded between 30.2 and 36.8.

Solution:

Keystrokes	*Screen Display*	*Explanation*
Set the WINDOW dimensions to [28, 42]2 by [-.06, .25].1.		First set the viewing screen parameters.
Y= CLEAR 2nd DISTR ▶ 30.2 , 36.8 , 35 , 2) ENTER	`ShadeNorm(30.2,,3 6.8,35,2)`	The ShadeNorm command will display the distribution and find the area.