Introduction: *The following activity will help you explore the advanced graphing capabilities of the Texas Instrument TI-89 graphing calculator. The TI-89 can graph much more than the basic linear or quadratic equations. Following the steps below you will learn the following technique(s):*

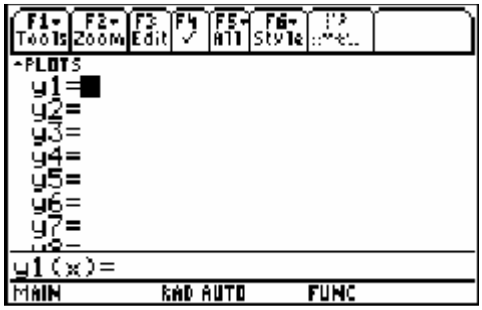
- Graphing a Piecewise Function

Let's get started!

Graphing a Piecewise Function:

Step 1: Turn the calculator on – press ON
Step 2: Go to the Y=Editor – press ◆F1

If you have correctly navigated to the Y=Editor your screen should look like this



If your Y=Editor doesn't look like this you need to clear out existing information. Use the arrow keys ◀▶▲▼ to highlight each existing formula in the y1 through y99 individually and press CLEAR to empty their contents.

Now, consider the following that we want to graph:

$$f(x)=\begin{cases} -x, & \text{when } x<0 \\ 5\cos(x), & \text{when } x\geq 0 \end{cases}$$

We can organize this in a table to help us better see what we need to graph.

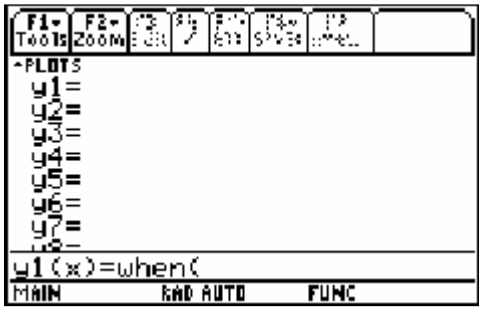
When:	Use Expression:
$x<0$	$-x$
$x\geq 0$	$5\cos(x)$

To do this the **when** function will be useful for graphing a two-piece function. The syntax for the **when** function in the TI-89 is:

when(*condition, trueExpression, falseExpression)*

We will use this information to enter the expression into the Y=Editor.

Step 3: To start a **when** function press [CATALOG] [.] [ENTER]
You will then have a screen that looks like the following



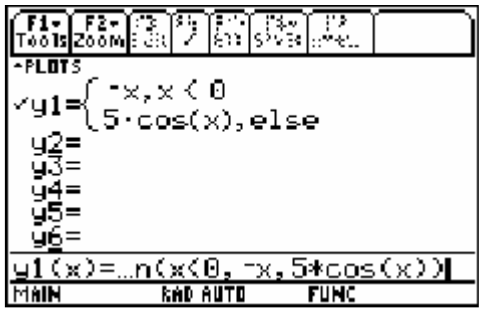
We need to recall what the function is we are trying to graph.

$$f(x)=\begin{cases}-x, & \text{when } x<0\\ 5\cos(x), & \text{when } x\geq 0\end{cases}$$

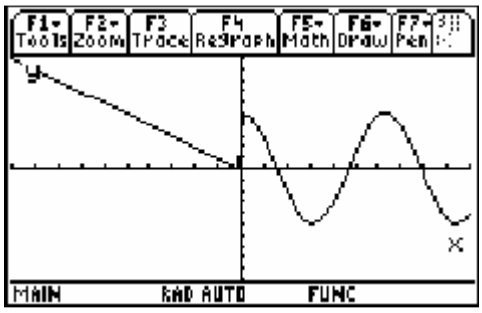
Step 4: Enter the first expression of the piecewise function. Press [X] [2nd] [0] [0] [,] [(-)] [X].
This enters the *trueExpression* part of the **when** function.

Step 5: Enter the *falseExpression* part by pressing [,] [5] [2nd] [Z] [X] [)] [)].
Then press [ENTER].

The calculator should "Pretty-Print" the equation and your screen will look like the following:



Step 6: To see what the graph of this piecewise function looks like press [◆] [F3].
Note: Press [F2] [6] to resize the window view and fit the graph to the screen.
Your graph should look like the following.



As you can see from the screen we have the graph of $-x$ leading up to $x = 0$ at the origin and then it becomes a cosine wave after that. If you graph does not look like the one above, first make sure you followed the second part of Step 6 to resize the window and check to be sure you entered the formula correctly. If you still have problems please come see me before moving on.

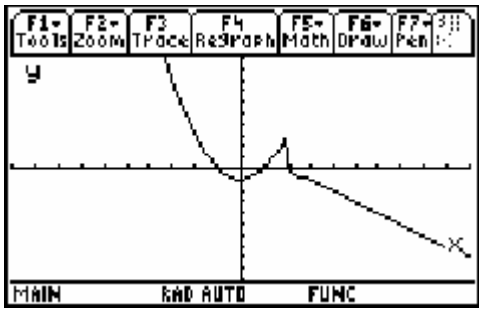
Before taking a look at a piecewise function with 3 or more parts to it, lets try to do another example with simply two pieces. Return to the Y-Editor and clear out the values there and try to plot the following piecewise function:

$$f(x) = \begin{cases} x^2 - 1, & \text{when } x < 2 \\ 2 - x & \text{when } x \geq 2 \end{cases}$$

Enter your $y =$ as it appears in the calculator in the space below

_____

You can also check your function with the graph below:



If your graph doesn't match this one, go back through the previous steps to see where your error might be. Make sure that your window is set to the **standard** zoom. If you are still having problems please see me before moving on to the next section.

We will now look at graphing a piecewise function with 3 or more pieces. Consider the function defined by:

$$f(x)=\begin{cases}4\sin(x) & \text{when } x<\pi \\ 2x+6 & \text{when } x\geq\pi \text{ and } x<0 \\ 6-x^2 & \text{when } x\geq 0\end{cases}$$

Again we can organize this as:

When:	Use Expression:
$x<-\pi$	$4\sin(x)$
$x\geq\pi$ and $x<0$	$2x+6$
$x\geq 0$	$6-x^2$

Step 7: To accomplish this we are going to have to **nest** our **when** functions. Start by returning to the Y=Editor by pressing ◆F1.

Step 8: Clear the y1 function by using the ▲▼ keys to highlight the function and press CLEAR.

Step 9: To input a new function press ENTER.

Step 10: Start another **when** function by pressing CATALOG . ENTER.

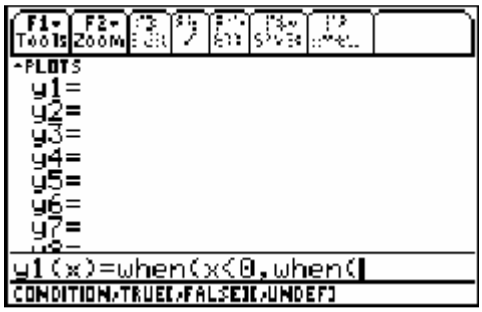
To enter the nested function, start with the upper bound on the middle term (i.e. $x<0$) and then start another **when** function as your *trueExpression* to complete the expression. Your completed function, with the nexted **when** function is going to look like this

$$\text{when}(x<0,\text{when}(x<-\pi,4*\sin(x),2*x+6),6-x\,\hat{}\,2)$$

Use the steps below to accomplish this.

Step 11: Press [X][2nd][0][0][,] to enter the $x < 0$ bound, then press [CATALOG][.][ENTER] to begin the nested **when** function.

Before moving on, check to make sure your screen matches the picture below:

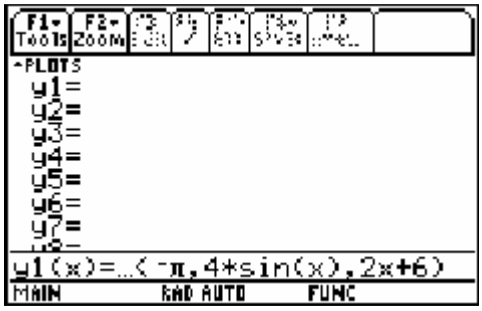


Now, use the lowest bounds and expression as the *trueExpression* and the expression for the center term as the *falseExpression*. Close the final part of the nested function by using the expression for the upper bound as the *falseExpression* for the outer **when** function.

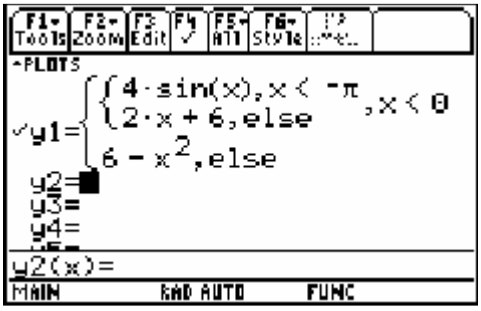
Step 12: To accomplish this press [X][2nd][0][(-)][2nd][^][,] to set the *condition* for the nested **when** function as $x < -\pi$. Then press [4][×][2nd][Y][X][)][,] to set the *trueExpression* as $4*\sin(x)$.

Step 13: Now, press [2][X][+][6] to enter $2x+6$ as the *falseExpression* and then [)] to complete the inner nested **when** function.

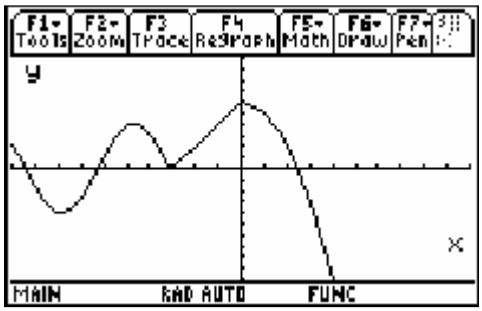
Before moving on check your screen against the one below:



Step 14: To finish the outer **when** function press [,][6][−][X][^][2][)] to enter the final expression $6-x^2$ and close the final parenthesis. Press [ENTER] enter to complete the y1 function and check your screen against the one below.



Step 15: Press ◆F3 to view the graph of our 3-part piecewise function.



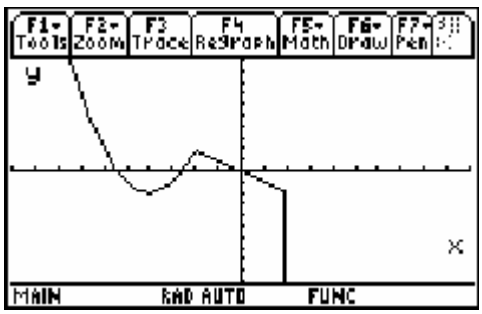
Again, before moving on to the questions at the end of this activity, let's have you try an example.

$$f(x)=\begin{cases}(x+4)^2-2 & \text{when } x\le -2\\ -x & \text{when } -2<x\le 2\\ -(x+4)^2+2 & \text{when } x>2\end{cases}$$

Enter your $y=$ as it appears in the calculator in the space below

_____

You can also check your function with the graph below:



Questions: *Now that you've learned how to do something new on your calculator, answer the following questions below to try out your knowledge. Use the steps above and if you need* ***try the solution in the calculator!***

1. Fill in the missing pieces for the syntax of the **when** function?

   when(_____ , *trueExpression,* _____)

2. Which of the bounds $x < 0$ and $x \geq 0$ would you enter into the **when** function and which would you leave to be handled by the else statement?

   _____

   _____

   _____

   _____

3. What do we call it when we have one **when** function inside another?

   _____

   _____

   _____

4. What editor did we use to input functions for graphing?

   a. Text
   b. Program
   c. Y=
   d. Matrix

Happy Calculating!

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