

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

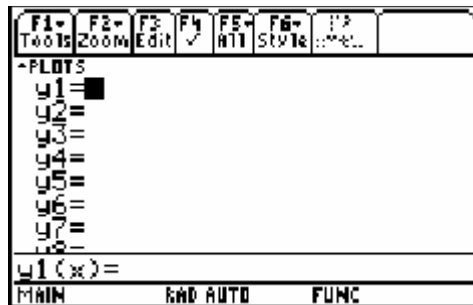
Let's get started!

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.

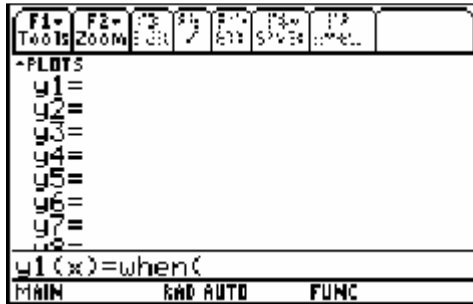
When:	Use Expression:
$x < 0$	$-x$
$x \geq 0$	$5\cos(x)$

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:

$$\text{when}(\text{condition}, \text{trueExpression}, \text{falseExpression})$$

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



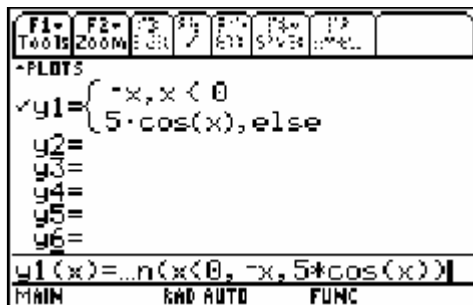
We need to recall what the function is we are trying to graph.

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

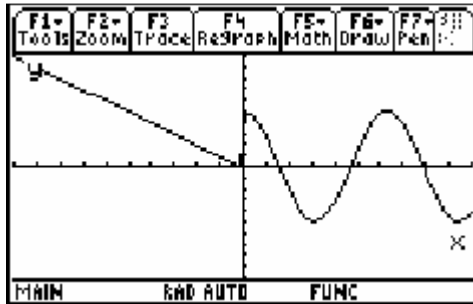
Step 4: Enter the first expression of the piecewise function. Press `X` `2nd` `0` `0` `,` `(-)` `X`.
 This enters the *trueExpression* part of the **when** function.

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.



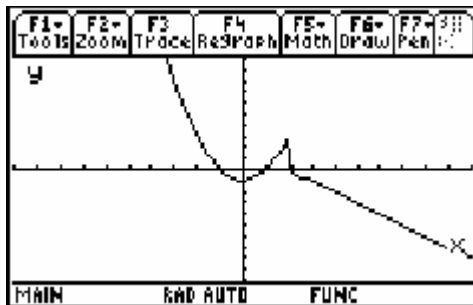
As you can see from the screen we have the graph of $-x$ leading up to $x = 0$ at the origin and then it becomes a cosine wave after that. If your graph does not look like the one above, first make sure you followed the second part of Step 6 to resize the window and check to be sure you entered the formula 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, let's 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 \blacklozenge [F1].

Step 8: Clear the y1 function by using the $\ominus\ominus$ 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

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

Use the steps below to accomplish this.

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

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

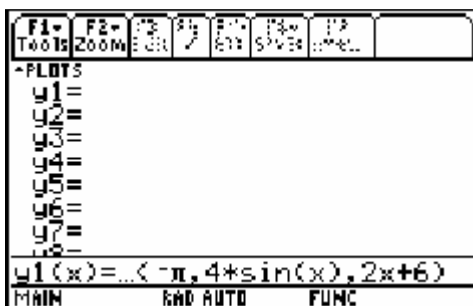


Now, use the lowest bounds and expression as the *trueExpression* and the expression for the center term as the *falseExpression*. Close the final part of the nested function by using the expression for the upper bound as the *falseExpression* for the outer **when** function.

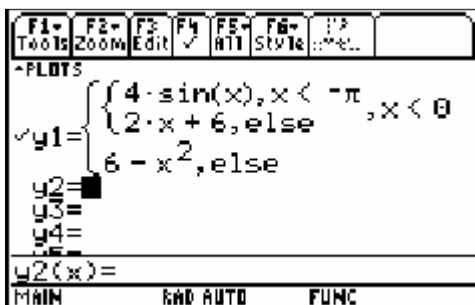
Step 12: To accomplish this press $\boxed{X}\boxed{2nd}\boxed{0}\boxed{-}\boxed{2nd}\boxed{\wedge}\boxed{,}$ to set the *condition* for the nested **when** function as $x < -\pi$. Then press $\boxed{4}\boxed{\times}\boxed{2nd}\boxed{Y}\boxed{X}\boxed{,}$ to set the *trueExpression* as $4 * \sin(x)$.

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

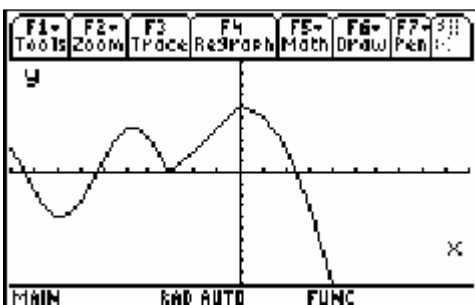
Before moving on check your screen against the one below:



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



Step 15: Press \blacklozenge [F3] to view the graph of our 3-part piecewise function.

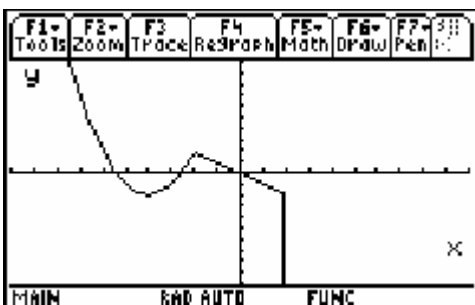


Again, before moving on to the questions at the end of this activity, let's have you try an example.

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

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!

Written by Jeremy Smoyer, Kutztown University, 2004