Checking Answers:
Sum, Difference, Product, Quotient, Composition, and Factoring of Functions

Instructions for the TI-84 Plus

Example: For the functions $f(x) = x^2 - x - 6$ and $g(x) = x + 2$, find $(f+g)(x)$, $(f-g)(x)$, $(fg)(x)$, $(f \div g)(x)$, and $(f \circ g)(x)$. Also, factor $f(x)$ completely.

Entering Functions into the Calculator

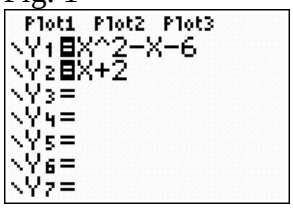
The TI-83 and TI-84 series of calculators do NOT have a computer algebra system, so they can not produce answers that use variables. However, after you do the algebra, you can use your calculator to check many of these problems.

We will use the graphing and table functions of the calculator to check our answers to this problem. If you are not familiar with the graphing and table capabilities of your calculator, please work through these other calculator instruction guides: *Preparing your Calculator for Graphing*, *Graphing a Function*, and *Creating a Table*.

For this problem, we have two functions that we will use. We need to enter these functions into the function editor. You can enter these functions on any of the lines, but let's use Y_1 for $f(x)$ and Y_2 for $g(x)$.

After you turn your calculator on, press [Y=] to enter the function editor. If there are any functions in this menu, erase them using the [CLEAR] key. We will enter $f(x)$ into Y_1 by using the arrow keys to put the cursor to the right of the equal sign beside Y_1 and pressing [X,T,Θ,n] [x^2] [−] [X,T,Θ,n] [−] [6]. Then we will use [▼] to position the cursor to the right of the equal sign beside Y_2. Then we will enter $g(x)$ by pressing [X,T,Θ,n] [+] [2]. At this point, your screen should look like figure 1.

Fig. 1

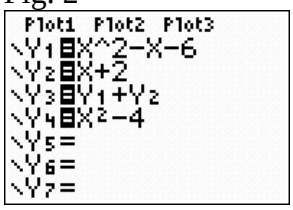


We will use Y_3 for the calculator's answer to the problem and Y_4 for our answer to the problem.

The first problem was to find $(f+g)(x)$.

We want to let the calculator find numerical answers to the problem. Use the down arrow to position the cursor to the right of the equal sign beside Y_3. Press [VARS] to access the variables menu. Press [▶] to highlight Y-VARS and bring up the y-variables menu. Press [ENTER] to tell the calculator that we are working with functions. After you do this, the calculator will show a menu listing the names of the functions. We want Y_1, so we will press [1]. Now we want to add Y_2, so press [+] [VARS] [▶] [ENTER] [2].
Let's say that we worked this problem by hand and got the answer $(f+g)(x) = x^2 - 4$.
To enter our answer, we will use the arrow keys to position the cursor to the right of the equal sign beside Y_4 and press [X,T,Θ,n] [x^2] [−] [4] to enter our answer.
Now your screen should look like figure 2.

Fig. 2

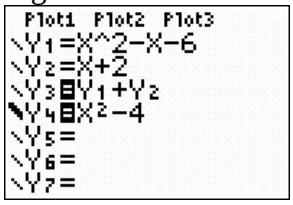


Checking using a Graph

If we worked our problem correctly, the answers to Y_3 and Y_4 should be identical. At this point, we do not care about the answers to Y_1 and Y_2. We can keep those functions from graphing or appearing in our table by turning off (unhighlighting) the equal sign next to them. Use the arrow keys to position your cursor on top of the equal sign beside Y_1 then press [ENTER]. When you move your cursor to Y_2, you will notice that the equal sign beside Y_1 is no longer highlighted. This will allow the calculator to use Y_1 in its calculation of Y_3, but we will not see the equation in the graph or table. Use the arrow keys to position your cursor on the equal sign beside Y_2 and press [ENTER] to turn off that equation too.
If our answer is correct, the graphs of Y_3 and Y_4 should be exactly on top of each other. Let's change the thickness of the line for Y_4 so that we can watch both graphs as they are drawn. To do this, use the arrow keys to position your cursor on the slash in front of Y_4 and press [ENTER]. This will make the slash dark to indicate that the line drawn for Y_4 will be thicker than the one drawn for Y_3.

Now your calculator should look like figure 3.

Fig. 3



Now press graph and watch your screen. You will see the calculator draw a parabola with a thin line for Y_3 (the answer that the calculator got to the problem) then it will trace the same parabola with a thick line for Y_4 (our answer to the problem). This is a good indication that we have the correct answer.

If the graphs do not fall exactly on top of each other, either you made a mistake entering the information into the calculator or you made a mistake in your algebraic calculations. Go back and check your work.

If the graph of your equation does not fall on your graphing screen, you will have to work with the window function of your calculator to see the graphs. If it is not convenient to work with the graphing window or if you want further evidence that your answer is correct, you can use the table function to check your answers.

Checking using a Table

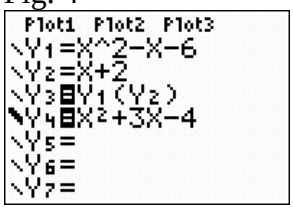
We already have the necessary functions entered in the function editor, so all we need to do is press 2nd GRAPH to access the table. If you have your table set to AUTO for both variables, you can use the arrow keys to scroll up and down for different X values. If you have your table set to ASK for the independent variable, enter several values for X. You will notice that the answers for Y_3 and Y_4 are identical for every value of X that you can see. This indicates that our answer is correct.

If any answers from columns Y_3 and Y_4 are not the same, either you made a mistake entering the information into the calculator or you made a mistake in your algebraic calculations. Go back and check your work.

Checking other Functions

At this point, we have done most of the work necessary for checking our other answers too. To check your answer to $(f-g)(x)$, $(fg)(x)$, $(f \div g)(x)$, enter your answer in Y_4 and change the plus symbol in Y_3 to minus, times, or divide as appropriate. The calculator uses $f(g(x))$ notation for composition of functions rather than $(f \circ g)(x)$, so use parentheses around Y_2 to tell the calculator to plug Y_2 into Y_1. To check this composition for the given functions, your function editor should look like figure 4.

Fig. 4



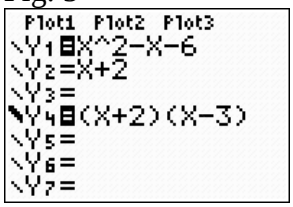
If you clear Y_4 while you are working with it, the thickness of the line will automatically reset to a thin line, so you will have to highlight the slash and press ENTER to make that line thick again.

Checking Factoring

To check the factorization of $f(x)$, we need to compare our answer for the factorization of $f(x)$ to $f(x)$. We already have $f(x)$ stored in Y_1, so let's just turn that equation back on by using the arrow keys to highlight the equal sign beside Y_1 and pressing ENTER. We no longer need the calculator to compute an answer, so you can clear Y_3 or turn it off. This time, we will clear the equation by placing the cursor to the right of the equal sign following Y_3 and pressing CLEAR. We will type our answer into Y_4 like we have done before.

At this point, your function editor should look like figure 5 with Y_1 and Y_4 turned on and Y_2 and Y_3 either erased or turned off.

Fig. 5



Now you can either use the graphing or table methods described earlier in this instruction guide to compare the answers to Y_1 and Y_4.

Our answers match therefore, Y_1 and Y_4 are equivalent. Our factors in Y_4 are linear factors, so we know they can not be factored further. Therefore, Y_4 is a complete factorization of Y_1.