

## Better Communication with Mathcad Prime<sup>™</sup>

**Find the solution to the system of equations:**

$$3x - 17y = 51$$

$$8x + 4y = 22$$

**Graph and check your solution**

$$y1(x) := \frac{51 - 3x}{-17} \quad y2(x) := \frac{22 - 8x}{4}$$

**Solving by substitution using Mathcad's Boolean equality symbol:**

$$3x - 17y = 51 \quad 8x + 4y = 22$$

$$3x = 51 + 17y \quad 4x + 2y = 11$$

$$4x = 11 - 2y$$

$$x = \frac{51 + 17y}{3} \quad x = \frac{11 - 2y}{4}$$

$$x = x$$

$$\frac{51 + 17y}{3} = \frac{11 - 2y}{4}$$

$$3(11 - 2y) = 4(51 + 17y)$$

$$33 - 6y = 204 + 68y$$

$$-74y = 171$$

**Use assignment statements to define solutions:**

$$y := \frac{-171}{74} = -2.311$$

$$x := \frac{51 + 17y}{3} = 3.905$$

**Use evaluation statements to check results:**

Check:  $3x - 17y = 51$

$$8x + 4y = 22$$



### **Written By Chris Hartmann**

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### **Acknowledgments**

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### **Questions or Corrections**

Please direct inquiries or questions regarding the contents of this tutorial to the Mathcad Academic Program at [MathcadEducation@ptc.com](mailto:MathcadEducation@ptc.com). Suggestions for improvement or further development will be gladly accepted.

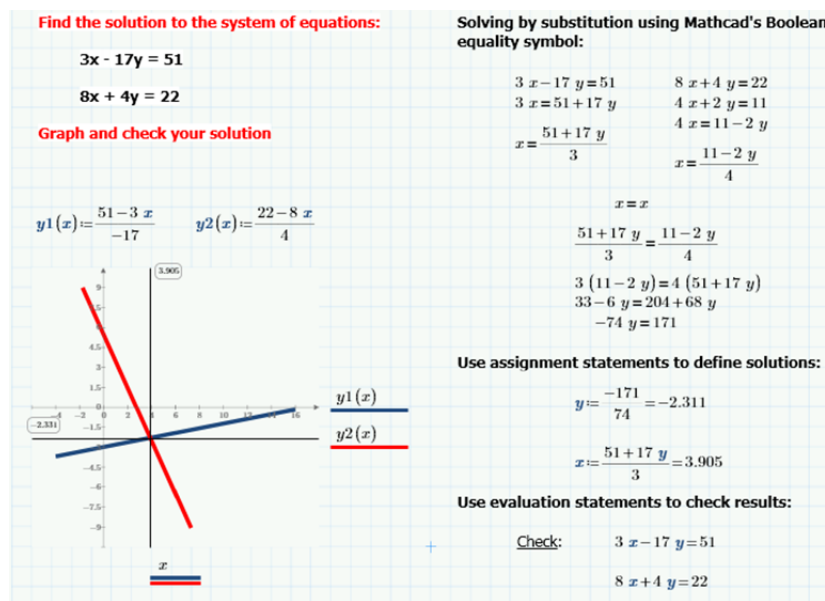
## Improve Mathematical Communication Skills with Mathcad Prime

Did you know that with Mathcad is used by teachers and students world-wide to increase student achievement in mathematics and science? With the release of Mathcad Prime 1.0 the benefits of using Mathcad in math and science courses are better than ever and even easier to achieve.

With Mathcad Prime children can...

- Complete homework assignments more neatly and with greater accuracy
- Perform step-by-step symbolic mathematics using Mathcad's Boolean equality symbol
- Produce professional quality graphs of functions and data
- Write science lab reports in a single document that features live mathematics
- Become a better problem solver as he/she develops computational thinking strategies

Mathcad Prime's WYSIWIG interface helps learners express their strategies and calculations in an environment where they are easy to review, share, revise, and publish.

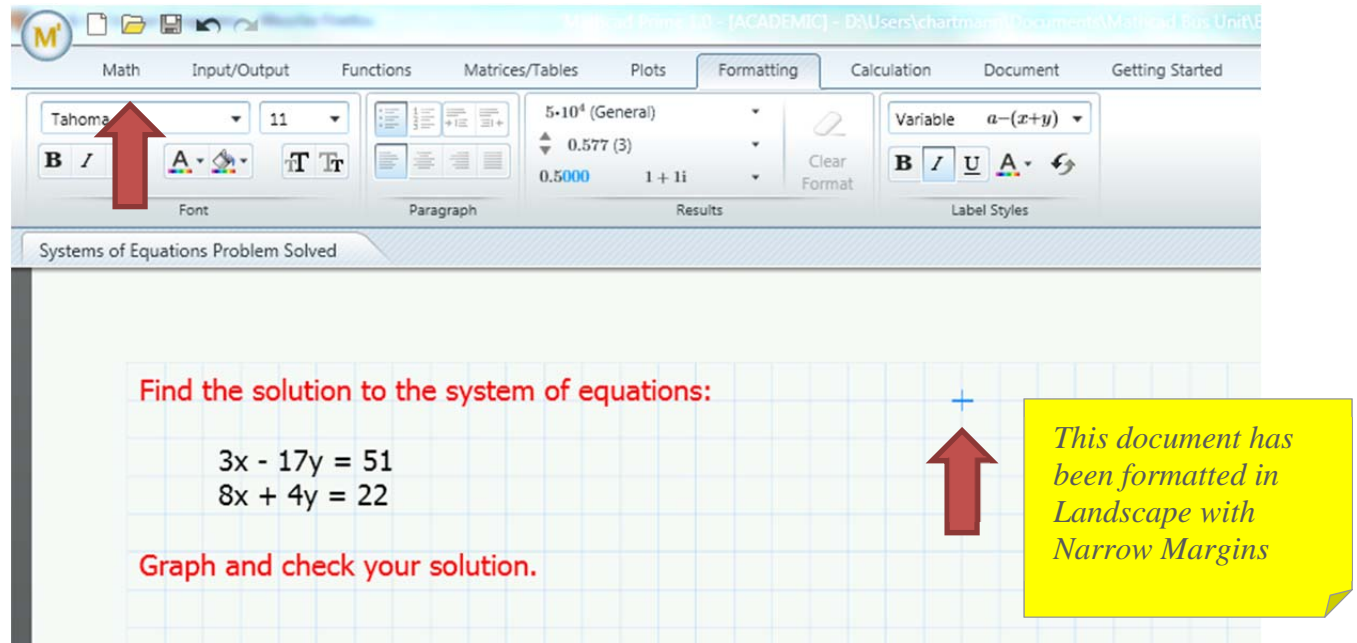


*Help your children go beyond the basics this year with Mathcad Prime 1.0!*

The pages below include a step-by-step tutorial for completing the problem shown in the image above.

Follow the steps below to learn how to use Mathcad Prime to complete algebra problems like the one in the image above.

1. Open the file **Systems of Equations Problem.mcdx** contained in the folder for this tutorial.



2. In the space to the right of the problem statement, create a new Text Box by following these steps:

- Place the blue cursor as shown in the image above
- Click on the Math ribbon
- Click the Text Box icon on the Math ribbon
- Type the following text in the Text Box

*Solving by Substitution using Mathcad's Boolean equality symbol*

- Resize the Text Box by dragging the edges with your mouse (if necessary)

#### **Mathcad's Boolean Equality Symbol**

*Mathcad has different equality symbols to reflect the different roles that the “=” symbol plays in mathematical expression. The Boolean Equality Symbol “=” appears in Bold type. It is used to express equivalence, the idea that one quantity or expression “is the same as” another. You can use Mathcad's Boolean Equality symbol to either state or evaluate equivalence.*

**Notes:**

1. In this tutorial Red Text will be used for keystrokes such as the **<Enter>** key and the **<CTRL>=** key combination below.
2. The multiplication symbol in Mathcad is the asterisk "\*" or **<Shift>8**. Notice that we omitted the asterisk in the second expression, yet Mathcad was able to express the equation correctly.

3. Using the keystrokes below the image express both of the equations in the given system as math regions as shown. Mathcad's default region type is a Math region, so you can begin typing without inserting a Math Region. The keystroke combination for the Boolean equality symbol is **<ctrl>=**.

Solving by Substitution using Mathcad's Boolean equality symbol:

$$3 \cdot x - 17 \cdot y = 51 \qquad 8x + 4y = 22$$

$$3*x-17*y<ctrl>=51<Enter> \qquad 8x+4y<ctrl>=22<Enter>$$

4. One method by which to solve by substitution is to rewrite each equation so that it is solved for the same variable. Follow the keystrokes below to show the steps involved in solving each of the equations for the variable x.

$$3 \cdot x - 17 \cdot y = 51$$

$$3x<ctrl>=51+17y<Enter>$$

$$x<ctrl>=51+17y<spacebar><spacebar><spacebar>/3<Enter>$$

$$3x = 51 + 17y$$

$$x = \frac{51 + 17y}{3}$$

**Notes:**

1. The **<spacebar>** is used to select multiple terms in a Math Region
2. The "/" is the Mathcad keystroke for Division

$$8x + 4y = 22$$

$$8x = 22 - 4y$$

$$x = \frac{22 - 4y}{8}$$

Solving by Substitution using Mathcad's Boolean equality symbol:

$$3 \cdot x - 17 \cdot y = 51$$

$$8x + 4y = 22$$

$$3x = 51 + 17y$$

$$8x = 22 - 4y$$

$$x = \frac{51 + 17y}{3}$$

$$x = \frac{22 - 4y}{8}$$

You can drag any Mathcad region to a new location with your mouse cursor. If necessary drag the regions in this step so they do not overlap.

5. Here are the mathematical steps that we want to complete next:

**Try to complete this on your own!**

$x = x$

$$\frac{51 + 17y}{3} = \frac{22 - 4y}{8}$$

**Scratch Calculations**

$$8 \cdot 17 = 136$$

$$66 - 408 = -342$$

$$3(22 - 4y) = 8(51 + 17y)$$

$$66 - 12y = 408 + 136y$$

$$-342 = 148y$$

$$y = \frac{-342}{148}$$

+

<Spacebar> is very important in this step. Make sure to select the whole expression!

I have shown my scratch calculations using two math regions. I used Mathcad's "=" evaluation equality symbol instead of the Boolean Equality Symbol so that Mathcad calculates the result for me. "Scratch Calculations" is in a Text Box above the math regions.

6. So far we have used Mathcad to express mathematics in the same way we would present it on paper with a pencil. This capability is important for presenting the steps that you proceed through in an algebra problem. Learning these symbolic techniques is important!

However, Mathcad is designed to perform many mathematical operations for you, the simplest of which are the types of calculations shown as Scratch Calculations in the above image. In Step 7 you will use variable definitions to enable Mathcad to do some of the work for you in the rest of the problem.

7. Based on our work so far we believe that the y-coordinate of the solution to this system is  $-342/148$ . Define a variable called y and assign it the value  $-342/148$  using these keystrokes:

**y:-342/148<enter>**

Now define an expression to evaluate x:

**x:51+17y<spacebar><spacebar><spacebar>/3<Enter>**

We have now defined, but not evaluated, two variables x and y. To evaluate them, simply type “x=” and “y=” in the space beneath the variable definitions. The results should appear as below.

The screenshot shows the following steps in Mathcad:

$$x = x$$

$$\frac{51 + 17y}{3} = \frac{22 - 4y}{8}$$

Scratch Calculations

$$8 \cdot 17 = 136$$

$$66 - 408 = -342$$

$$3(22 - 4y) = 8(51 + 17y)$$

$$66 - 12y = 408 + 136y$$

$$-342 = 148y$$

$$y = \frac{-342}{148}$$

$$y := \frac{-342}{148}$$

$$x := \frac{51 + 17y}{3}$$

$$x = 3.905 \quad y = -2.311$$

### Assignment Statements

*The Mathcad equality symbol for assignments such as variable and function definitions is “:=” which has the keystroke :*

*In this exercise we have used Boolean expressions to develop a solvable equation, assignment statements to calculate the solution, and evaluation statements to report the results.*

*The values  $x=3.905$  and  $y=-2.311$  represent the one-and-only pair of values  $(x,y)$  that make both of the equations in the system true.*

8. Now that we have defined a variable containing our prediction of the correct value for both x and y, we can easily check the results using Mathcad. First, let's do some formatting.

- Use your mouse to drag the evaluations of x and y down to create space for a new Text Box
- Add a new Text Box in the space you created and type the text "Solutions and Check" in the Box

$$x := \frac{51 + 17 y}{3}$$

Solutions and Check

$$x = 3.905 \quad y = -2.311$$

#### Drag Selection

*You can drag-select both  $x=3.905$  and  $y=-2.311$  by left-clicking on your mouse and dragging over both regions. Then, you can move them in tandem.*

9. We will use two different methods to show that these are the correct solutions. First, we will state and evaluate the left side of each of the original equations as shown below.

$$3x - 17y = \langle \text{Enter} \rangle$$

$$8x + 4y = \langle \text{Enter} \rangle$$

Solutions and Check

$$x = 3.905 \quad y = -2.311$$

$$3 x - 17 y = 51$$

$$8 x + 4 y = 22$$

*Since these evaluation statements result in the original equations, we are now confident that the results are correct!*



10. Now we can check the original result by producing a plot of the two equations. When we make the plot, we will be looking for the two lines to intersect at the point  $(x,y) = (3.905,-2.311)$  on the graph. We will make the plot in the space beneath the original problem and to the left of our existing solution.

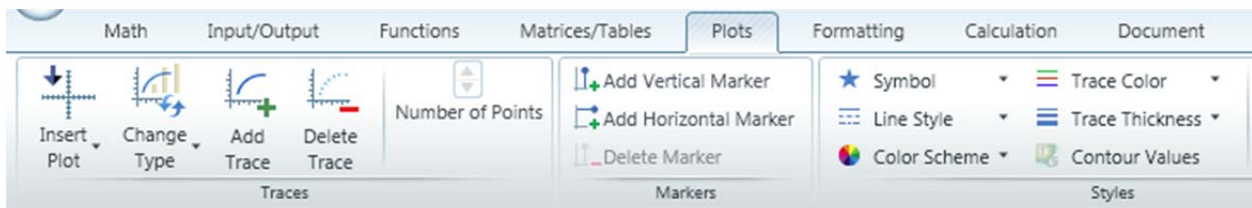
First, we need to express each equation as solved for  $y$ . (We currently have them solved for  $x$ .) Here is an image of the first and last steps:

Graph and check your solution.

$3 \cdot x - 17 \cdot y = 51$	$8x + 4y = 22$
$y = \frac{51 - 3x}{-17}$	$y = \frac{22 - 8x}{4}$

You can copy and paste these from the original Boolean statements that you typed.

Now we need to create a plot. **Make sure that your cursor is in an open area on the Mathcad worksheet, then Left-Click to select the Plots Ribbon.** Follow the steps below to create a plot.



- **Left-Click** on **Insert Plot** to open the drop-down menu and choose **XY Plot**
- When the plot region appears use your mouse to move it into a suitable location

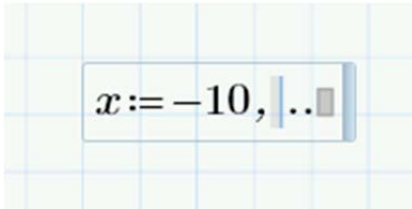
Type this expression here:  
(This is the placeholder for the **Dependent Variable** or Expression)

$$\frac{51 - 3x}{-17}$$

Type x here in the placeholder for the **Independent Variable**

Since we have already defined a value for  $x$  above in finding a solution to the system, if we want to use  $x$  as a variable on the plot we need to define it as a range of values using a **Range Variable**.

- Click in the space above the plot window
- Type:  $x := -10, \dots$

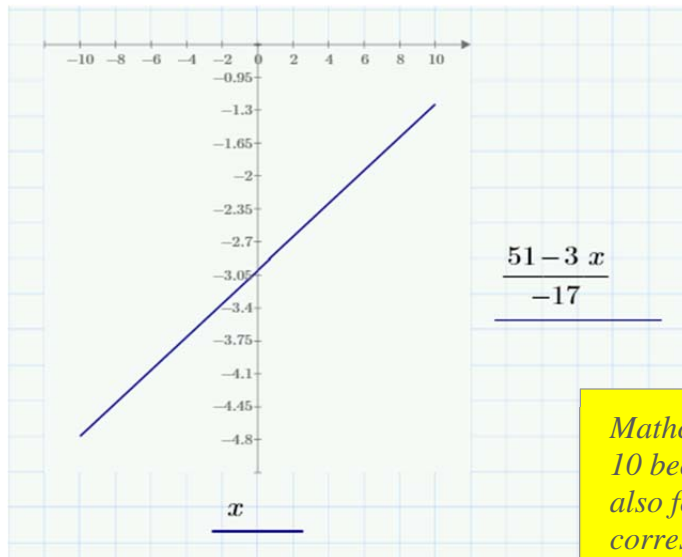


### Range Variables

*A Mathcad Range Variable assigns a series of values from a **minimum** to a **maximum**, using a second value at the start of the list to set the **increment** or step size.*

- Enter -9.9 in the first placeholder to make the step between values equal to 0.1
- Enter 10 in the second placeholder to set the maximum value for  $x$  to 10

Your plot should now appear as follows:

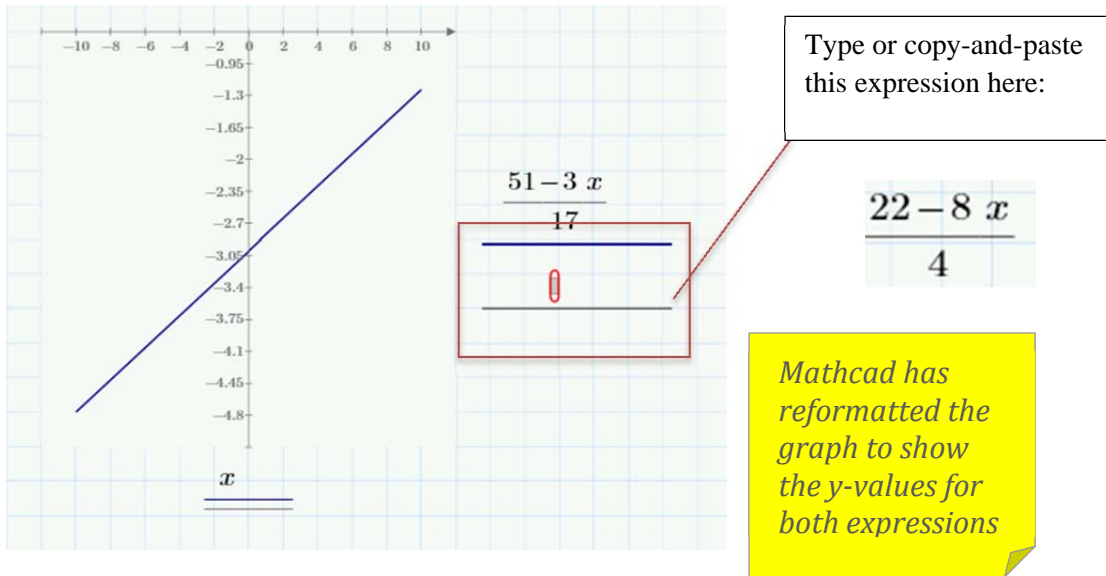


*Mathcad has formatted the  $x$ -axis from -10 to 10 because of our Range Variable. It has also formatted the  $y$ -axis to show the corresponding values of the expression in the space for the dependent variable.*

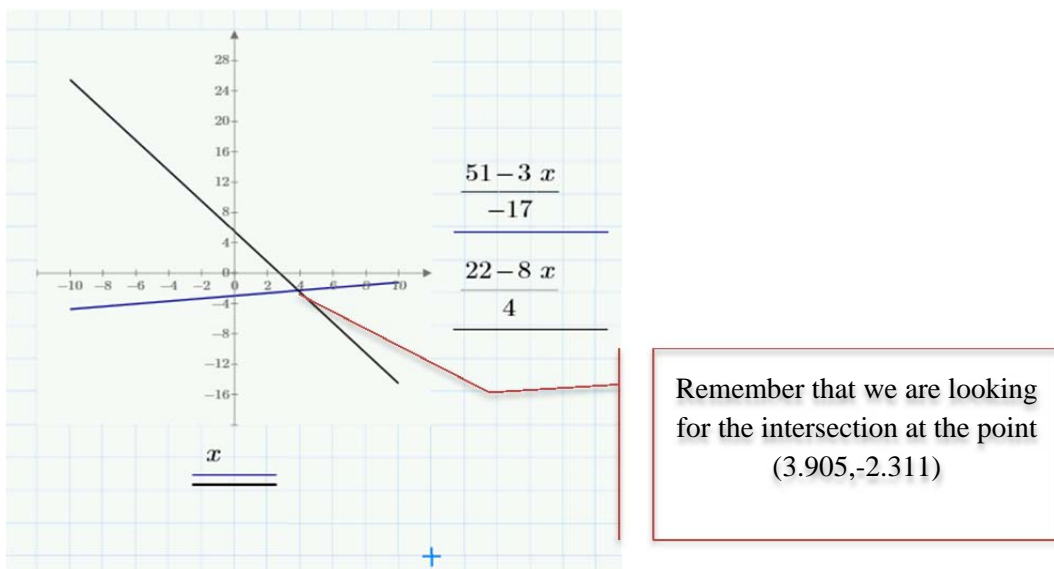
Plots are called traces in Mathcad Prime. In order to add the second equation to our graph, we need to add a new trace to the dependent variable region on the right side of the graph.

- Click in the Dependent Variable region to the right of the plot
- Click Add Trace on the Plots ribbon

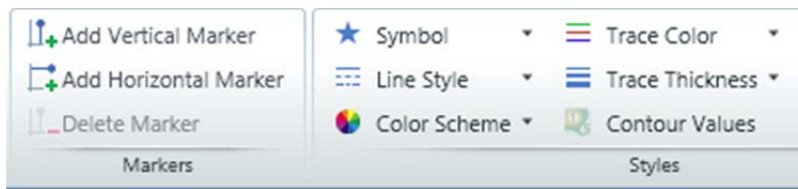
11. Here is the graph:



The graph appears to show that we have an intersection point where it is expected.

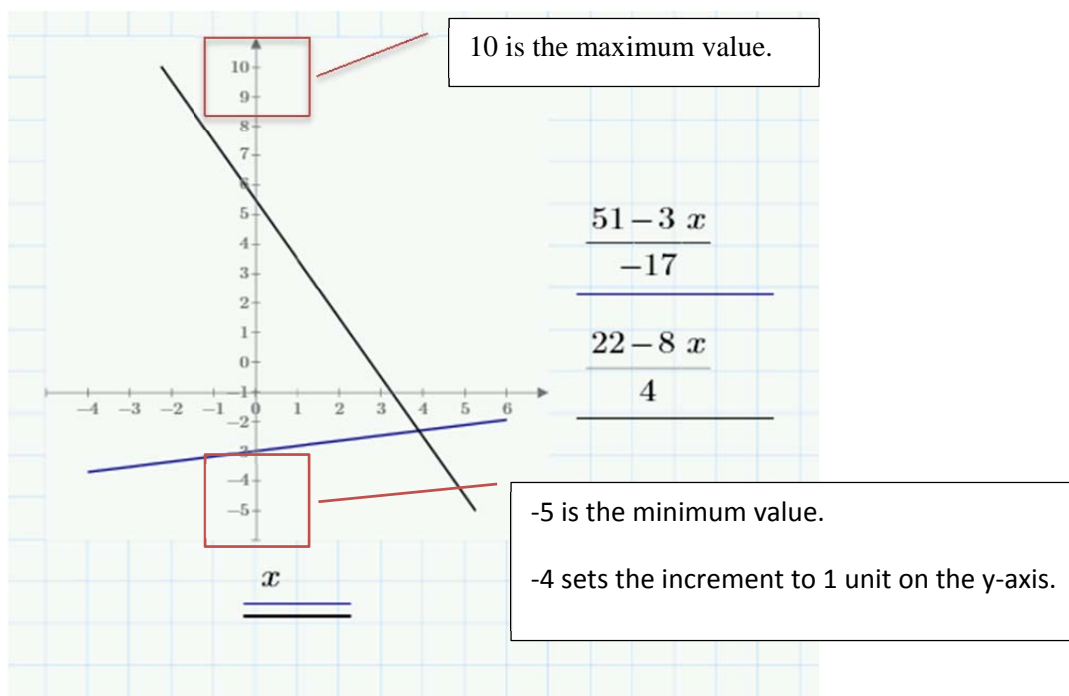


Mathcad's Plots tab has some nice features that we can use to adjust the appearance of the graph.



- You can add Vertical or Horizontal Markers that help to show particular x- and y-values
- You can change the Style of the Line, the Trace Color, the Trace Thickness
- You can add Symbols to plots to show data values more clearly

We can also change the range of values shown on the graph by selecting and typing over particular values. Edit the minimum and maximum values on either axis to change the range of values that are displayed. Edit the values adjacent to the minimums to set the increment.



*Great job with this tutorial!*

*For more resources about learning to use the capabilities demonstrated in this tutorial, consult the Mathcad Prime Tutorials available on the Getting Started Tab.*