


# Typing Math: Symbols and Graphing

The purpose of this assignment is to learn how to produce word-processed documents containing mathematical expressions and graphs that look like they could have come from a textbook. The introductory information is to show the difference between how math expressions look when typed by an amateur and when typed by a connoisseur of the mathematical typewritten word. In the second section, you'll find brief instructions on how to use the equation editor built into Microsoft Word. There are other equation editors out there, but this one is available to all of you for free. The third section is a primer on producing good graphs with GeoGebra. Finally, you will find an assignment to complete using those skills.

## Introduction: How "good math" looks on the page.

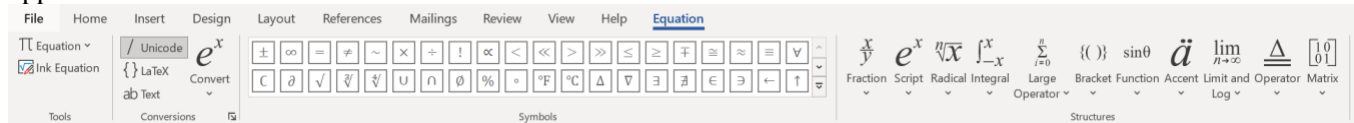
In the table below you will find examples of incorrectly and correctly typeset mathematical expressions.

Incorrect	Correct	Comments
$y = -(x-2)^4 + 1$	$y = -(x - 2)^4 + 1$	Four things here. The obvious one is that the exponent should be typed as a superscript rather than with a caret (^). The others are more subtle. Variables are italicized, in general, as are the names of points and constants like $e$ and $\pi$ . There should be spaces around the subtraction sign. Finally, a minus sign (or negative sign, depending on the context) is not just a hyphen, it's an en dash, which is longer. <b>Important:</b> Microsoft's equation editor takes care of the italics and the longer minus sign for you. You just type in an equation field, and it handles that formatting, including automatically changing the hyphen to the longer version. If you choose to type the names of variables in a sentence, though, you have to italicize them yourself.
$\sqrt{(\sin x)/(1+x^2)}$	$\frac{\sqrt{\sin x}}{1 + x^2}$	The one in the second column is beautiful by comparison, don't you think? The equation editor handles the fraction, the radical, and the italics all at once. (And slanted fractions are evil.) Notice that the trig function name is <i>not</i> in italics. That is formatted correctly. You type a space after the function name to make Word recognize it.
$f(1/2x) = f( x /2)$	$f\left(\frac{1}{2}x\right) = f\left(\frac{ x }{2}\right)$	Could you tell in the first expression whether the $x$ was in the denominator? Neither can anyone else. Don't use slanted fractions. The equation editor will make the parentheses and absolute value bars taller to match the argument if you select those from the $\{\{\}\}$ menu, but not if you just type them on the keyboard. Also, notice that function names are italicized, but parentheses and numbers are not. A good equation editor does that automatically; if you were typing "regular" text in a word processor, you would have to do it yourself.
$\begin{cases} x, & \text{if } x \geq 0 \\  x  = \begin{cases} x, & x \geq 0 \\ -x, & x < 0 \end{cases} \end{cases}$	$ x  = \begin{cases} x, & x \geq 0 \\ -x, & x < 0 \end{cases}$	The first is a noble but ill-fated attempt to type the definition of absolute value as a piecewise-defined function. The second is how it ought to look. It uses a 2x2 grid to organize the parts of the piecewise function; this is found in the $\begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$ menu. The correct version also has a single left brace that will grow to the needed height automatically, found in the $\{\{\}\}$ menu. By the way, while $\geq$ can be found in a menu, $>$ and $<$ are just keys on the keyboard.
$y^2 = 4 \Rightarrow y = +/-2$	$y^2 = 4 \Rightarrow y = \pm 2$	The implication arrow and the plus-or-minus sign are in the symbols section, which looks like this.  You can scroll with the $\downarrow$ on the right end or click on the $\downarrow$ to see entire categories of symbols. In general, you will have a much simpler time typing mathematical work if you type regular words as text in your word processor, and then insert an equation whenever you need a mathematical expression.
$2.3 \times 10^{-5}$ $2.3 \times 10^{-5}$	$2.3 \times 10^{-5}$	The $\times$ sign is in the symbols. Use of the italicized $x$ for multiplication not only looks funny, it's just plain wrong. Even if the $x$ isn't presented in italics, it's not the same character as an actual multiplication sign.
$h(x) = 2x^2/(x^2 - 9)$	$h(x) = \frac{2x^2}{x^2 - 9}$	This one wasn't completely wrong to begin with, just not easy to read. <b>Avoid the use of slanted fractions</b> , especially when there is more than one term in either the numerator or denominator. They require very careful use of parentheses, and even then they can be hard to follow. <b>Clarity is essential.</b>
$\lim_{x \rightarrow 0} [(\sin x)/x]$	$\lim_{x \rightarrow 0} \frac{\sin x}{x}$	You can find the limit symbol that lets you put the $x \rightarrow 0$ in the right place in the Limit and Log menu.

## Microsoft's Equation Editor: Perfectly adequate, and built-in

While this is not my favorite tool, I've spent far too long looking into alternatives that never seem to be the right thing. What I have actually been using for the last few years to create tests is Apple's Pages (on a Mac) with its built-in LaTeX-lite editor. However, that has a much steeper learning curve and does not support point-and-click. At this point in your mathematical education, I think Word's equation editor is the best option. By virtue of your school Office 365 account, you can download all of the basic Office apps onto multiple personal computers to use while you are a student in the Polk County Schools in addition to using them on your school-issued laptop. The *online* version of Word has added the ability for you to insert or edit equation objects. Unfortunately, it will not allow you to type all the expressions you would need, so you'll be using the desktop version on the school computers to do the assignment here. All of the screenshots in this document were taken from the desktop version.

To insert a new expression, go to the Insert tab. On the right end, click the big  $\pi$  button to insert a mathematical expression. You will be presented with an Equation editor object like this: "Type equation here." Also, the Equation tab appears and is active. That looks like this.



You can find not only the symbols immediately visible in the middle, but also several more screens of those by either scrolling down with the  $\downarrow$  or clicking on the  $\square$  to see entire categories of symbols, like the first image in the table below. The number of symbols you see at once on the Equation tab is dependent on the width of the current window.

### Microsoft's Equation Editor symbol and template menus for reference, with some comments:

	<p>Most of the symbols you are likely to need will be in Basic Math. The symbols for various sets are in a different group, and you'll find the Geometry section useful, too. If you're interested in investigating what some of these mean, check the Wikipedia article "<a href="#">Glossary of mathematical symbols.</a>"</p>
	<p>The first fraction template is going to be the best one in almost every circumstance. <b>Don't</b> use slanted fractions when you're typing math. It looks unprofessional.</p>
	<p>I cannot explain the presence of a radical with an index of 2. Who does that?</p>
	<p>When you select these, you get boxes to type in. I find it annoying that the cursor never seems to start out in the box where I want it. Use your arrow keys to navigate.</p>
	<p>This is where I stop showing everything in the template menus. You're not going to need anything beyond the first row for this (two-year) course.</p>

Similarly here, only the first row is likely to be useful to you in high school.

I don't think it would ever occur to me to use any of these. I would just type. If you type a space after "sin" (for instance), the equation editor recognizes that as a function name and removes the italics.

The parentheses and vertical bars in the first section will get larger to hold contents with fractions and superscripts. The "single brackets" section is where you find the one-sided { for piecewise functions.

The overbar (second choice in the third row) is useful for typing the names of segments.

The limit template is here, along with the logarithm template that allows a base to be entered.

The "Operator Structures" are NOT the ones you want for lines, rays, and such. Those were in the Accents menu just above.

This is how I spaced the contents of the definition of absolute value on the first page. The one I used, a  $2 \times 2$  grid, is the first one on the second row.

There are some quirks. When you want an expression to appear "inline," which is to say in a sentence of text or next to a problem number, you need to have some text on the line first. If you don't, Microsoft will make the equation a "display" version, which is centered on the page. It's possible to change that after the fact, but it's easier to make sure there's already some text on the line.

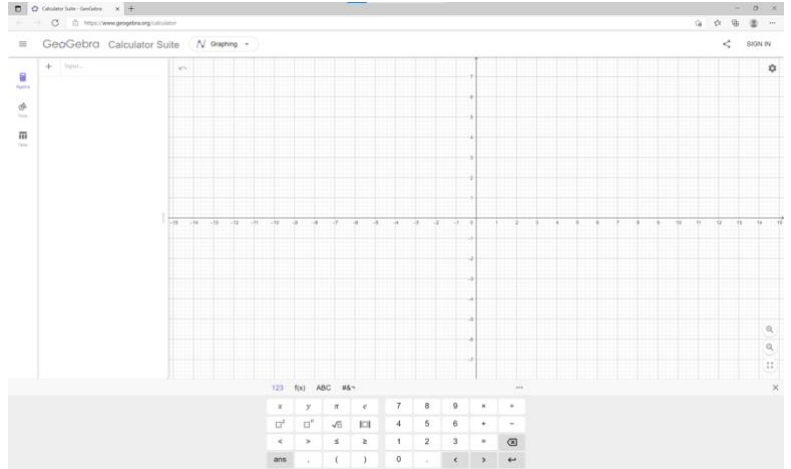
## GeoGebra: Graphs and so much more






GeoGebra can be accessed at <https://www.geogebra.org>; I prefer the version called Classic 5, but that has to be installed from the App Downloads page — and you don't have permissions to install it on your school laptop. (You might decide to use that on your home computer, though.) This free program can be run as an applet in a browser window, too, and I have used the browser version to make the graphs in this file. GeoGebra is under continuous development by Markus Hohenwarter<sup>1</sup> and a team of collaborators. As suggested by its name it combines geometry and algebra and will do some really useful things other than graphing.

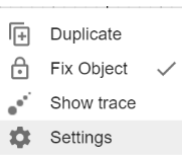
GeoGebra is more than a set of free tools to do math. It's a platform to connect enthusiastic teachers and students and offer them a new way to explore and learn about math.



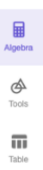
When you first open GeoGebra by clicking on Start Calculator, you get a window like the one shown at the right. To graph a function, type it in the Input... field at the left side. You enter expressions basically like you would in a calculator, with \* for times, / for division, and ^ for powers. The numbers  $e$  and  $\pi$  are entered as e and pi, respectively, and the square root function is sqrt() with an argument inside the parentheses. You can also use the buttons at the bottom of the screen for many basic tasks. Use parentheses carefully, just like you have to on a calculator. You can give your function a name, like  $f(x)$ , start with "y =", or just type the expression you want to graph and a name will be assigned automatically. When you do want it to have a name like  $g(x)$ , it works best if you initially enter it that way. While the graph starts showing up as soon as you've begun to type, hit the enter key to keep it. To graph another function along with the first, repeat the process in the new Input... box. Implicit functions involving polynomials in  $x$  and  $y$  can be graphed without solving for  $y$  first. You'll learn what those are later, but if you want to see how cool they can be, try graphing  $x^2 y + y^2 x = 1$  by typing it in the Input box. For a list of the special functions that GeoGebra knows and how to enter them, see [http://wiki.geogebra.org/en/Predefined\\_Functions\\_and\\_Operators](http://wiki.geogebra.org/en/Predefined_Functions_and_Operators).



Right-clicking is really useful in this program. For instance, right-clicking on a curve and choosing **Settings** will open a pane on the right to allow you to change the color and thickness of the graph, as well as its name and formula. When **Show Label** is checked, the default is just the name of the function (like  $f$ ), but you can use the drop-down menu to change this to **Name & Value** to see its formula or **Caption** to see whatever caption you type in the field there. There are lots of options on the last few tabs, some of which allow for quite powerful control of objects. The gear icon on the right will also get you to that settings pane, and you can close it with the  $\times$ . If you don't see the settings for the object you're trying to customize, try clicking on the object while the settings pane is open, or click in an empty space on the graph to customize the grid and axes. Clicking on an object also brings up      to let you quickly change the color, line type, and label. You can choose to show or hide individual curves by clicking on the little colored circles to the left of their equations.



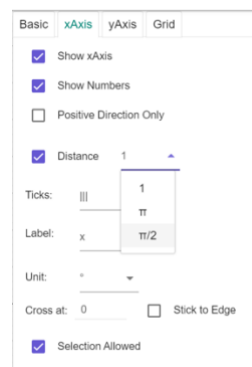
GeoGebra has a geometric soul, and you change from the Algebra entry window to get lots of construction tools by clicking on Tools on the left side of the screen. Eventually, you will certainly see how I have used some of those, but for the current assignment, you won't need them. You can zoom in and out on a graph both by pinching and by scrolling, and you can set max and min values for each axis in the settings pane.



To customize the graphing window, click in a blank area of the graph while the settings pane is open. You can turn the grid on or off here, and the **Basic** tab lets you type in maximum and minimum values for each axis. The

<sup>1</sup> I have discovered that you can find the dissertation for which Dr. Hohenwarter initially created this program at <https://www.geogebra.org/m/qe9dzbsm>. To read it requires a working knowledge of German.

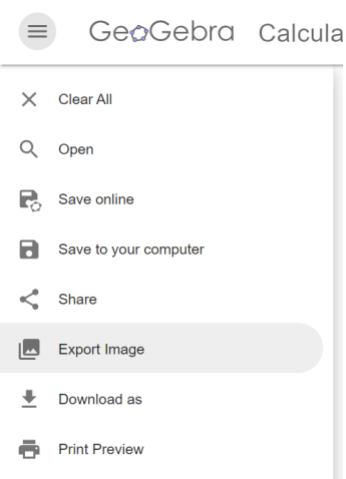
separate xAxis and yAxis tabs there are where you can have the tick marks in terms of  $\pi$  or  $\frac{\pi}{2}$  if needed and set the names of the axes to  $x$  and  $y$  (or whatever you need, including words). In addition to the choices in the drop-down menus, you can type in your own values. Annoyingly, the Unit seems to default to  $^\circ$ ; you mostly would want to backspace that out. As expected, the Grid tab controls whether and how the grid displays.



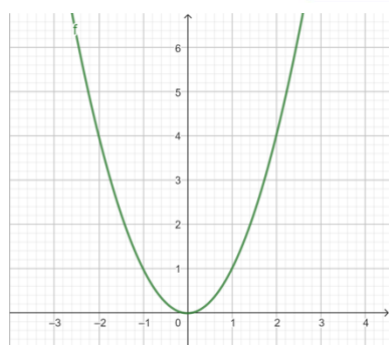
As you might expect, it is important to save your work. If you make a GeoGebra account (for which you should be able to use your Office 365 sign in; this is a PCSB approved site), you can choose **Save online** from the menu at the top left. You can also choose to download the .ggb file to your own computer. My recommendation

would be to use the GeoGebra online storage, since your computer may get swapped out if it has issues at some point. You could also upload a downloaded .ggb file to your OneDrive. To make a brand new graph without having to change the current one, just go to <https://www.geogebra.org/calculator> to start fresh.

Getting a graph into a word processing document is simple, *but* it can be challenging to format the image well for your file in the browser version of the program. With the graph displayed as you like it on screen (you can and should resize the window, too), choose **Export Image** from that left side menu. Then **Copy to Clipboard** and paste it into your document. (Downloading produces a .png file, if that's useful.) You can resize it by dragging a corner. That's generally a good idea, because huge computer-generated graphs are rarely worth so much space. I wrapped the text

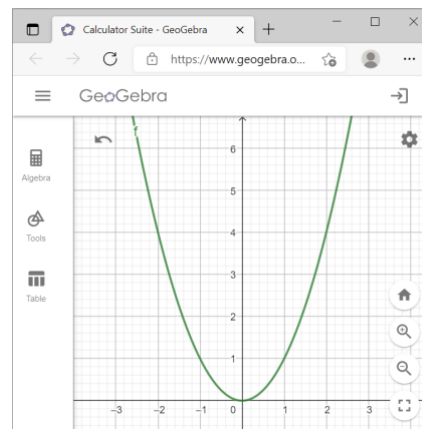


around the pictures in this document using Word formatting commands, but you'll probably want Inline, which is likely what you get when you initially paste in an image. You may need to make the font size larger in the Global section of the settings pane to make things easier to read; unfortunately, that also makes it larger everywhere. You'll see what I mean if you try it. The best practice is to make the graph you see on screen in GeoGebra look as much like the final version you want in your document as you possibly can, including its size and shape. Windows are easy to resize. Practice that.



The graph in the paragraph above is a terrible picture for a word processing document because of all the wasted space. Can you read anything on it without zooming way in? To the left is a much better version. I made that by separating the GeoGebra tab from the rest of the browser tabs and then resizing that window to be *much* smaller onscreen, which looks like the window at right. (That's the *entire* browser window.) I adjusted the text size and

arranged the graph in the window where I wanted it. This is both important and kind of annoying. Sorry about that, but it can't be helped.



You can customize your graphs a lot, but it's important to remember that if a graph is hard to understand, it won't help your communication, no matter how cool it may look to you. Also, in many ways the computer is just a bigger version of your graphing calculator, and the software is subject to some of the same limitations, like not always showing holes and possibly connecting dots it shouldn't. You can restrict a function to a limited domain by using the Function command. Try typing `Function[(x-1)^2-2,-1,3]` to see how that works.

## The Assignment

Your assignment is to reproduce the things you see below, yourself. **Your goal is to have your work look as much like mine as possible**; pay attention to detail. I have used Word's equation editor to create all of the mathematical expressions and the GeoGebra Calculator Suite for all graphs. The assignment counts 50 points.

Begin by opening Microsoft Word from the Start menu (NOT in a browser) and creating a new Microsoft Word document. Give it a meaningful title; here something like Typing Math followed by your name would be a good choice. Including your name in the title of something you're submitting to a teacher electronically is often wise.

Give the work whatever header you generally do for things you type for class. On a new line, type **Geometry**, followed by the number of the first item and the words that follow. Then insert an equation from the Insert tab in Word. Be sure your work is saving; you probably have Word set to auto-save, but you should check.

You've been warned. You must use the **desktop** version of Word on your school laptop; there are multiple things here that the online version is still unable to produce correctly.

Type **everything** that follows this paragraph, making it look as much like what I have typed as you can. There are **two exceptions** to this. First, you may choose **whatever colors you like** for the graphs as long as they remain readable. Second, **you may use just one column instead of two, which means that your lines may be longer than mine**. Pay attention to the parenthetical advice that follows some of the expressions — you must type it *and* do what it says. You will be uploading your work on Schoology as a Microsoft Word document (*not* a PDF). Find the assignment and click Submit Assignment in the Submissions area in the right column to upload the file. Once it is uploaded, click Submit.

### Geometry

1. Congruent segments  
 $\overline{AB} \cong \overline{BC}$

2. Similar triangles  
 $\triangle AMY \sim \triangle TED$   
(That's a "similar" tilde. I had to turn off italics on the delta symbols manually.)

3. Angle measure  
In  $\triangle ABC$ , we calculated that  $m\angle A = 82^\circ$ .

4. Perpendicularity  
 $\overleftrightarrow{PQ} \perp \overrightarrow{EF}$   
(Look closely at the arrows. The first is a double arrow, and the second is a single one.)

### Algebra

5. Piecewise-defined function  
$$f(x) = \begin{cases} 3x^2, & x < -1 \\ 2x - 5, & x \geq -1 \end{cases}$$

6. Rational expression  
$$\frac{x^3 + 2x^2 - 7}{(x - 5)(2x + 9)}$$
  
(I got the fraction to be large by clicking on the equation, then the drop-down menu on the right side of that. I chose "Change to Display" and then Justification > Left. Word wants to insert an extra line above the expression, but you can select the whole line and delete it. This actually took quite a while to figure out. Make yours look like mine.)

7. Radical expression  
Rational exponents can be used to rewrite  $\sqrt{15} \cdot \sqrt[3]{35}$  as  $\sqrt[6]{4,134,375}$ .

8. Quadratic formula  
If  $ax^2 + bx + c = 0$ , then  
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
  
(Again, make the fraction normal size using the technique from #6.)

9. Complex fraction  
$$\frac{\frac{2}{x-5} + 1}{7 - \frac{3}{x+2}}$$

10. Binomial theorem  
$$(a + b)^n = \sum_{r=0}^n \binom{n}{r} a^{n-r} b^r; a, b \in \mathbb{R};$$
  
 $n, r \in \mathbb{Z}^+$   
(You make the sigma sign large the same way you did the fractions. I'm going to stop explaining this.)

### Probability and Statistics

11. Probability of the occurrence of either of two events  
$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

12. Conditional probability

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

13. Formula for standard deviation

$$\sigma = \sqrt{\frac{\sum_{i=1}^k f_i(x_i - \bar{x})^2}{n}}, \text{ where } n = \sum_{i=1}^k f_i.$$

(Be careful where the subscripts and superscripts show up. This time I didn't choose Display mode.)

### Trigonometry

14. Pythagorean identity

$$\sin^2 \theta + \cos^2 \theta = 1$$

15. Sum and difference identity

$$\cos(\alpha \pm \beta) \equiv \cos \alpha \cos \beta \mp \sin \alpha \sin \beta$$

(Yes, that's a minus-or-plus, rather than a plus-or-minus, on the right-hand side. Note the equivalence symbol.)

### Calculus

16. Limit

$$\lim_{x \rightarrow \infty} \left( \frac{1}{x} \right) = 0$$

17. Derivative

$$\frac{d}{dx} [\tan x] = \sec^2 x$$

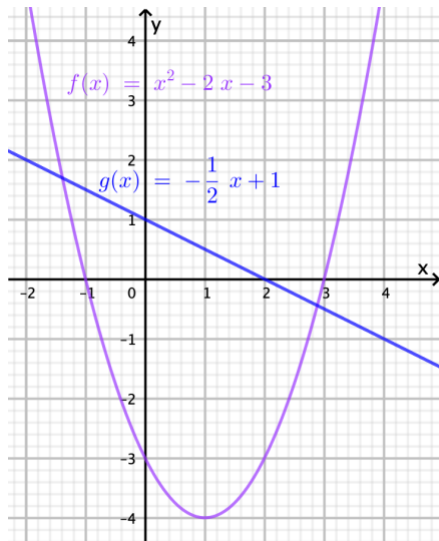
18. Integral

$$\ln x = \int_1^x \frac{1}{t} dt, x > 0$$

(That's lowercase LN, the natural logarithm.)

### Graphing

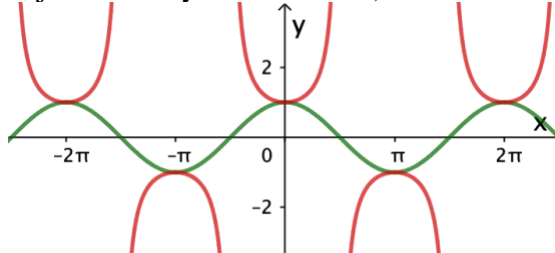
19.  $f(x) = x^2 - 2x - 3$  and  $g(x) = -\frac{1}{2}x + 1$



(Be sure to type the equations for the functions along with the graphs here. Also pay attention to the details shown on the graphs. I will. If your equations on the graph are not as pretty as mine, re-enter the function with  $f(x)$  and  $g(x)$  typed explicitly.)

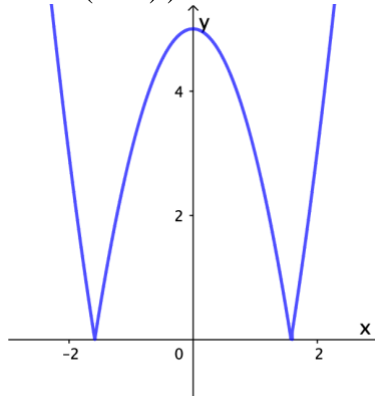
20. The graphs of  $y = \cos x$  and  $y = \sec x$  nest together nicely.

(You enter these with parentheses around the  $x$ , just like on your calculator.)



21.  $y = |2x^2 - 5|$

(You type the absolute value into GeoGebra as abs(stuff).)



22.  $h(x) = \sqrt{25 - x^2}$

(It's a semicircle, and it should look like one. You get the square root in GeoGebra as sqrt(stuff).)

