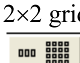
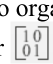
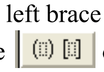
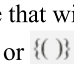
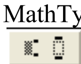
# Typing Math: Symbols and Graphing

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 next section, you'll find brief instructions on how to use MathType 6 to produce professional-quality results. Unfortunately, it's apparently no longer possible for me to install that on the school laptop cart, so if you're using a school computer, the second section will show you how to use the equation editor built in to Microsoft Word in class. It works okay, and it's free for you, too. The next 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.

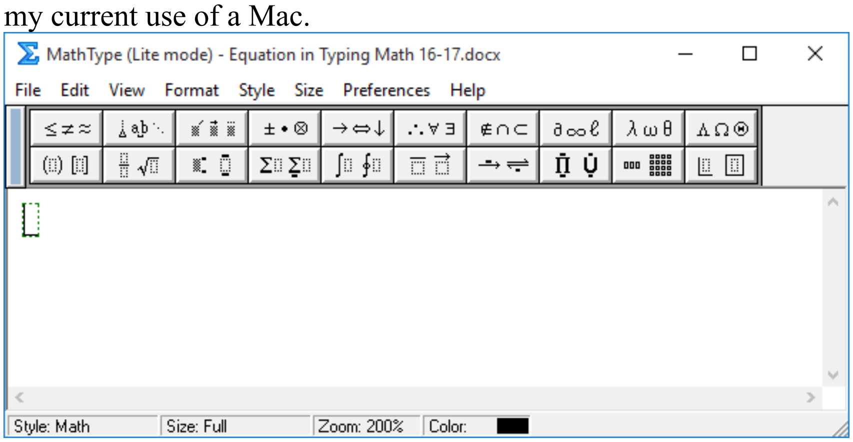
| Incorrect | Correct* | Comments |
|---|---|---|
| *In each case, the second example uses the Microsoft equation editor. | | |
| y = -(x-2)^4 + 1 | $y=-\left(x-2\right)^4+1$; $y=(x-2)^4+1$ | Three things here. The obvious one is that the exponent should be typed as a superscript rather than with a caret (^). The other two are more subtle. Variables are italicized, in general, as are the names of points and constants like *e* (in the U. S., anyway). Finally, a minus sign (or negative sign, depending on the context) is not just a hyphen, it's an en dash, which is longer. **Important**: Both MathType and Microsoft's equation editor take care of the italics and the longer minus sign for you. You just type in an equation field, and it handles that formatting. If you choose to type the names of variables in a sentence, though, you have to italicize them yourself. |
| √(sin x)/(1+x$^2$) | $\frac{\sqrt{\sin x}}{1+x^2}$; $\frac{\sqrt{\sin x}}{1+x^2}$ | The second one is beautiful by comparison, don't you think? The equation editors handle the fraction, the radical, and the italics all at once. (And slanted fractions are evil.) Also, I really do prefer the look of MathType. You can get the version I used to create those expressions for free. I will help you with that if you want to use it. |
| f(\|-x\|$^2$)= f(\|x$^2$\|) | $f\left(\left\|-x\right\|^2\right)=f\left(\left\|x^2\right\|\right)$; $f(\|-x\|^2)=f(\|x^2\|)$ | Notice here how MathType lets me have parentheses and vertical bars that grow with the expression inside. Microsoft does, too, but the choices it makes here are not so obviously larger. You don't get the expanding versions by just typing parentheses and vertical bars. You choose them from menus (or with keyboard commands). Also, notice that function names are italicized, but parentheses and numbers are not. Equation editors do that automatically; if you were typing "regular" text in a word processor, you would have to do it yourself. |
| {x, if x >=0<br>\|x\| = {-x, if x < 0 | $\|x\|=\begin{cases}x, & x\ge 0\\ -x, & x<0\end{cases}$; $\|x\|=\begin{cases}x, & x\ge 0\\ -x, & x<0\end{cases}$ | The first is a noble but ill-fated attempt to type the definition of absolute value as a piecewise function. The second is how it ought to look. It uses a 2×2 grid to organize the parts of the piecewise function; this is found in the  or  menu. The correct version also has a left brace that will grow to whatever height is needed, automatically, from the  or  menu. By the way, while ≥ can be found in a menu, > and < are just keys on the keyboard. |
| y$^2$ = 4 => y = +/-2 | $y^2=4\Rightarrow y=\pm 2$; $y^2=4\Rightarrow y=\pm 2$ | The implication arrow and the plus-or-minus sign are in menus. In general, you will have a much simpler time doing this if you type regular words as text in your word processor, and then choose Insert Equation whenever you need a mathematical expression. In particular, keeping MathType open and copying and pasting from there seems to cause crashing problems. |
| 2.3 *x* 10$^{-5}$ | $2.3\times 10^{-5}$; $2.3\times 10^{-5}$ | The × sign is in a menu. Use of x italicized for multiplication not only looks funny, it's just plain wrong. |
| $h(x) = 2x^2/(x^2-9)$ | $h(x)=\frac{2x^2}{x^2-9}$ | This one wasn't completely wrong to begin with, just not easy to read. **Avoid the use of slanted fractions**, especially when there is more than one term in either the numerator or denominator. They require very careful use of parentheses, and even then can be hard to follow. |
| lim [(sin x)/x]<br>x->0 | $\lim\limits_{x\to 0}\frac{\sin x}{x}$; $\lim\limits_{x\to 0}\frac{\sin x}{x}$ | MathType's command to put the x → 0 part right under the limit is in the  menu. Microsoft's is in the menu that says limit. |

## *MathType: Using the program*

MathType was sold to another company, Wiris, in 2017. Unfortunately, MathType 7, the new version, is actually a renamed version of Wiris's previous product — not at all the same. Even more unfortunately, the new program does not have a forever-free version; they only operate on an annual subscription. With the old version, if you install the demo version and, after 30 days, you don't pay for it, it reverts to a program called MathType Lite, which is what I originally used to type this document. Clearly, the Lite version will do everything you need, and it's free. As I type this, older versions are still available at https://store.wiris.com/en/products/downloads/mathtype/v6 . You download the installer for your platform (Windows or Mac) at the top of the appropriate column. If this link goes away, I still have the installers for MathType 6.9 for Windows and MathType 6.7 for Mac, the last ones produced before the switch.

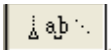
When you first install MathType and have Microsoft Word on your Windows computer, you automatically get a MathType tab, and the very first choice there, "Inline," is the one you want. (Unfortunately, Word 2016 for Macintosh does not work well with MathType, but Pages and Word 2011 should. I strongly recommend Pages.) If you're using some other word processor, I can't promise the automatic button, but after you've installed the program, you can go to the Insert menu or tab and choose Object, then MathType equation. While you are students in the Polk County Schools, you have access to Office 365 and can install Microsoft Office on your own computer. Start at https://polkschoolsfl.com and click on Office 365 on the left side of the Students drop-down. **MathType 6 does not work with the online versions of Word.**

When you insert an equation, you're presented with a window more or less like this. (You may have more rows of things during the first 30 days.) I am aware that the date of this screen shot is old; that has to do with my current use of a Mac.




You type in the large middle area. The buttons at the top are all drop-down menus of various symbols (on the top) and templates (on the second row). The names don't matter so much, but the difference is that the boxes on the second row provide places for you to input more expressions. The symbols on the buttons give you some idea of the types of things you will find in the menu. In general, when you need one of the things on the second row, like a fraction or a vector, you should choose the template first, then type the numbers or letters. In the full version, some commonly used things are more readily accessible, and you can click on those, too. At the end of the MathType section of this document, you will find a set of screen shots of those menus that may help you find things more easily at first.

For the most part, the program works exactly like you would expect it to. For instance, if you choose a fraction template from the second row, you first type in the numerator, then either click in or tab to the denominator. The tab key will move you through the various parts of an expression easily. To update the equation in your document and close the window all at once, use Control-F4 (Windows) or ⌘-W (Mac).

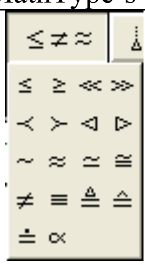
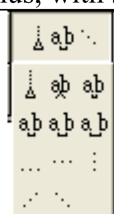
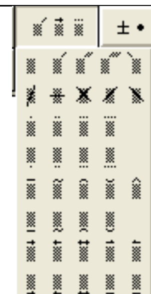
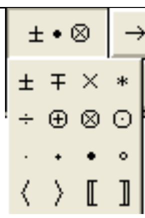
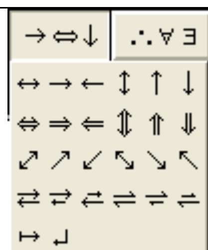
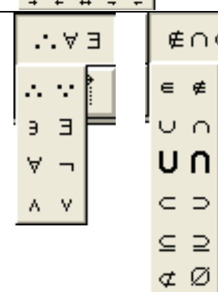
A couple of things to know: Sometimes, the program will treat an expression like a variable when you know it shouldn't. For instance, entering this integral normally gives $\int arc\csc xdx$. (Don't worry now about what it means. What you need to know is that the part after the squiggly sign should look like "arccsc x dx" — with no italics on the first part, and a space between x and dx. To fix that, select the "arccsc" part, and choose Function from the Style menu. That will remove the automatic italics. You can insert a space not, as you would expect, by just typing the space key (fooled you!), but choosing a space in the  menu. If you just try a space in Math style, the program will beep at you, indicating that it thinks it's smarter than you are in matters of mathematical typesetting. And to be fair, that's generally true. Here's how the integral should look: $\int \operatorname{arccsc} x \, dx$.

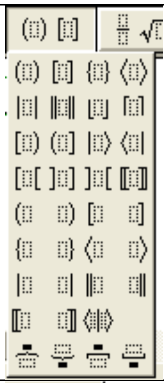
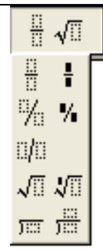
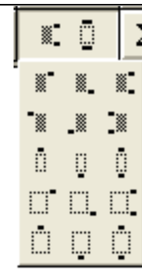
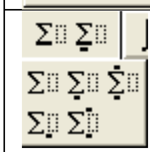
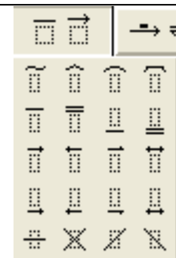
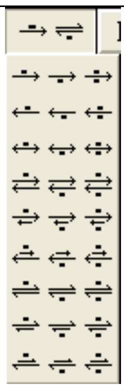
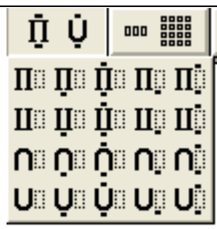
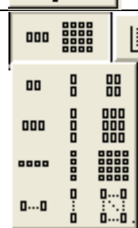
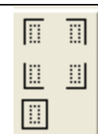
Secondly, there's another oddity about integrals (a calculus thing, for those of you who still haven't figured out when you're going to run into them). Compare these two expressions:

$$\textstyle\int_{-1}^{2} \frac{3x}{x^2+3} dx \quad \text{and} \quad \displaystyle\int_{-1}^{2} \frac{3x}{x^2+3} dx.$$

See how the second one looks better? MathType doesn't automatically use an expanding integral sign, while parentheses, brackets, and so on, all adjust size automatically. To get the second one, hold down the Shift key while clicking on the menu and selecting the integral (the one with little black rectangles where you see the numbers in mine). That makes it adjust to fit what you type.

MathType's symbol and template menus, with some comments:

| | | |
|---|---|---|
|  Note that $\prec$ and $\succ$ are not > and <. The latter pair is on the keyboard. Of the computer. On the comma and period keys. |  For changing spacing and making dots. |  Some of the things on this menu are not available in Lite mode. You can tell when the cursor changes as you hover over them. I never use those. |
|  This is where the multiplication symbols are found. For a multiplication dot, you want the smallest one. The open circle you see here is not the degree sign. That's a few menus down. |  This is where to find the implication arrow (⇒) and function mapping symbol (↦). |  Logical operators and set symbols. |
|  This is the menu with the degree sign, doublestruck set names, and the angle symbol from geometry. |  Lowercase pi ($\pi$), theta ($\theta$), alpha ($\alpha$), beta ($\beta$), phi ($\phi$), sigma ($\sigma$), and omega ($\omega$) are all here. |  Upper case Greek letters. The Δ (delta) is also useful as a triangle symbol. |

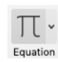
| | | |
|---|---|---|
|  This is where you'll find parentheses, brackets, and absolute value signs that expand to hold what you type, as well as one-sided versions of those. |  The first one is a regular fraction and the second is a smaller fraction. Remember that slanted fractions are evil, and don't use them. Also, you have the square root sign as well as a template that lets you put in a different index to tell which root. |  The very first one is for superscripts. The one that you want for the limit I typed in my examples is in the middle of the third row. The ones with bigger boxes make the text in them bigger, too. |
|  These are summations. The little black boxes are places you can type additional small text. |  Remember that to get one of the integral (curvy S) signs that expands with what you type, you have to hold down the shift key while selecting from this menu. |  The lowered bar on a single character (see #16) is in the first row, not here. These are used to put more than one character in a box. |
|   The arrows here look like they belong in ChemistryType, not MathType. |  These are good for matrices, but equally excellent for aligning things evenly, as in the absolute value (piecewise function) example at the beginning. |  These make borders on various sides; they could be used to make things like times-tables. |

Some of the most commonly used things have easy-to-use keyboard shortcuts. The ones I use the most are Ctrl-F for a fraction, Ctrl-R for a radical, and Ctrl-H for superscript (up High) — note that on a Mac, this last one is ⌘E for exponent (as the system command ⌘H hides the current program).

If you're interested in investigating what some of these symbols mean, a good place to start would be [http://en.wikipedia.org/wiki/List_of_mathematical_symbols](http://en.wikipedia.org/wiki/List_of_mathematical_symbols).

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

I've already indicated that this is not my favorite tool, but I've spent far too long looking into alternatives that never seem to be the right thing. I'm willing to concede, for now, that many of you are going to need to use it.

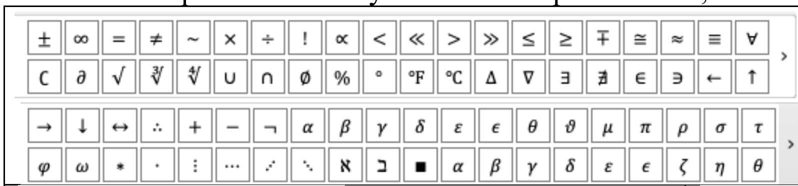
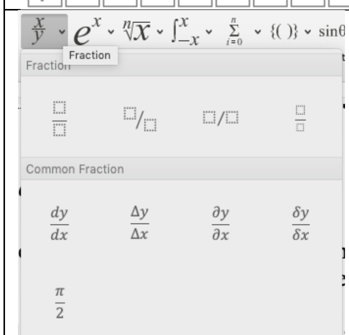
The screen shots in this section are from a Mac, but I think you'll find that the Windows version is similar enough that you'll be able to follow on a school laptop. To insert a new expression, go to the Insert tab. On the right end, the Equation icon is both a button to click (easiest) and a drop-down menu to choose some expressions that someone thought were going to get a lot of use. Just click the big 

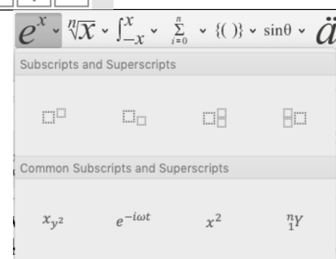
button. You will be presented with an Equation editor object like this: 

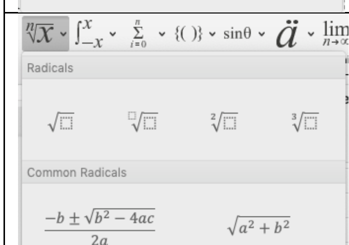
. You will also see that the Equation tab appears and is active. That looks like this:

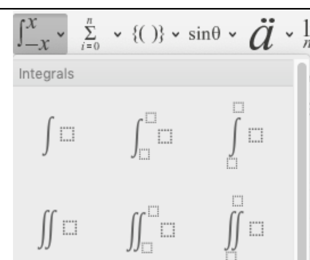

You can find not only the symbols immediately visible on the left, but also a few more screens of those by either scrolling to the right with the > or hovering above the characters and clicking on the ∨ to get a scrolling list.

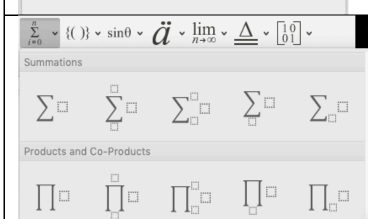
Microsoft's Equation Editor symbol and template menus, with some comments:

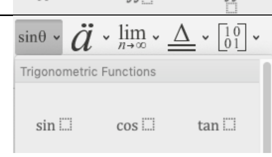
<table>
<tr><td colspan="2"> Most of the symbols you are likely to need will be in these first two screens. The capital delta (Δ) and the symbols for various sets are a little farther along.</td></tr>
<tr><td>

The first fraction template is going to be the best one in almost every circumstance. Don't use slanted fractions when you're typing math. It looks unprofessional.</td><td>

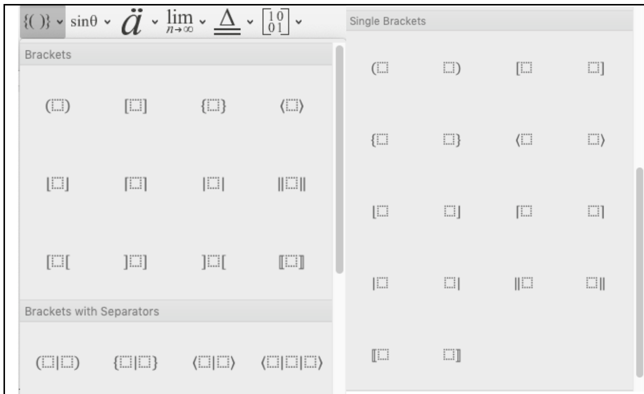
When you select these, you get boxes to type in. I find it annoying that the cursor never seems to end up where I want it. You can use the arrow keys on the keyboard to select the correct box to type in.</td></tr>
<tr><td>

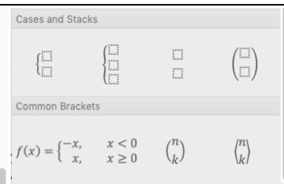
I cannot explain the presence of a radical with an index of 2. Who does that?</td><td>

This is where I stop showing everything in the template menus. You're not going to need anything beyond the first row for this course.</td></tr>
<tr><td>

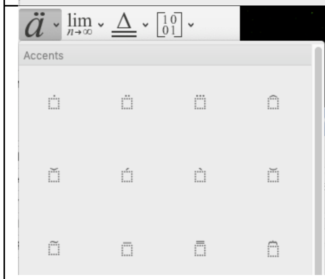
Similarly here, only the first row is likely to be useful to you in high school.</td><td>

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 program recognizes that as a function name and removes the italics.</td></tr>
</table>



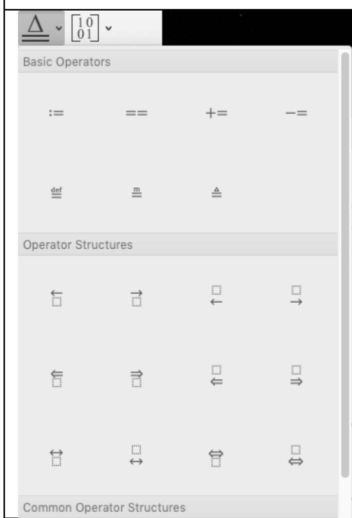




The parentheses and vertical bars in the first section will get larger to hold contents with fractions and superscripts. The "single brackets" section is where you find the one-sided { for piecewise functions.

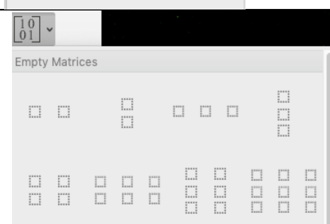



The overbar in the third row is useful.


The limit symbol is here.




You can find arrows to go over vectors and lines in this menu.



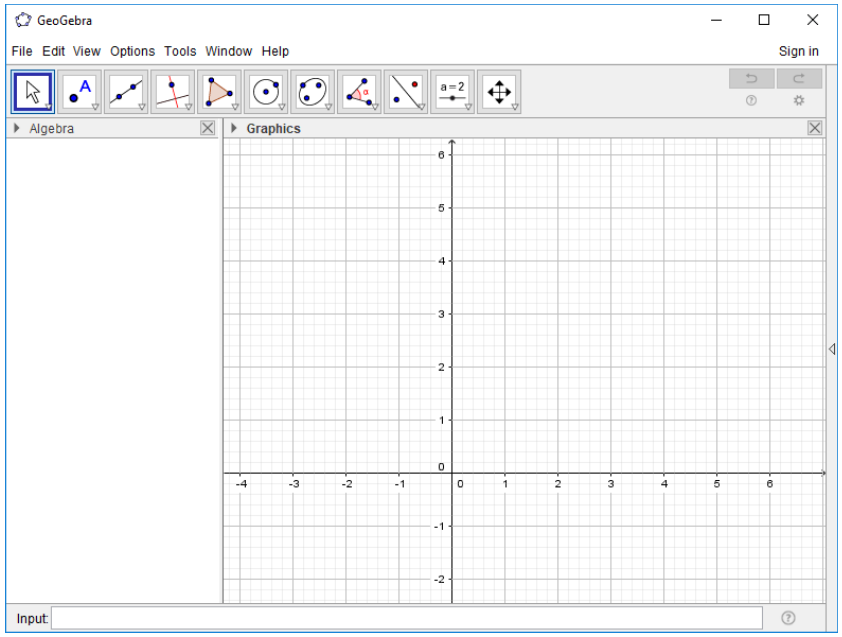

This is how I spaced the contents of the definition of absolute value on the first page.

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.

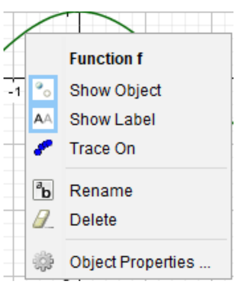
I have not spent a lot of time using this product, and I'm sure that if I had, I would have more advice for you. Feel free to point out things you discover. Perhaps I will add more to this document and update it online for you.

## *GeoGebra: Graphs and so much more*

GeoGebra (http://www.geogebra.org/download; I prefer the version called Classic 5, and that's what has been used to prepare this file) is a free program that can be run as an applet in a browser window or as a separate application of its own on several different platforms. It is under continuous development by Markus Hohenwarter 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.




When you first open GeoGebra, you get a window like the one shown here. To graph a function, type it in the Input: field at the bottom. 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. Use parentheses carefully, just like you have to on a calculator. You can give it a name, like $f(x)$, start with "$y =$," or just type the expression you want to graph and a name will be assigned automatically. Once you've entered the expression, hit the enter key to see the graph. To graph another function along with the first, repeat the process.[1]




Right-clicking is really important in this program. For instance, right-clicking on a graph and choosing Object Properties… will allow you to change the color and thickness of the graph, including its name and formula. If you choose Show Label, the default is just the name of the function (like $f$), but in Object Properties, you can 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 are allow for quite powerful control of objects.


There are traditional menus (File, Edit, etc.) at the top, but the buttons under those in the toolbar act as tool menus, too. Click on an arrow in the bottom right corner to see the choices you get. For graphing purposes, you will mainly want the first one with the white arrow which represents the Move tool and the last one with the axes that has the Move Graphics View, Zoom In, and Zoom Out tools. Holding down the Shift key also let you move the graphics view around. The escape key switches to the Move tool.

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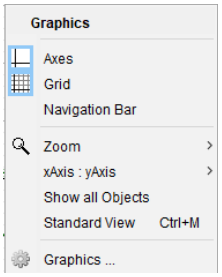
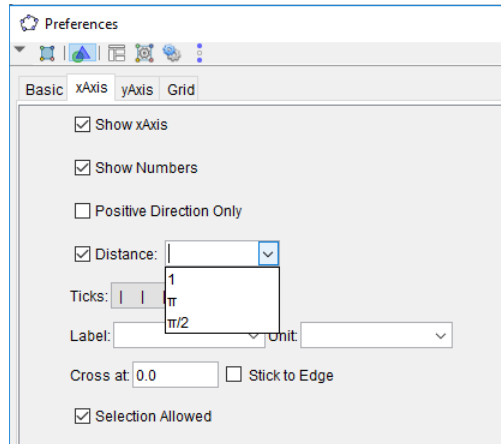
[1] *For a list of the special functions that GeoGebra knows and how to enter them, see* *http://wiki.geogebra.org/en/Predefined_Functions_and_Operators*.

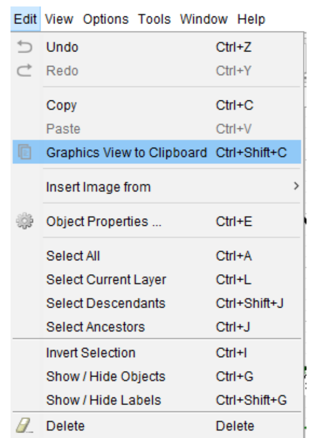



To set up the graphing window, right-click in a blank area of the graph. You can turn the grid on or off here, and Graphics… lets you type in maximum and minimum values for each axis. The separate xAxis and yAxis tabs there are where you can have the tick marks in terms of $\pi$ or $\frac{\pi}{2}$ if 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. Save Settings will let you see the changes without closing the settings window to see if you've gotten the effect you want. 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^2y + y^2x = 1 by typing it in the entry line.




As you might expect, it is important to save your work. If you save the GeoGebra file, you can open it up later to tweak your graph. If you are using a school computer, save it to OneDrive or your own flash drive. You can also choose to show or hide individual curves by clicking on the little circles to the left of their equations.

Getting a graph into a word processing document is simple. With the graph displayed as you like it on screen (you can resize the window, too), choose Graphics View to Clipboard in the Edit menu. Then paste it into your document. You can resize it by dragging a corner. That's generally a good idea, because huge computer-generated graphs are rarely worth that much space. You can type around the graph, as I have done with the pictures in this document, by right-clicking on the picture, and choosing Tight, Square, or something else from the Text Wrapping menu (this is in Word, mind you). Then you can drag the graph wherever you'd like it to be. You may need to make the font size larger in the Options menu to make things easier to read; unfortunately, that also makes it larger everywhere. You'll see what I mean if you try it.




You can customize your graphs a lot, but 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, the computer is just a bigger and possibly more colorful 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. You may choose whatever colors you like on the graphs as long as they remain readable. **Your goal is to have your work look as much like mine as possible**; pay attention to detail. I have used MathType, so there will be some unavoidable differences if you use Word's built-in equation editor. That's not a problem. The assignment counts 50 points.

Begin by opening a new Microsoft Word for Windows or Pages for Mac document and typing Geometry:, followed by the number of the first item and the words that follow. Then insert an equation, either in MathType or in the Word equation editor. (If you're using MathType, close the MathType window, telling it to save your work, and go on to the next one. Do not copy and paste.) If you're using a school computer, save your work to OneDrive or your own removable device (flash drive). Save early and often on any computer. You've been warned. You *cannot* use the online version of Word for this; it does not currently support any mathematical typesetting, and if you open your pretty document online, it will not show your math.

Type **everything** that follows this paragraph, making it look as much like what I have typed as you can. Pay attention to the parenthetical advice that follows some of the expressions. (If you use the Microsoft equation editor, there will be some font and spacing differences. There is no penalty for that.) The one exception is that you may use one column rather than two. You must submit your work to me electronically, on Edmodo. Find the assignment and click Turn In to upload the file. If for some reason you must choose a word processor that is neither Word nor Pages, tell me what you used in the comment box where you upload your file.

Geometry:

1. Congruent segments
   $\overline{AB} \cong \overline{BC}$
2. Similar triangles
   $\Delta JOE \sim \Delta TED$
   (That's a "similar" tilde.)
3. Angle measure
   In $\Delta ABC$, we calculated that $m\angle A = 82°$.
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
   $$\frac{x^3 + 2x^2 - 7}{(x-5)(2x+9)}$$
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 $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$.
9. Complex fraction
   $$\frac{\frac{2}{x-5} + 1}{7 - \frac{3}{x+2}}$$
10. Binomial theorem
    $$(a+b)^n = \sum_{r=0}^{n} \binom{n}{r} a^{n-r} b^r;\ a,b \in \mathbb{R};\ n,r \in \mathbb{Z}^+$$

Probability and Statistics:

11. Probability of occurrence of either of two events
    $$p(A \cup B) = p(A) + p(B) - p(A \cap B)$$
12. Conditional probability
    $$p(A \mid B) = \frac{p(A \cap B)}{p(B)}$$
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.)

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

$\lim\limits_{x\to\infty}\frac{1}{x} = 0$

17. Derivative

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

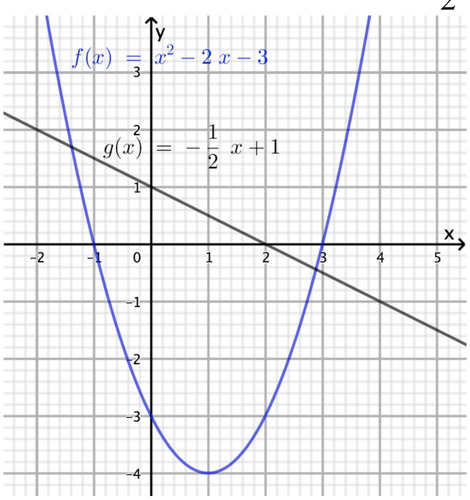
18. Integral

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

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

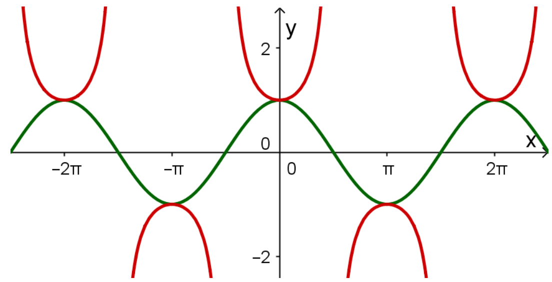
Graphing:

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



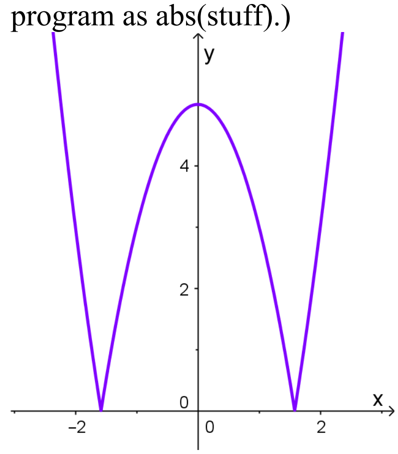

(Be sure to type the equations for the functions along with the graphs here. Also pay attention to the details shown in the graphs. I will.)

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 the graphing program 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).)