




Typing Math

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 to produce professional-quality results (some professionals actually *use* this program). That's followed by a primer on producing good graphs with Winplot. 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 several examples of incorrectly and correctly typeset mathematical expressions.

Incorrect	Correct	Comments
$y = -(x-2)^4 + 1$	$y = -(x - 2)^4 + 1$	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 should be italicized, in general, as should the names of points and constants like e and π . Finally, a minus sign (or negative sign, depending on the context) is not just a hyphen, it's an en dash, which is longer. I got the π from the Insert Symbol command in MS Word (although it is also the lower-case p in the Symbol font) and the en dash by typing control-minus (the minus on the number keypad). Important: The MathType program takes care of the italics and the longer minus sign for you. You just type, and it handles that formatting.
$\sqrt{(\sin x)/(1+x^2)}$	$\frac{\sqrt{\sin x}}{1+x^2}$	Beautiful by comparison, don't you think? This one I did in MathType. It handles the fraction, the radical, and the italics all at once. (And slanted fractions are evil.)
$f(-x ^2) = f(x^2)$	$f(-x ^2) = f(x^2)$	Notice here how MathType lets me have parentheses and vertical bars that grow with the expression inside. You don't get that 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. MathType does that automatically, but if you are typing “regular” text, you have to do it yourself.
$ x = \begin{cases} x, & \text{if } x \geq 0 \\ -x, & \text{if } x < 0 \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 function. The second is how it ought to look. It uses a 2x2 grid to <u>organize</u> the parts of the piecewise function; this is found in the  menu. The correct version also has a left brace that will grow to whatever height is needed, automatically, from 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 “implies” arrow comes from the Symbol font, and I got it from the Insert Symbol command in Word. The \pm character is in all ordinary fonts (Alt-0177), but I also located it in the same dialog. (If you have a Mac instead, it's just shift-option-+) Incidentally, I type the italics and superscript on the fly, rather than going into MathType, because it's faster for me. If you feel more comfortable doing all of the formulas in the separate program, that's fine, too. But <i>beware!</i> You will have a much simpler time doing this if you type text as text in your word processor, and then choose Insert Equation whenever you need to use something from MathType. Just keeping MathType open and copying and pasting from there seems to cause crashing problems. I don't know why, but the program just behaves much better when used in the insert mode.

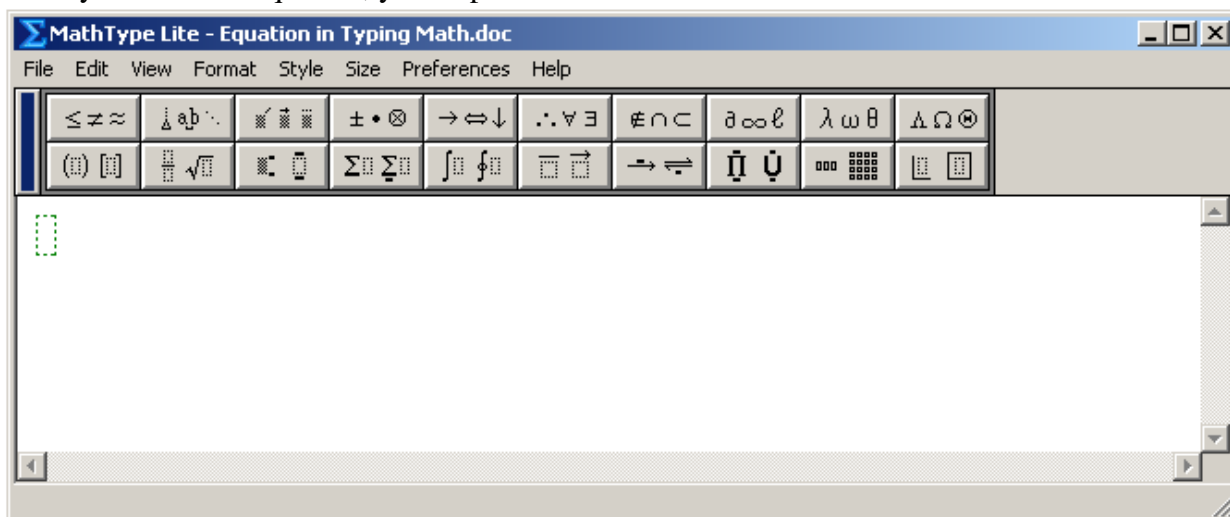
2.3×10^{-5}	2.3×10^{-5}	The \times is from the Symbol font, and I used a correct negative sign. Use of x italicized for times not only looks funny, it's just plain wrong.
$h(x) = 2x^2/(x^2 - 9)$	$h(x) = \frac{2x^2}{x^2 - 9}$	This one wasn't completely wrong to begin with, just not easy to read. Avoid the use of slanted fractions when there is more than one term in <i>either</i> the numerator or denominator. They require very careful use of parentheses, and even then can be hard to follow. (If you have trouble remembering this advice, you can simplify it to the mantra, "Slanted fractions are evil. Slanted fractions are eeeeevil.")
$\lim_{x \rightarrow 0} [(\sin x)/x]$	$\lim_{x \rightarrow 0} \frac{\sin x}{x}$	Again, a decent attempt, but look how it ought to be. MathType has a command in the  menu that lets you put the $x \rightarrow 0$ part right under the limit. And the fraction doesn't require lots of grouping to look right.

MathType: Using the program

First of all, MathType is a commercial program, but you can download a free 30-day evaluation copy. If, after 30 days, you don't pay for it, it reverts to a program called MathType Lite, which is the version I'm actually using to type this document. Clearly, the Lite version will do everything you need, and it's free. The URL is <http://www.mathtype.com/>. From the main page, choose **MathType** and then **Download a 30-day trial**. You can choose either Windows or Macintosh. Note that providing your e-mail address is strictly optional. It will download just fine without that information.

When you install MathType and have Microsoft Word on your computer, you automatically get buttons on a toolbar for inserting equations. It's a blue Σ sign. After it reverts to the free version, you may lose that, but it's easy to make a "watch-me" type macro to do the same thing. Without a button to click, or if you're using some other word processor, after you've installed the program, you go to the Insert menu or tab and choose Object, then MathType equation. As far as "non-Word" word processors, those will also generally behave well with MathType. I know that people always seem to have problems getting the inserted formulas to align correctly in Microsoft Works, so you're probably best off avoiding that. If that's your primary word processor, I'd suggest downloading OpenOffice (<http://openoffice.org-suite.com/index.asp>, again, completely free) to use on your home computer when you need the functionality of MathType. It actually comes with a Math program that can be used to do what MathType does, but I've never used that part myself. Mainly I use OO to open just about any word-processing file type that I run across (especially WordPerfect, which I can't get to open with Word or really anything else).

When you insert an equation, you're presented with a window more or less like this.



You type in the white 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.

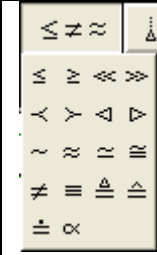
A couple of things to know: Sometimes, the program will treat an expression like a variable when you know it shouldn't. For instance, entering this integral normally gives $\int \textit{arc csc x dx}$. (Don't worry now about what it means. What you need to know is that the part after the squiggly sign *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 "arc" part, and choose Text 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 by typing Control-Space (I used two to get the separation I wanted). 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: $\int \text{arc csc } x dx$.

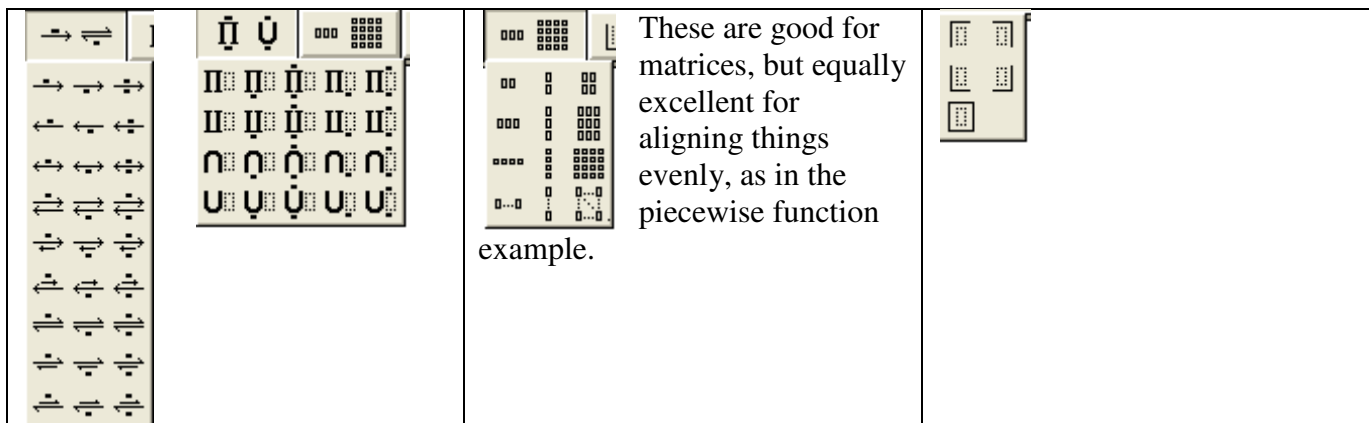
Secondly, there's another oddity about integrals (a calculus thing, for those of you who still haven't figured out when you're going to run into them). Compare these two expressions:

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

See how much better the second one looks? For reasons known only to Design Science, its publisher, 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:

	<p>Note that $<$ and $>$ are <i>not</i> $>$ and $<$. The latter pair is on the keyboard. Of the computer.</p>		<p>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.</p>
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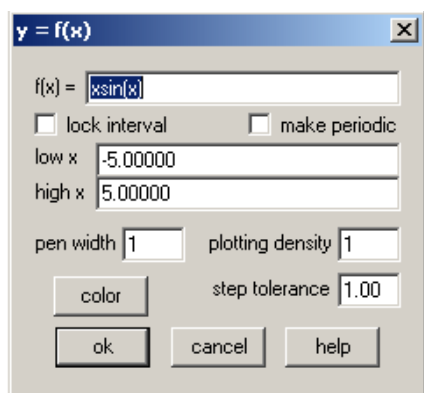
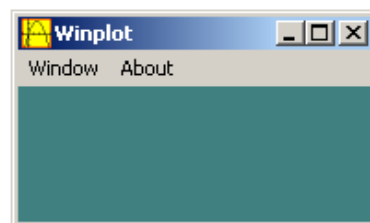


These are good for matrices, but equally excellent for aligning things evenly, as in the piecewise function example.

Winplot: Making pretty function graphs

Winplot is a free program written by Richard Parris, a math teacher at the prestigious Philips Exeter Academy in Exeter, New Hampshire. Either Exeter pays a lot better than your average high school, or Mr. Parris is a philanthropist, because he has an entire suite of free math programs that you can download and use at your leisure. All of Peanut Software (his imprint) is available at <http://math.exeter.edu/rparris/>; the link for Winplot itself is <http://math.exeter.edu/rparris/winplot.html>. You'll want to click on the very first word on that page to download the current version of the program. The version on the lab computers is not the most recent, but Parris constantly updates it on his site. As I type this, the most recent version is four days old.

When you first start up Winplot, you're presented with an unimpressive little window. Don't be fooled. From the Window menu, choose 2-dim. This will open up a grid. Then in that window, from the "Equa" menu, choose Explicit. Here's where you can enter your expression to be graphed. You enter expressions basically like you would in a calculator, with * for times, / for division, and ^ for powers. Use parentheses carefully, just like you have to on a calculator. In this window you can adjust the initial domain and the color of the curve, but there's a lot more you can do from other locations. For instance, you can set

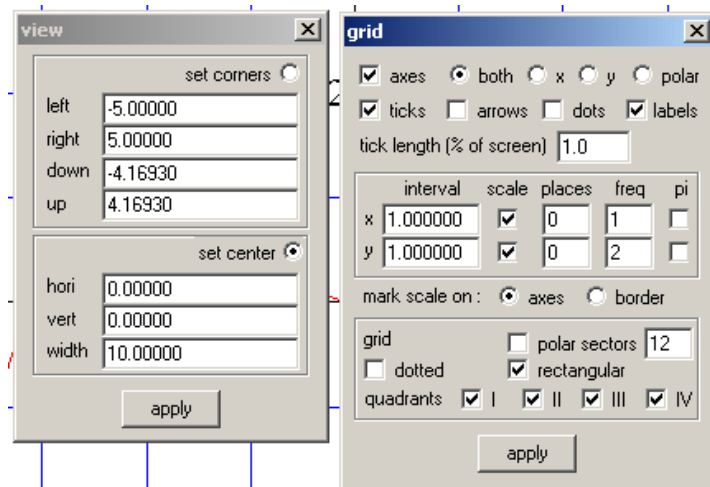


whether or not the grid shows, how often numbers are put on the axes and how they look, whether the axes should be given in terms of pi, and lots of other things. When you hit OK, you'll get the initial graph as well as a window in which you can change settings and add other graphs to the same axes. You'll probably want to experiment with some of these things. In particular, clicking on the "Equa" button in the Show portion of the box will show or hide the expression graphed, but it will look the same way it did when you typed it, not like it would if you used MathType. That's a good thing to remember when handing in work....

The most important things to know about getting a graph to look like you want are how to use the View command and how to set up the Grid. Both of these are found in the View menu of the graph itself.

First, the View. Initially, you'll probably find the radio button for "set center" turned on, which is different than what you're used to on a graphing calculator. To set the window like you would on your calculator, be sure to click in the radio button for "set corners" in addition to typing in the Xmin, Xmax, Ymin, and Ymax values in the appropriate boxes.

Then the Grid. What you see here is pretty standard. You probably want 0 in the Places boxes, since you don't generally need decimal places in axis labels (1.0, 2.0, etc.). Interval indicates how often the grid lines should be drawn, and Freq indicates how often they should have numbers by them. You can experiment by changing settings and using the apply button without actually closing the dialog. If you're graphing something trigonometric and you want axis labels in terms of pi, you have to do two things. First, you'll check the "pi" box on the x-axis. You'll also enter an interval for x in terms of pi. A common setting is "pi/2," typed that way.



There are a tremendous number of graph types that this program can handle. Of particular use to you might be the ability to have points and vertical lines plotted. They are both available from the Equa menu. Try them out yourself. The Line command will plot any line, but is particularly useful for vertical ones, since you can't solve them for y and use the standard Explicit command. To add a second curve to the same graph as the first, just choose the appropriate type from the Equa menu of the current graph. If you want a new graph entirely, you can save the current one (or not), and choose New from the File menu. If you don't choose to save it and you need to change it later, you have to start from scratch. MathType equations, on the other hand, can be double-clicked to edit later.

Getting the graphs into a word processing document is simple. With the graph displayed as you like it on screen, choose Copy to Clipboard from the File menu. It seems to work best to make the window on screen more or less the size you're going to want it in your document before copying. (On the lab computers, it may help to make the font size of the numbers on the axes bigger, too.) Then go to your word processing document and paste. There it is. You can resize it by dragging a corner. That's generally a good idea, because full-page 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.

For printing purposes, a white background is advisable. If that's not what you currently see, it can be set from the Misc, Colors, Background menu. Remember, if a graph 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 more colorful version of your graphing calculator, and the software is subject to some of the same limitations, like not always showing holes and connecting dots it shouldn't. You can restrict a function to a limited domain when entering it (or editing it) by choosing Lock Interval along with the minimum and maximum x-values you need. That allows you to get correct piecewise functions.

The Assignment

Your assignment is to reproduce the things you see here, *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, although you don't have to type the comments I typed in parentheses and you don't have to use two columns. The assignment counts 50 points.

Begin by opening a new Microsoft Word document and typing the number of the first problem and the words that follow. Then insert an equation. In general, it is *not* a good idea to do more than one equation at a time in MathType. So insert the equation, close the MathType window, and go on to the next one. *Important:* only save your work to the folder on the lab computer that's explicitly for student work or to your own removable device. If you save it anywhere else on the lab computer, your work *will* be lost when the computer is next shut down. Save early and often. You've been warned.

You will submit your work to me electronically. You can do this by e-mailing me the finished document from your own web mail or by asking me to let you save it to my flash drive in the lab.

Geometry:

1. Congruent segments
 $\overline{AB} \cong \overline{BC}$
2. Similar triangles
 $\triangle JOE \sim \triangle TED$
(On my screen that looks like a minus sign, but it's really a "similar" tilde.)
3. Angle measure
 $m\angle A = 82^\circ$
4. Perpendicularity
 $\overline{PQ} \perp \overline{EF}$
(Look closely at the arrows. The first is a double arrow for a line, and the second is a single arrow for a ray.)

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
$$\sqrt{15} \cdot \sqrt[3]{35}$$
8. Complex fraction
$$\frac{\frac{2}{x-5} + 1}{7 - \frac{3}{x+2}}$$

9. Quadratic formula

$$\text{If } ax^2 + bx + c = 0, \text{ then } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

10. Binomial theorem

$$(a + b)^n = \sum_{r=0}^n \binom{n}{r} a^{n-r} b^r, \quad a, b \in \mathbb{R}; n, r \in \mathbb{N}$$

Vectors:

11. Named with endpoints
 $\overrightarrow{AB} + \overrightarrow{BC} = \overrightarrow{AC}$
(Those are right-pointing arrows on top.)
12. Using unit vectors
$$\begin{pmatrix} -2 \\ 3 \end{pmatrix} = -2\mathbf{i} + 3\mathbf{j}$$

(There's a vector style for the bold)
13. Formula for the angle between vectors

$$\cos \theta = \frac{\mathbf{u} \cdot \mathbf{v}}{\|\mathbf{u}\| \|\mathbf{v}\|}$$

Probability and Statistics:

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

16. 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:

17. Pythagorean identity

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

18. Sum and difference identity

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

(yes, that's a minus-or-plus, rather than a plus-or-minus, on the right-hand side.)

Calculus:

19. Limit

$$\lim_{x \rightarrow \infty} \frac{1}{x} = 0$$

20. Derivative

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

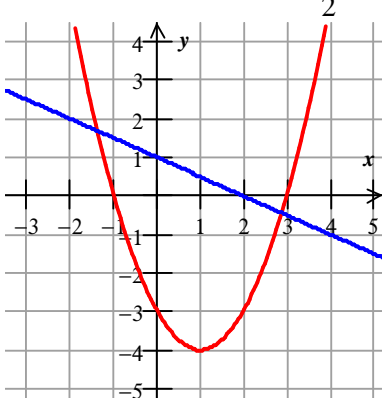
21. Integral

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

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

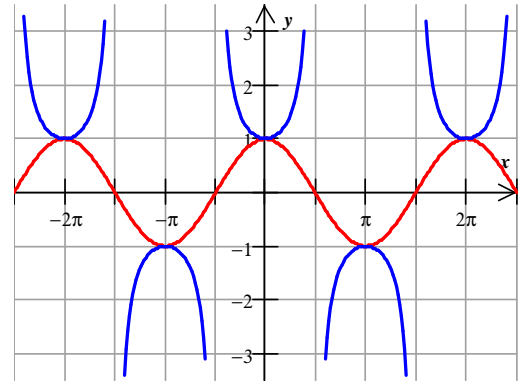
Graphing:

22. $y = x^2 - 2x - 3$ and $y = -\frac{1}{2}x + 1$



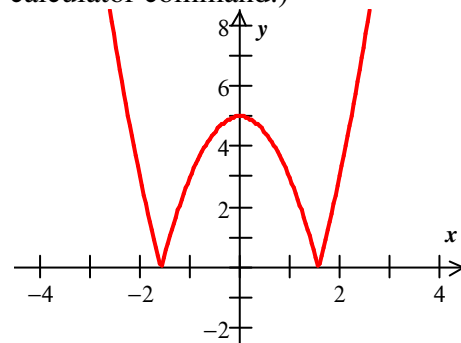
23. $y = \cos x$ and $y = \sec x$

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



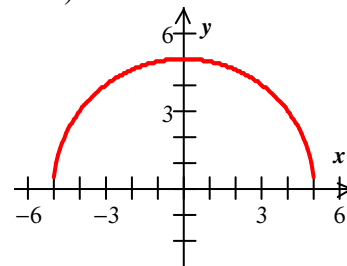
24. $y = |2x^2 - 5|$

(You type the absolute value into the graphing program as abs, just like the calculator command.)



25. $y = \sqrt{25 - x^2}$

(It's a semicircle, and should look like one.)



Once you have finished this and turned it in, go to the precalculus page of my web site, and work through the Graphing in Excel tutorial. You do not have to turn in the graph you make, but you should be able to follow all the steps. This is another skill that you will need down the road.