

**WHY MY TESTS  
WILL ALWAYS LOOK  
BETTER THAN YOURS  
(EVEN IF THE MATH ISN'T)**

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## Overall Key Ideas



- I. Keeping your hands on the keyboard is faster—learn keyboard shortcuts for things you use a lot.
- II. Find the (often somewhat hidden) actual/proper way to do what you want in Word rather than manipulating it to seem like it's doing what you want.
- III. Use MathType for text in assembled graphics because the Word text boxes don't behave well.
- IV. Use the Word drawing tools to trace/recreate graphics from elsewhere (i.e. trace over Sketchpad graphs) as imported graphics don't always look good and are harder to alter.
- V. When creating graphics in Word, it is much easier to create the graphic LARGE in a blank document and copy it over.
- VI. When creating graphics in Word, it is often helpful to draw in extra horizontal and vertical “helping” lines to help you line things up, then delete out these helping lines.

# Shortcut Keys

## General Shortcut Keys

	 Windows	 Macintosh
Cut	<b>Ctrl</b> + <b>X</b>	<b>⌘</b> + <b>X</b>
Copy	<b>Ctrl</b> + <b>C</b>	<b>⌘</b> + <b>C</b>
Paste	<b>Ctrl</b> + <b>V</b>	<b>⌘</b> + <b>V</b>
Select All	<b>Ctrl</b> + <b>A</b>	<b>⌘</b> + <b>A</b>
Undo	<b>Ctrl</b> + <b>Z</b>	<b>⌘</b> + <b>Z</b>
Redo	<b>Ctrl</b> + <b>Y</b>	<b>⌘</b> + <b>Y</b> or <b>⌘</b> + <b>⇧</b> + <b>Z</b>
Application Switching	<b>Alt</b> + <b>Tab</b> (hold <b>Alt</b> to display list of apps)	<b>⌘</b> + <b>Tab</b> (watch dock for list of apps)
Close Window	<b>Alt</b> + <b>F4</b> or <b>Ctrl</b> + <b>F4</b> (depending on context)	<b>⌘</b> + <b>W</b> (or <b>⇧</b> + <b>H</b> hides an application)
Misbehaving Programs	<b>Ctrl</b> + <b>Alt</b> + <b>Del</b> (Task Manager, “End Process”)	<b>⌘</b> + <b>Option</b> + <b>Esc</b> (“Force Quit”)

## Word Shortcut Keys

	 Windows	 Macintosh
Bold	<b>Ctrl</b> + <b>B</b>	<b>⌘</b> + <b>B</b>
Italics	<b>Ctrl</b> + <b>I</b>	<b>⌘</b> + <b>I</b>
Underline	<b>Ctrl</b> + <b>U</b>	<b>⌘</b> + <b>U</b>
Center Align	<b>Ctrl</b> + <b>E</b>	<b>⌘</b> + <b>E</b>
Hanging Indent	<b>Ctrl</b> + <b>T</b>	<b>⌘</b> + <b>T</b>
Move to Beginning of Line	<b>Home</b>	<b>Home</b>
Move to End of Line	<b>End</b>	<b>End</b>
Move Forward One Word	<b>Ctrl</b> + <b>→</b>	<b>⌘</b> + <b>→</b>
Move Back One Word	<b>Ctrl</b> + <b>←</b>	<b>⌘</b> + <b>←</b>
Move Down One Paragraph	<b>Ctrl</b> + <b>↓</b>	<b>⌘</b> + <b>↓</b>
Move Up One Paragraph	<b>Ctrl</b> + <b>↑</b>	<b>⌘</b> + <b>↑</b>
Move to Top of Document	<b>Ctrl</b> + <b>Home</b>	<b>⌘</b> + <b>Home</b>
Move to End of Document	<b>Ctrl</b> + <b>End</b>	<b>⌘</b> + <b>End</b>
New Page (not new section)	<b>Ctrl</b> + <b>Enter</b>	<b>⌘</b> + <b>Enter</b>
Page Setup	<b>Alt</b> + <b>F</b> , <b>U</b>	—

# MathType Shortcut Keys

	Windows	Macintosh
Parentheses	<b>Ctrl</b> + <b>9</b>	<b>⌘</b> + <b>9</b>
Absolute Value	<b>Ctrl</b> + <b>T</b> , <b> </b> (vertical bar)	<b>⌘</b> + <b>T</b> , <b> </b> (vertical bar)
Exponent/Superscript	<b>Ctrl</b> + <b>H</b>	<b>⌘</b> + <b>E</b>
Subscript	<b>Ctrl</b> + <b>L</b>	<b>⌘</b> + <b>L</b>
Fraction (full-size)	<b>Ctrl</b> + <b>F</b>	<b>⌘</b> + <b>F</b>
Fraction (small)	<b>Ctrl</b> + <b>T</b> , <b>⇧</b> + <b>F</b>	<b>⌘</b> + <b>T</b> , <b>⇧</b> + <b>F</b>
Square Root	<b>Ctrl</b> + <b>R</b>	<b>⌘</b> + <b>R</b>
Less Than or Equal To	<b>Ctrl</b> + <b>K</b> , <b>,</b>	<b>⌘</b> + <b>K</b> , <b>,</b>
Greater Than or Equal To	<b>Ctrl</b> + <b>K</b> , <b>.</b>	<b>⌘</b> + <b>K</b> , <b>.</b>
Not Equal	<b>Ctrl</b> + <b>K</b> , <b>+</b>	<b>⌘</b> + <b>K</b> , <b>+</b>
Approximately Equal	<b>Ctrl</b> + <b>K</b> , <b>~</b>	<b>⌘</b> + <b>K</b> , <b>~</b>
Congruent (Modulo)	<b>Ctrl</b> + <b>K</b> , <b>=</b>	<b>⌘</b> + <b>K</b> , <b>=</b>
Plus or Minus	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>=</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>=</b>
Minus or Plus	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>+</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>+</b>
Multiplication-type Dot	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>.</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>.</b>
Angle Symbol	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>A</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>A</b>
Degree Symbol	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>D</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>D</b>
Thin Space	<b>Ctrl</b> + <b>Space</b>	<b>⌘</b> + <b>Space</b>
Em Space	<b>Ctrl</b> + <b>K</b> , <b>4</b>	<b>⌘</b> + <b>K</b> , <b>4</b>
Baseline Horizontal Ellipsis	<b>Ctrl</b> + <b>.</b> , <b>_</b>	<b>⌘</b> + <b>.</b> , <b>_</b>
Centered Horizontal Ellipsis	<b>Ctrl</b> + <b>.</b> , <b>-</b>	<b>⌘</b> + <b>.</b> , <b>-</b>
Greek Letters (Uppercase)	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> , <b>⇧</b> +	<b>A</b> <b>B</b> <b>C</b> <b>D</b> <b>E</b> <b>F</b> <b>G</b> <b>H</b> <b>I</b>
	Yields	<b>A</b> <b>B</b> <b>X</b> <b>Δ</b> <b>E</b> <b>Φ</b> <b>Γ</b> <b>H</b> <b>I</b>
	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> , <b>⇧</b> +	<b>J</b> <b>K</b> <b>L</b> <b>M</b> <b>N</b> <b>O</b> <b>P</b> <b>Q</b> <b>R</b>
	Yields	<b>Θ</b> <b>K</b> <b>Λ</b> <b>M</b> <b>N</b> <b>O</b> <b>Π</b> <b>Θ</b> <b>P</b>
Greek Letters (Lowercase)	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> , <b>⇧</b> +	<b>S</b> <b>T</b> <b>U</b> <b>V</b> <b>W</b> <b>X</b> <b>Y</b> <b>Z</b>
	Yields	<b>Σ</b> <b>T</b> <b>Y</b> <b>ζ</b> <b>Ω</b> <b>Ξ</b> <b>Ψ</b> <b>Z</b>
	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> ,	<b>A</b> <b>B</b> <b>C</b> <b>D</b> <b>E</b> <b>F</b> <b>G</b> <b>H</b> <b>I</b>
	Yields	<b>α</b> <b>β</b> <b>χ</b> <b>δ</b> <b>ε</b> <b>φ</b> <b>γ</b> <b>η</b> <b>ι</b>
Greek Letters (Lowercase)	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> ,	<b>J</b> <b>K</b> <b>L</b> <b>M</b> <b>N</b> <b>O</b> <b>P</b> <b>Q</b> <b>R</b>
	Yields	<b>φ</b> <b>κ</b> <b>λ</b> <b>μ</b> <b>ν</b> <b>ο</b> <b>π</b> <b>θ</b> <b>ρ</b>
	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> ,	<b>S</b> <b>T</b> <b>U</b> <b>V</b> <b>W</b> <b>X</b> <b>Y</b> <b>Z</b>
	Yields	<b>σ</b> <b>τ</b> <b>υ</b> <b>ω</b> <b>ω</b> <b>ξ</b> <b>ψ</b> <b>ζ</b>

# The Applications

## Word

While there are some people who like using Word, I am not one of them. I have been an avid WordPerfect user since before I could write by hand, I am well aware that using  $\text{\TeX}$  and/or  $\text{\LaTeX}$  generally produces better-looking mathematics than Word with MathType, and I'm beginning to learn the virtues of Mathematica notebooks. Word has, however, become a de facto business and education standard for a variety of reasons that aren't important here. Because it is practically everywhere and practically everyone has it, using Word is a must if you are collaborating with other people. The key thing to remember is that Word didn't come to its current position as the market leader by being the best possible word processor.

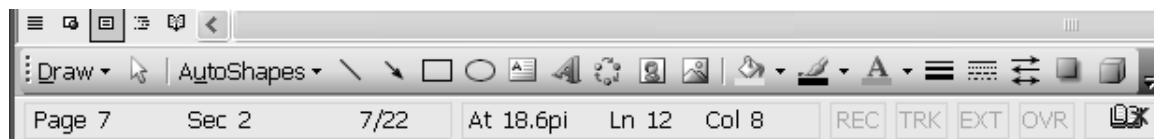
The most immediate stumbling block with Word is that there is no obvious paradigm for the mechanics of formatting a document. In a practical sense, this means that knowing how to do one formatting task doesn't generally translate into knowing how to do other, similar formatting tasks. Combined with the numerous oddities in the actual formatting techniques, the result is that most Word users develop a large set of "workarounds" to make Word do what they want. A simple example is using large numbers of spaces or extra blank lines to move text (or other things) to various locations on a page. While these workarounds get the job done at the time, they result in documents that break down or become jumbled when simple changes are made and are generally harder to maintain. To the greatest extent possible, it is important to learn how to do things the "correct" way so that the document can be modified easily later (so that when you need to change that one problem in the middle of the third page of the final exam, the whole thing doesn't disintegrate).

Broadly speaking, there are levels to the formatting of a Word document. There are things that apply to the whole document or to whole "sections" of a document, such as page layout (margins, paper orientation); there are things that apply to paragraphs, such as line spacing and indentation; and there are things that apply to individual characters, such as font settings. The settings I find myself changing most often are the margins (Word's default of  $1\frac{1}{4}$ " on the left and right is a bit overly generous and tests and quizzes often do just fine with  $\frac{1}{2}$ " or  $\frac{3}{4}$ "; the top and bottom default to 1" and can be cut down as well, but you might want to leave them at 1" if you're using a header and/or footer), tabs and indenting (I usually make these changes on the ruler at the top of the Word window), line spacing (it is often advantageous to do this in points rather than as single/double/etc., as you have more precise control), and other character formatting (beyond just bold, underline, italics, etc., small caps as well as adjusting the letter spacing, stretching or compressing the font, and other such things).

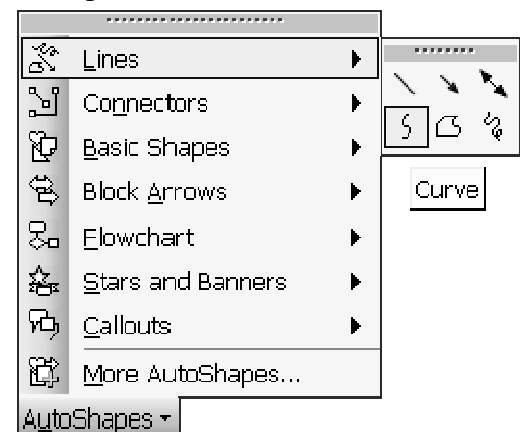
There are two primary categories of fonts, serif fonts (commonly Times/Times New Roman, Palatino, Garamond, Courier, Bookman Old Style) and sans-serif fonts (Helvetica, Arial, Verdana, Futura). Font size is generally measured in "points" (for graphic design and publishing purposes, "picas" and "points" are often the measurement of choice; there are 6 picas per inch and 12 points per pica; measurements are often given as picas and points: 4p6 would be 4 picas and 6 points or  $\frac{3}{4}$ "). The font size roughly

refers to the height of the characters, though there can be as much as 10% variance or more between different fonts at the same size (all the font names above are set at 12pt, yet show obvious size differences). While sans-serif fonts may produce clearer-looking text (a good choice for PowerPoint slides, perhaps), large amounts of text are generally easier for people to read when set in serif fonts. It is a good idea to limit the number of different fonts or variations on the font (bold, underline, italics, etc.) used in a given document and to be consistent about how particular variations are used.

One part of Word that we will be using most is the set of Word drawing tools. In the “View” menu, in the “Toolbars” submenu, check “Drawing” if it is not already checked.



On Windows machines, the toolbar often defaults to appearing at the bottom of the window. The “Draw” menu item on the toolbar contains a few key features we’ll be using—grouping and ungrouping, order modification (which objects are on top of which), and transformations (rotation/reflection). Next over is the pointer tool, useful for selecting objects and avoiding regular text. After the pointer, we have the “AutoShapes” menu, where we will find many of the specific object tools we want to use, such as the curve tool, highlighted in the screenshot at right. Continuing along the Drawing toolbar, we have the line tool, the arrow tool, the rectangle tool, the ellipse tool, the text box tool, the WordArt tool, and three buttons for inserting particular types of objects. After the dividing line, we have formatting selectors: fill color, line color, font color, line style, dash style, arrow style, shadow style, and 3-D style. Our primary tools will be the line tool and the curve tool, though we will occasionally use other shapes. While we can use the arrow tool, we will generally use the line or curve tool, then add arrow styling afterwards.

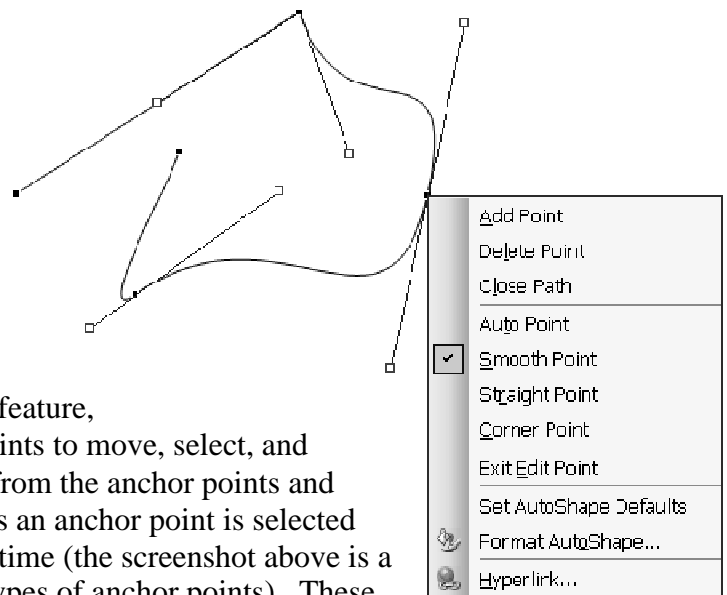


For creating a drawing of any complexity, working in a document with text or anything else just complicates the work on the drawing. It is far simpler to work in a new, blank document. With the entire page blank, we are also free to use more space if we want and we can always scale down our drawing later. When we begin to draw, newer versions of Word present us with the “Create your drawing here” annoyance shown at left—the “canvas” object. While this does actually have some advantages, we aren’t going to use it, so if it pops up, we need to make sure we don’t draw in it. We can either draw outside of it or press **Esc** to make it go away (but we will still have our current tool). Once we begin drawing, there are a few key things to



keep in mind. First, Word has an underlying grid and has a default setting of “Snap to Grid,” which causes all objects to naturally move (and be drawn) in jumps, as if every point and edge were drawn to lattice points in the plane. We can take advantage of this to help us align and uniformly space objects. When we have one or more objects selected, we can move them with the arrow keys—this will move them in uniform steps, so a counted-out number of presses of the arrow keys will yield repeatable spacing. When we want to escape the limitations of the grid, we can “nudge” objects using the arrow keys while holding down **Ctrl** (on Windows) or **⌘** (on Mac), moving them in very small increments. When we are drawing two-dimensional objects, like rectangles and ellipses, holding down **⇧** will force the aspect ratio to be 1, forming squares and circles. Holding down **⇧** while drawing a line will force it to be horizontal, vertical, or at a 45° angle. When resizing an object, **⇧** will maintain the aspect ratio of a 2-D object and maintain the direction of a line.

The curve tool is one of the most powerful tools in Word. Curves are based on anchor points and behavior at those anchor points. In the composite screenshot at right, we have a curve with five anchor points (black boxes). Once a curve is drawn (or, rather, roughed in), we can fine tune it using the “Edit Points” feature, where we are presented with the anchor points to move, select, and modify. Normally, the “handles” coming from the anchor points and ending in white boxes are not shown unless an anchor point is selected and then are only shown for one point at a time (the screenshot above is a composite of several to show the various types of anchor points). These handles, roughly speaking, determine the direction of the curve at the anchor point and how far away from the anchor point the effect lasts.



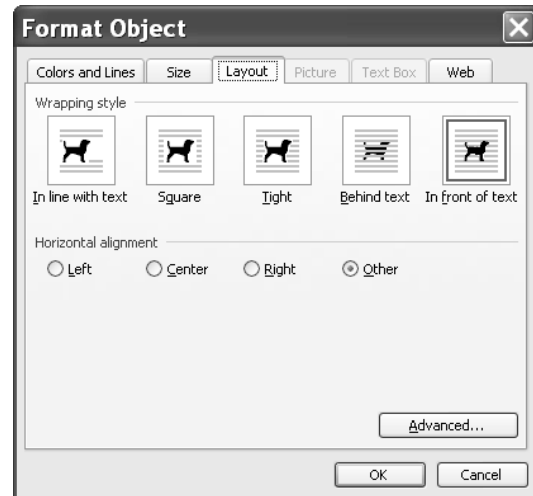
Beginning from the leftmost point and moving clockwise, the first point is an “Auto Point” and has no handle, so the behavior of the curve at that point is largely governed by the surrounding points. The segment joining that point to the second point is set as a “Straight Segment,” as opposed to the rest of the segments which are set as “Curved Segment.” The second anchor point is a “Corner Point,” so the two handles move completely independently from one another, allowing a sharp corner in the curve. The third anchor point, as shown in the menu, is a “Smooth Point,” so the handles are always the same length and in opposite directions, leading to a smooth curve. The fourth point is a “Straight Point,” similar to the “Smooth Point” but allowing the handles to have different lengths. The final point, like the first, is an “Auto Point.”

When we create a drawing composed of multiple objects, we will usually want to group those objects together so that they stay positioned properly and can be safely moved and resized. Grouping makes the collection of objects behave as a single object. For grouped objects in particular, as well as for individual objects, we will often need to format the object so that it behaves in a particular way with respect to the rest of our

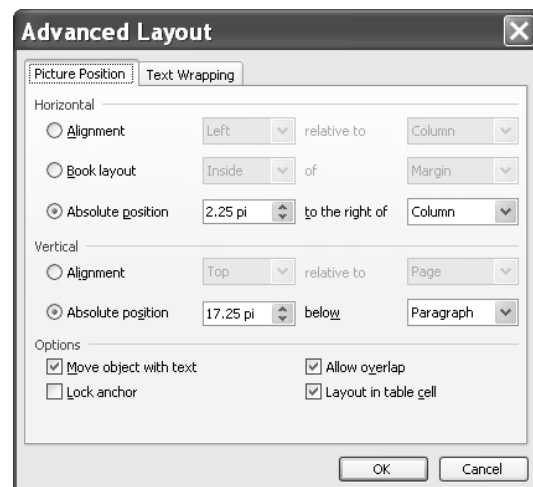
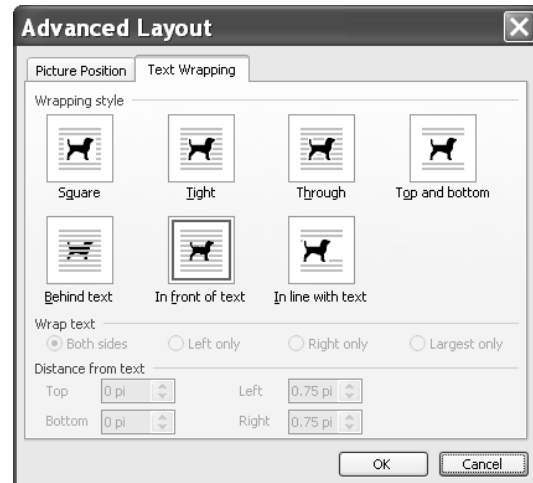
Word document. While many people place their graphics in tables to position them, it is far better to format the object so that it interacts well with the rest of your document.

Key to this is the “Layout” part of an object’s formatting. The “Layout” tab of the “Format Object” dialog is shown at right. There are five basic wrapping styles, as shown in the dialog. “In line with text” is the default, though perhaps the least useful for any large object. “Square” and “Tight” cause the object to carve out space and force the text around the object with “Square” keeping the text out of a rectangular region containing the object and “Tight” allowing the text to come closer and mold around the shape of the object. “Behind text” and “In front of text” don’t wrap the text at all; these are most useful for our intermediate work when creating drawings. From this tab, we can also set the horizontal alignment of the object.

The “Advanced” button provides a number of additional options. To begin with, the “Text Wrapping” tab gives us more wrapping options. “Through” is tighter than “Tight,” allowing the text to take up empty space nestled in the object. “Top and bottom” provides a more classical interjected figure, where text is above and below the object, but not exactly wrapped around it. For the styles that actually allow wrapping, we also have the added option of keeping the wrapped text to only one side of the object and of specifying how much space to leave between the object and the text being wrapped around it. The “Picture Position” tab gives us a number of choices as to how exactly the object will be positioned on the page. While this is a powerful feature, it is not one that we will use heavily, so I will not provide much detail on these settings except to note the “Move object with text” check box toward the bottom of the window. This is checked by default, causing objects to move up or down as you edit text around them. Most of the time, this is a good behavior, but it can be helpful to know how to turn it off when you want an object to stay put regardless of what edits you make to the surrounding text.



From this tab, we can also set the



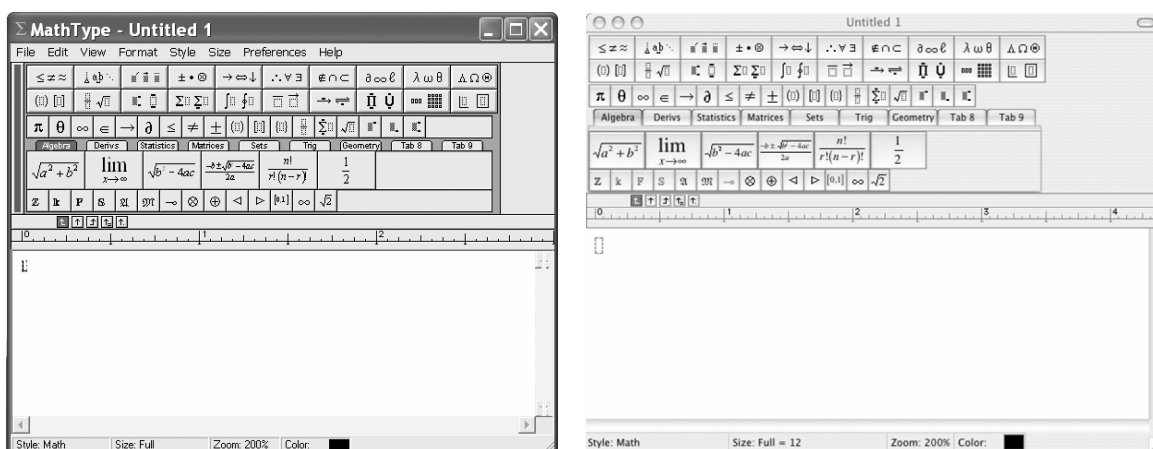
While Word has a “Text box” tool, we will avoid it entirely. The default settings for a text box include a border, a white background (that covers other objects), and a fairly large internal margin. These are all fixable, but there is a more fundamental flaw: though you can resize text boxes (particularly when they are grouped with other objects), the text inside them will not scale with the box, nor will the margins scale. The result is that if you use a text box grouped with other objects and attempt to resize the grouped objects, the text may be cut off or vanish, generally making the drawing harder to maintain.

Fortunately, MathType allows us to type anything we could have typed into a text box and MathType objects are better behaved. By default, MathType objects are transparent and have no border. While MathType objects that are pasted in have the default layout setting of “In line with text,” this is easily fixed (setting the layout to “In front of text” allows the object to move freely and be easily placed into drawings). In fact, when we need many MathType elements in a drawing, we can duplicate a properly-formatted one and edit the contents rather than having to repeat the formatting. These MathType objects can be grouped with other drawing objects and behave just like any other drawing object. In particular, MathType objects can be resized and their contents will scale properly. Because of all these advantages, it is greatly preferable to exclusively use MathType objects for labeling drawings in Word.

## MathType

Most mathematical documents require things that cannot readily be typed directly into a word processor. As a result, we need something else to help us get mathematical expressions into our documents. While Word includes “Equation Editor” (and most other word processing programs include something similar), there is a program called “MathType” that provides much more flexibility and a nicer interface. The Equation Editor included with Word is, in fact, a simplified version of MathType, produced by the same company. Most of the techniques here and used later on apply to Equation Editor as well.

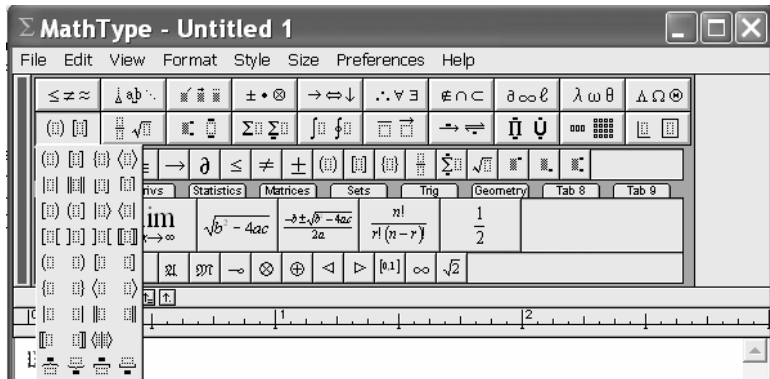
MathType generally installs some hooks into Word (i.e. toolbar, menu, etc.) to make it easier for you to insert MathType objects into Word. We will be ignoring these entirely, as they are somewhat inefficient and cumbersome to use when working on a document with many MathType objects. We want to start the MathType program running separately from Word. You can find MathType in your Start menu on Windows machines and in your Applications folder on Macs. When you start MathType, you will get an empty window, ready for input:



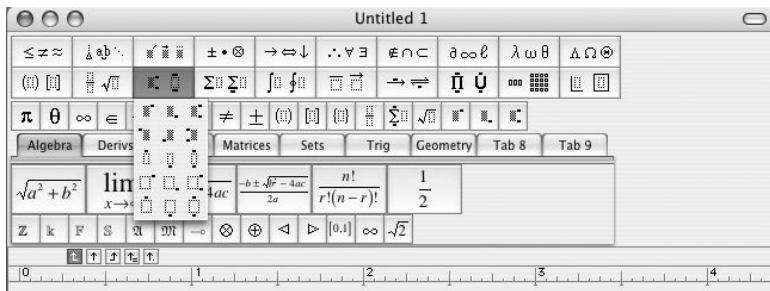
As the Mac and PC versions of MathType are virtually identical, going forward I will illustrate with screenshots from only one of the two platforms. The first two lines of buttons (below the menu bar in Windows) are the symbol and template palettes. Below the symbol and template palettes are a number of shortcut buttons that can be customized (particularly the lower tabbed area). Under all the buttons, we have the ruler (and the tab stops), and then we have our blank working area. The dashed rectangle is a common symbol to indicate an area that can or should contain something. At the bottom of the window is the status bar, which gives us information such as the current style setting, the font size setting, the current zoom, and the current color. When we work with the symbol and template palettes, the status bar will also tell us what shortcut keys can be used to access particular symbols and templates.

Some of the symbol and template palettes you are likely to use often are:

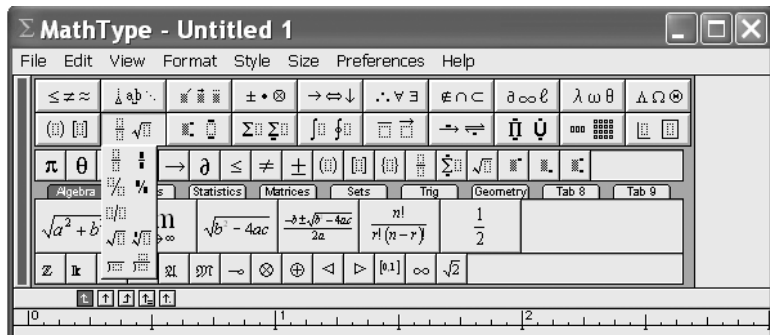
Fence Templates  
(Parentheses)



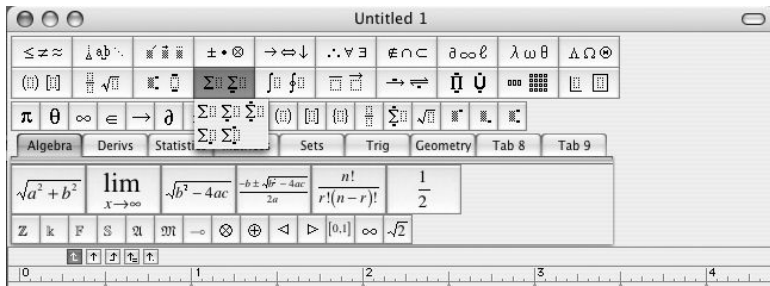
Subscript and Superscript  
Templates



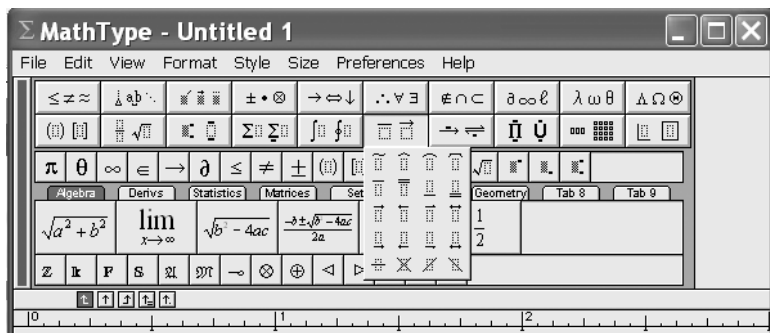
Fraction and Radical  
Templates



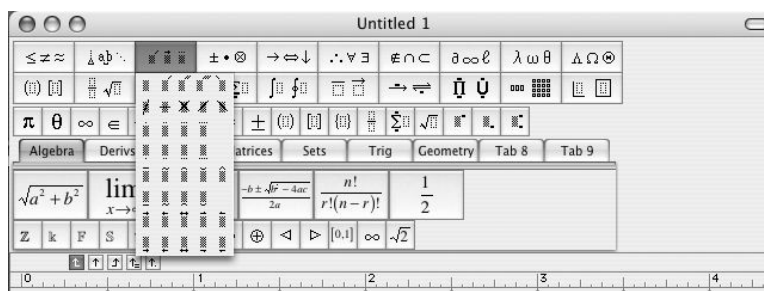
Summation Templates



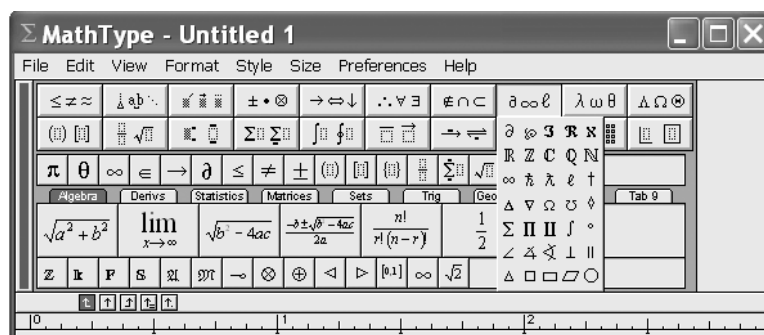
Underbar and Overbar  
Templates



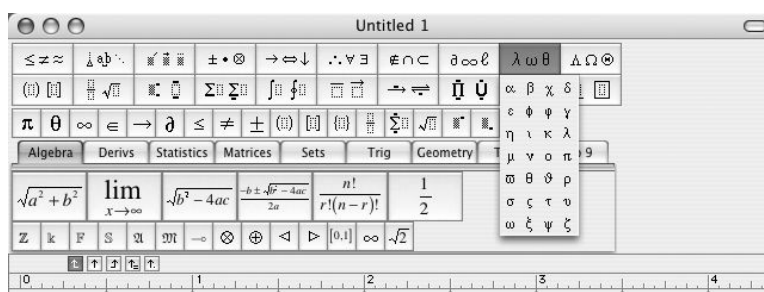
Embellishments (Small Underbar and Overbar)



Miscellaneous Symbols



Greek Characters (Lowercase)



One of the core paradigms of MathType is the nesting of templates and symbols. Each of the templates has one or more dashed boxes where that template can contain other things. For example, the standard parentheses template appears as  $(\quad)$ . As a result, most expressions consist of a number of nested templates and symbols. It is possible to have MathType show us this nesting by checking “Show Nesting” in the “View” menu. Looking at a familiar expression from the Quadratic Formula in this mode, for instance, we can see the entire expression is boxed, indicating the highest level of nesting, and within that, there is a box around the entire numerator and one around the entire denominator; within the numerator, there is another box under the radical, and the exponent on  $b$  under the radical is contained in another box. This expression is built from the fraction template and has a radical template in the numerator and inside the radical is an exponent (superscript) template.

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

When you type in MathType, you remain within the current nesting level unless you actively leave it—that is, when you use a template, you will stay in that template until you leave it (usually by pressing  $\rightarrow$ ). For example, if you were typing a general quadratic, you might type  $\boxed{A}$ ,  $\boxed{X}$ ,  $\boxed{\text{Ctrl} + \text{H}}$  (for an exponent template),  $\boxed{2}$ ,  $\boxed{+}$ ,  $\boxed{B}$ ,  $\boxed{X}$ ,

$\frac{\square}{\square}$ ,  $\square$ , but this would give  $ax^{2+bx+c}$  because you never exited the exponent template. To type the Quadratic Formula expression, you might type  $\text{Ctrl} + \text{F}$  (for a fraction template),  $\square$ ,  $\square$ ,  $\text{Ctrl} + \square + \square$ ,  $\square$  (for a plus/minus sign),  $\text{Ctrl} + \square$  (for a radical template),  $\square$ ,  $\text{Ctrl} + \square$  (for an exponent template),  $\square$ ,  $\rightarrow$  (leave the exponent),  $\square$ ,  $\square$ ,  $\square$ ,  $\square$  (moves outside the fraction template),  $\square$  (moves into the denominator of the fraction template),  $\square$ ,  $\square$ .

My preferred method of working with MathType is to have the independent MathType window open, create the object I want there, select it all and copy it, then tab into the Word document and paste it. On a PC, the maneuver to get the object into the Word document is achieved by (starting in the MathType window) typing  $\text{Ctrl} + \text{A}$ ,  $\text{Ctrl} + \text{C}$ ,  $\text{Alt} + \text{Tab}$ ,  $\text{Ctrl} + \text{V}$ . On a Mac, the same maneuver is done by  $\text{⌘} + \text{A}$ ,  $\text{⌘} + \text{C}$ ,  $\text{⌘} + \text{Tab}$ , release  $\text{⌘}$ ,  $\text{⌘} + \text{V}$ . When I work on a document this way, I begin with both Word and MathType open, start typing in Word, and when I get to a point where I need an equation, I tab over to MathType, type the equation, then bring it back into Word, where it pastes in right where I left off. In this way, my hands can stay on the keyboard throughout the entire process.

Learning the shortcut keys for the symbols and templates you use most often will also greatly increase the speed and ease with which you can create MathType objects. When you use the mouse to get a symbol or template, look in the status bar at the bottom of the window to see what the shortcut key is (if there is one). Most of the keys have been assigned fairly systematically—many involve the first letter in the name of the object, grouping symbols of various types tend to come from that symbol, ellipses come from  $\square$  followed by a key to indicate the type of ellipsis, Greek letters come from  $\square$ , followed by a key to indicate which Greek letter, many other symbols come from  $\square$  or  $\square + \square$  followed by another key to indicate which symbol.

## Sketchpad & Graphs

Sketchpad is likely the most readily available tool for graphing functions (among other things) for most teachers. While it is very flexible in many ways, the way that its graphics copy and paste into Word (at least, with the default settings) render them virtually unusable—the lines are too thin, the scale numbers are hard to read and the tick marks are hard to see, and getting exactly the part of the graph you want is difficult. These graphs do, however, provide an easy template for us to create better-looking curves using Word's drawing tools.

The “Graph” menu in Sketchpad contains the essentials we need. The “Plot New Function” item is all we'll be using, though the “Grid Form” submenu allows you to create polar graphs as well as rectangular graphs. The way in which functions are entered in Sketchpad is, unfortunately, quite a bit different than typing in MathType, but you can still see the expression in a standard, readable way as you enter it to check that you're entering what you want.

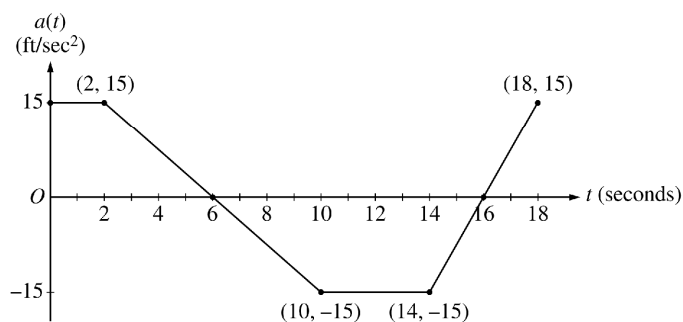
To get a graph from Sketchpad into Word, create the graph in Sketchpad (use “Plot New Function,” repeat for multiple graphs together), adjust the window and the scale (move the point at the origin and/or the point at one on the axis/axes) so that what shows in the window is what you want to copy to Word, then select only the axes and the curves you want to bring into Word and copy/paste into Word. By default, we will end up pasting an image that is formatted to be in line with text. In order to trace over it, we need to format it to be “Behind text” so that it is behind anything else we're working on and can move freely. It is generally best to create your axes before copying in the Sketchpad graph, then take the Sketchpad graph and move it into alignment with your axes. This can take several cycles through nudging it into place (matching the origins) and resizing so that the scales match (this may need to be done through the object formatting in order to get fine enough control over the size). Once the Sketchpad graph is lined up with your axes, you can use the Word drawing tools to create your graph directly on top of the Sketchpad graph, using it as a template. When you are done, select the Sketchpad graph and delete it.



# Putting It All Together

## Techniques Exemplified by Reproducing AP Calculus BC Problems

### 2001 AP<sup>®</sup> CALCULUS BC FREE-RESPONSE QUESTIONS



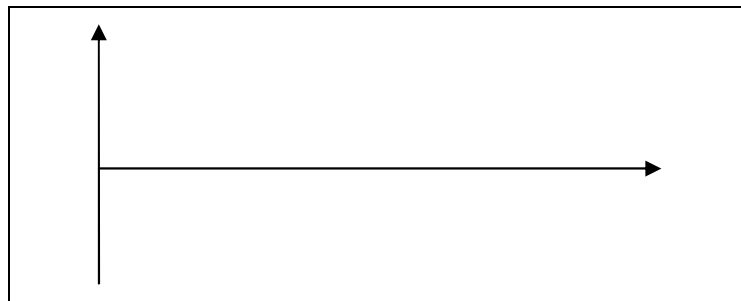
3. A car is traveling on a straight road with velocity 55 ft/sec at time  $t = 0$ . For  $0 \leq t \leq 18$  seconds, the car's acceleration  $a(t)$ , in ft/sec<sup>2</sup>, is the piecewise linear function defined by the graph above.
- Is the velocity of the car increasing at  $t = 2$  seconds? Why or why not?
  - At what time in the interval  $0 \leq t \leq 18$ , other than  $t = 0$ , is the velocity of the car 55 ft/sec? Why?
  - On the time interval  $0 \leq t \leq 18$ , what is the car's absolute maximum velocity, in ft/sec, and at what time does it occur? Justify your answer.
  - At what times in the interval  $0 \leq t \leq 18$ , if any, is the car's velocity equal to zero? Justify your answer.

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Let's begin with question 3 from the 2001 AP Calculus BC Exam. This is a fairly simple graph, so we can focus on general techniques for using Word's drawing tools to create graphs.

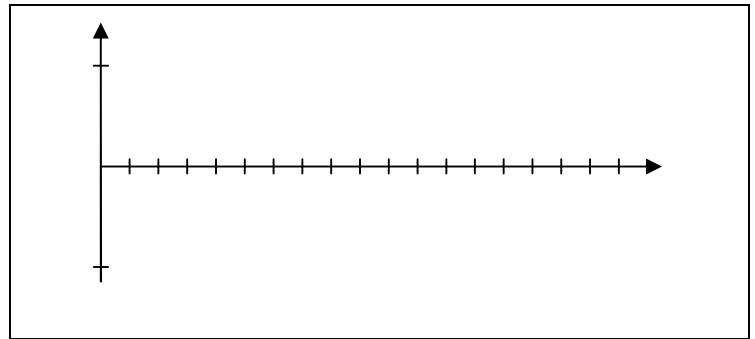
### Create the Axes.

Don't worry about length—we'll fix that when we do the tick marks. To put the arrowheads on, you may end up guessing which end is the "left" and which is the "right" (it depends on where you started and ended the line).



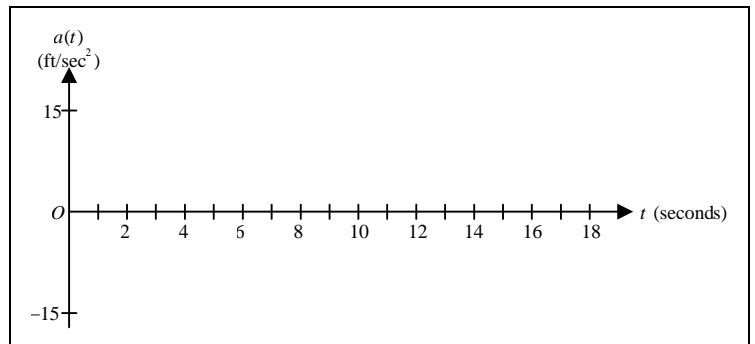
### Tick Marks.

Make a vertical segment as short as you can and position it against the axis (not across it yet). Duplicate it, put the copy directly over the original, then press  $\Rightarrow$  twice. Select both tick marks, duplicate the pair, put the new pair exactly  $2 \times \Rightarrow$  away. Repeat until you have enough tick marks, then select them all and nudge over the axis.



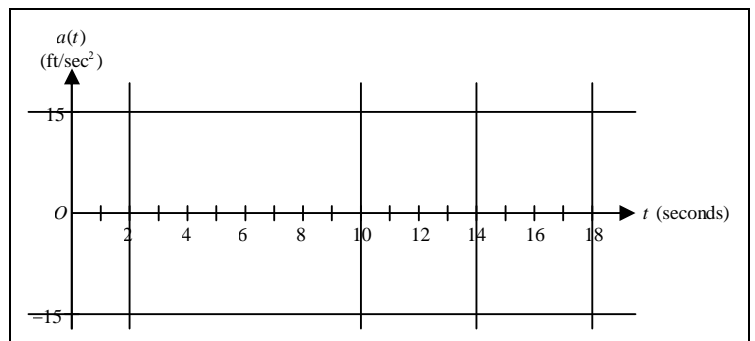
### Label the Axes.

Copy/paste in a MathType object with just an “O” for the origin. Format this MathType object to make it “In front of text” and move it to the right place. Duplicate it and edit the copies for the rest of the labels (this preserves the object formatting).



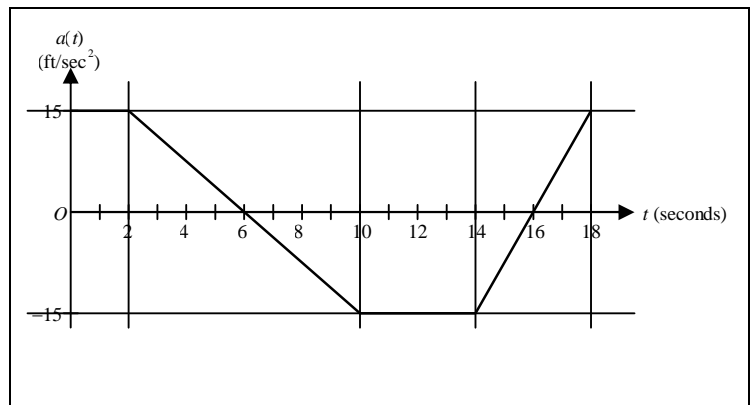
### Add Helping Lines.

Since the function passes through  $(2, 15)$ ,  $(10, -15)$ ,  $(14, -15)$ , and  $(18, 15)$ , draw in lines at  $x = 2$ ,  $x = 10$ ,  $x = 14$ ,  $x = 18$ ,  $y = 15$ , and  $y = -15$ .



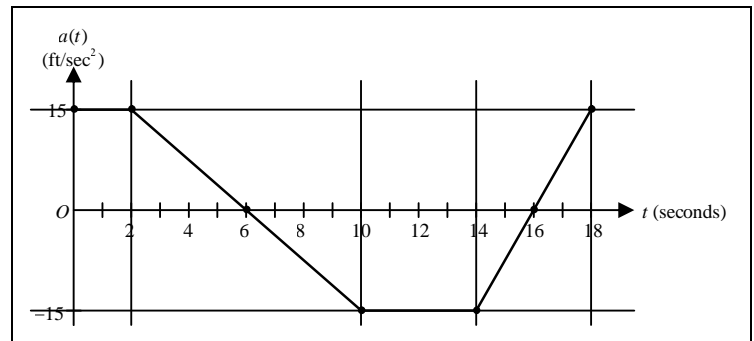
### Draw the Function.

Use the curve tool to roughly draw in the function. Single-click at the key points of the function, in sequence, double-clicking on the last point to end the curve—this creates a smooth curve that hits all the key points. Use “edit points” to change each segment to a “straight segment” (and edit points as necessary to line them up with the helping lines). Click off the curve, then reselect it and make it thicker (e.g. 1pt) to differentiate it from the axes.



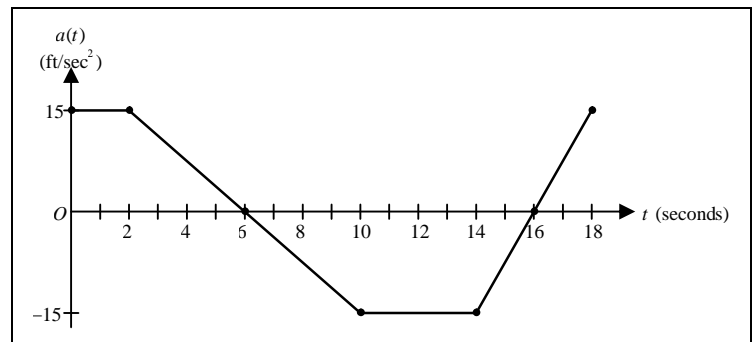
### Dots for Each Key Point.

Create a circle, then format it, changing its size to  $0.05'' \times 0.05''$  and making the fill color black. Roughly position it (probably tangent to the helping lines rather than centered over the intersection), replicate it, and position the copies similarly. Select all the dots together and nudge them all into place.



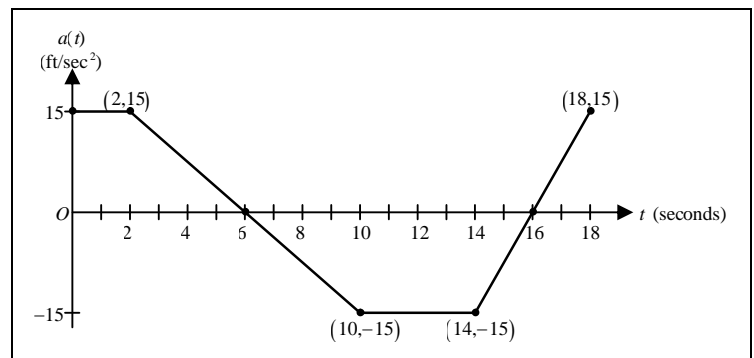
### Remove the Helping Lines.

If you try selecting more than one at a time, be careful not to delete anything else.

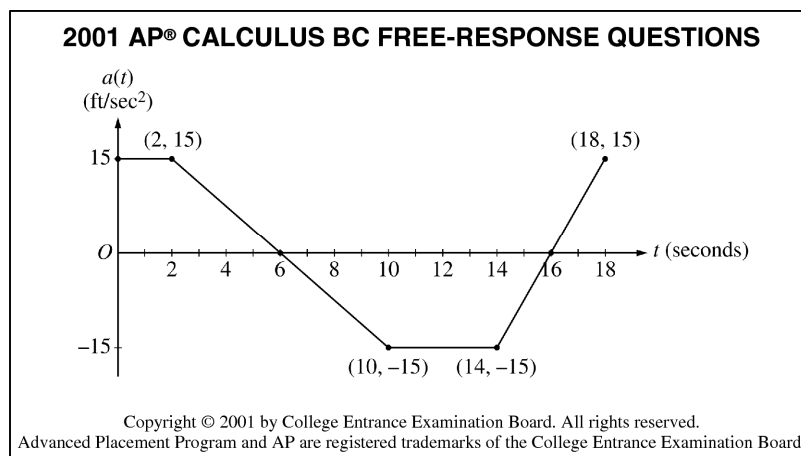


### Label the Points.

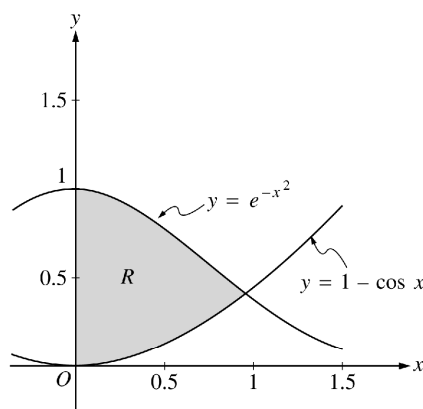
Replicate one of the existing MathType labels (to get the object formatting), and edit and position the copies to label the points.



For comparison, here again is the graph as it appeared on the AP exam:



2000 AP® CALCULUS BC FREE-RESPONSE QUESTIONS



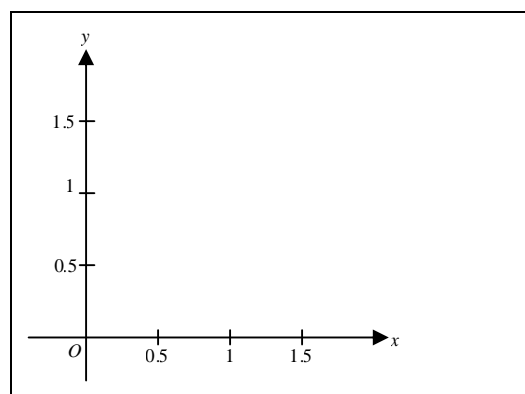
1. Let  $R$  be the shaded region in the first quadrant enclosed by the graphs of  $y = e^{-x^2}$ ,  $y = 1 - \cos x$ , and the  $y$ -axis, as shown in the figure above.
  - (a) Find the area of the region  $R$ .
  - (b) Find the volume of the solid generated when the region  $R$  is revolved about the  $x$ -axis.
  - (c) The region  $R$  is the base of a solid. For this solid, each cross section perpendicular to the  $x$ -axis is a square. Find the volume of this solid.

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Now that we've put together a graph, let's try question 1 from the 2000 AP Calculus BC Exam. Here, we have a few challenges we didn't have in the previous example. First, and most importantly, we have curved graphs and they are specific functions so they should have a specific shape. Second, we have a shaded region. The focus of this example is on using a Sketchpad graph as a template and tracing over the graph with the curve tool, then using the curve tool again to create the shaded region.

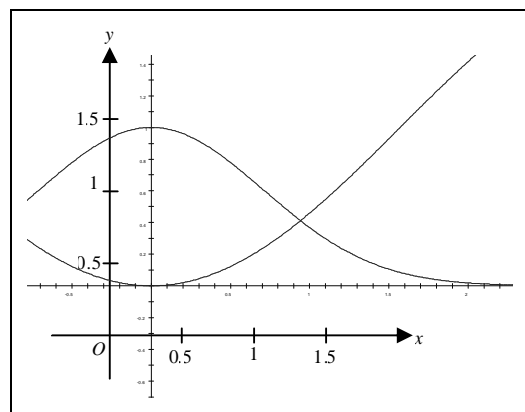
**Create Axes, Place Tick Marks and Labels.**

Same ideas as before—use  $\rightarrow$  (count how many times) to space the tick marks equally. Use MathType objects for the labels, formatting them to be “In front of text.”



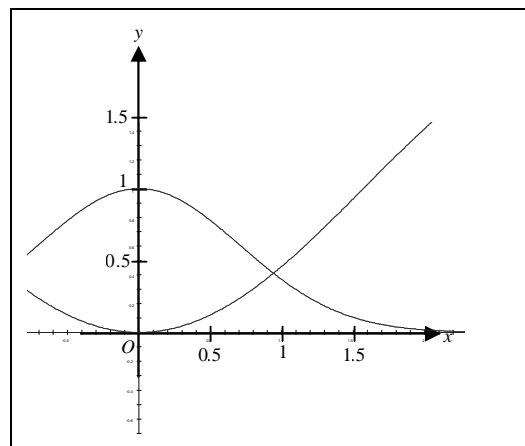
### Use Sketchpad to Graph the Functions, Copy into Word.

Plot the functions in Sketchpad, then manipulate the graph so that the part we want fills the window (roughly). Select the axes and the two curves, copy/paste into Word.



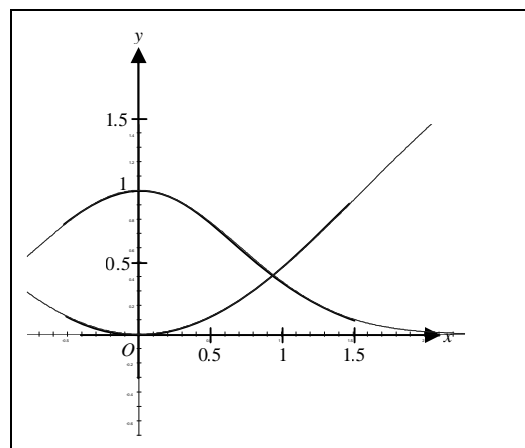
### Align the Sketchpad Graph with the Axes.

Format the object to be “Behind text” (this is different from the usual, but helpful in keeping the Sketchpad graph under our own graphics). Move it so that the axes are close to aligning and resize it so that the units match up—this may take several cycles of moving (and nudging) and resizing to get the two to match up.



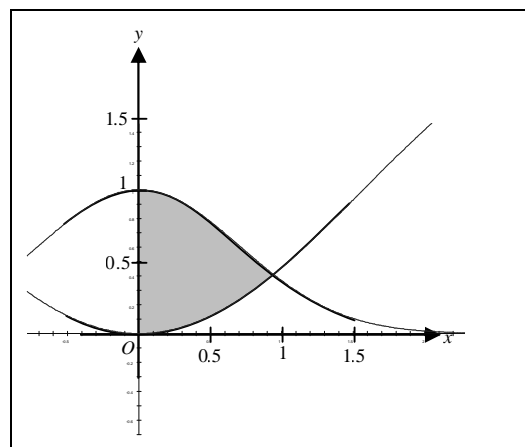
### Use the Curve Tool to Trace the Graphs.

With the curve tool, single-click at one end of the graph and double-click at the other end. This will create a straight line between the points. Now, edit the points, changing each endpoint to a “Straight Point,” moving the point as needed, and adjusting the handles on each end until the curve is exactly on top of the Sketchpad curve. Repeat for the second function.



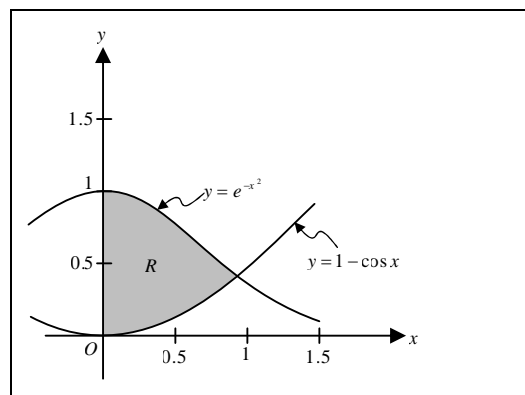
### Use the Curve Tool to Create the Shaded Region.

With the curve tool (or the closed curve tool), single-click at each vertex of the shaded region, then double-click on the initial vertex to close the region. Edit the points, changing the segments to straight or curved as appropriate, moving them as necessary, setting each point to be a “Corner Point” and adjusting the handles at each vertex until the curve is exactly on top of the Sketchpad curve. Now, format the object to have no border and be filled gray. You may also want to send it backward so that the drawn-in curves are on top of it.

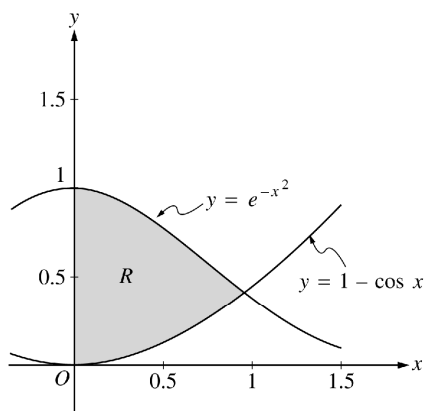


**Remove the Sketchpad Graph, Label Graphs and Region.**

Delete the Sketchpad graph since it is no longer needed. Use MathType objects to label the graphs and the region. You can create the S-curve arrows using the curve tool.

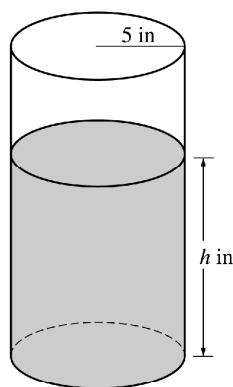


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2003 AP<sup>®</sup> CALCULUS BC FREE-RESPONSE QUESTIONS



5. A coffeepot has the shape of a cylinder with radius 5 inches, as shown in the figure above. Let  $h$  be the depth of the coffee in the pot, measured in inches, where  $h$  is a function of time  $t$ , measured in seconds. The volume  $V$  of coffee in the pot is changing at the rate of  $-5\pi\sqrt{h}$  cubic inches per second. (The volume  $V$  of a cylinder with radius  $r$  and height  $h$  is  $V = \pi r^2 h$ .)

(a) Show that  $\frac{dh}{dt} = -\frac{\sqrt{h}}{5}$ .

(b) Given that  $h = 17$  at time  $t = 0$ , solve the differential equation  $\frac{dh}{dt} = -\frac{\sqrt{h}}{5}$  for  $h$  as a function of  $t$ .

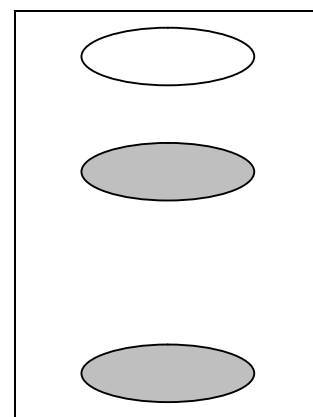
- (c) At what time  $t$  is the coffeepot empty?

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students and parents at [www.collegeboard.com/apstudents](http://www.collegeboard.com/apstudents).

In question 5 from the 2003 AP Calculus BC Exam, we have something entirely different. Rather than working on a graph, we are recreating a diagram. We will use various basic shapes to create the appearance of a three dimensional object with appropriate parts dashed and/or shaded.

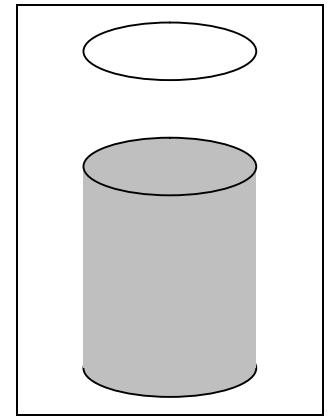
**Create Cross-Sections.**

Use the ellipse tool to draw the top of the cylinder. Duplicate it for the middle and bottom, setting the fills for those to gray and moving them into place.

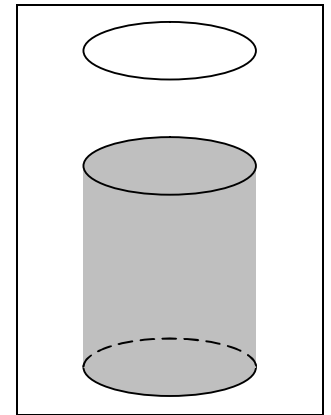


**Create the Shading.**

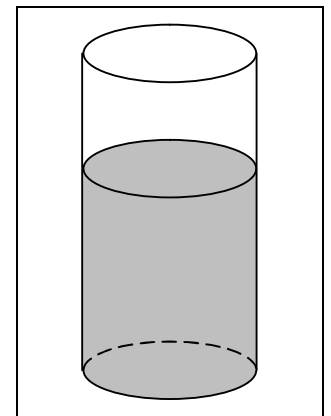
Draw a rectangle between the diameters of the middle and lower ellipses, setting the fill to gray and removing the border line. Since this covers the lower half of the middle ellipse, select that ellipse and bring it to the front (we want the rectangle to cover the upper half of the bottom ellipse).

**Draw the Dashed Half of the Bottom.**

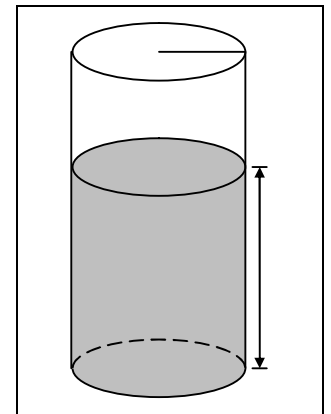
Use the arc tool, starting at the top of one of the ellipses and drawing to the right, then use the yellow diamond handle to extend the arc from the top to the left. Make the arc dashed and move it into alignment with the bottom ellipse.

**Draw the Sides.**

Use the line tool. You may need to nudge the line to get it into place.

**Draw the Measurement Lines.**

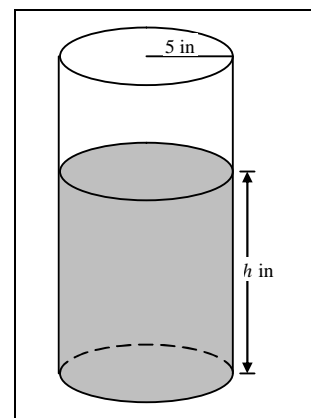
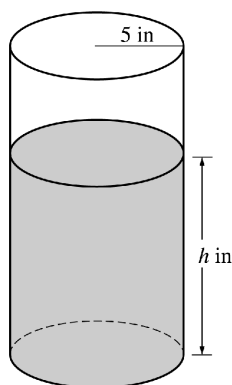
Use small segments, nudged into place, at the end of the arrows to create the proper look for the measurement along the side.





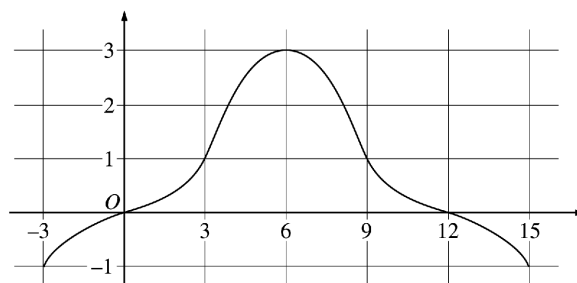
**Add Measurements.**

Use MathType objects, formatted to be “In front of text.” For the measurement that covers a measurement line, format the MathType object to have a fill color of white.

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2002 AP<sup>®</sup> CALCULUS BC FREE-RESPONSE QUESTIONS (Form B)



Graph of  $f$

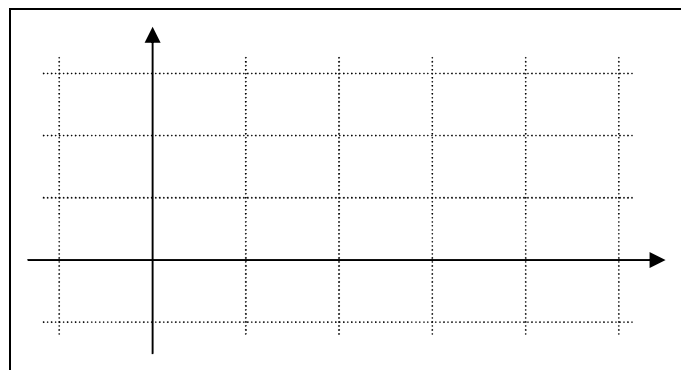
4. The graph of a differentiable function  $f$  on the closed interval  $[-3, 15]$  is shown in the figure above. The graph of  $f$  has a horizontal tangent line at  $x = 6$ . Let  $g(x) = 5 + \int_6^x f(t) dt$  for  $-3 \leq x \leq 15$ .
- Find  $g(6)$ ,  $g'(6)$ , and  $g''(6)$ .
  - On what intervals is  $g$  decreasing? Justify your answer.
  - On what intervals is the graph of  $g$  concave down? Justify your answer.
  - Find a trapezoidal approximation of  $\int_{-3}^{15} f(t) dt$  using six subintervals of length  $\Delta t = 3$ .

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With question 4 from the 2002 AP Calculus BC Exam (Form B), we return to graphs. The differences here are that we are using gridlines, we aren't given a formula, and our graph has symmetry. Because there isn't a formula, we only need to replicate the general shape, not trace a specific curve and we can take advantage of the symmetry and Word's transformational tools to simplify our work.

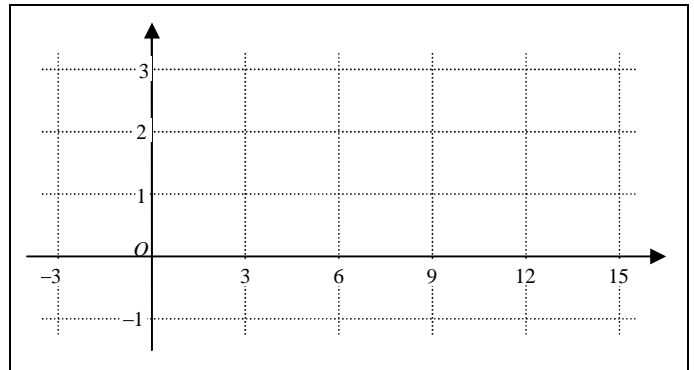
### Create Axes and Gridlines.

When drawing the gridlines, use the technique for tick marks to make the spacing equal.



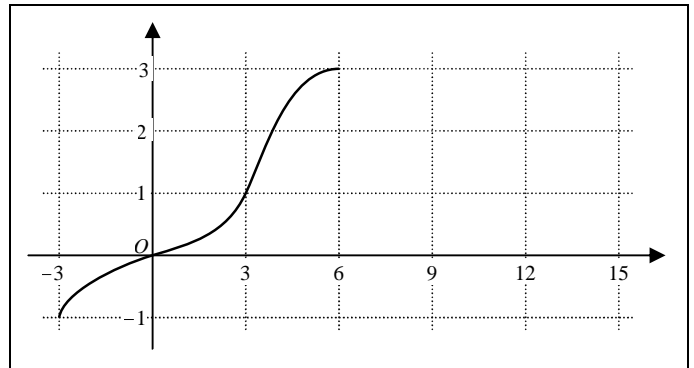
### Label the Axes.

Remember to format the MathType objects to be filled white so that they cover up the gridlines.



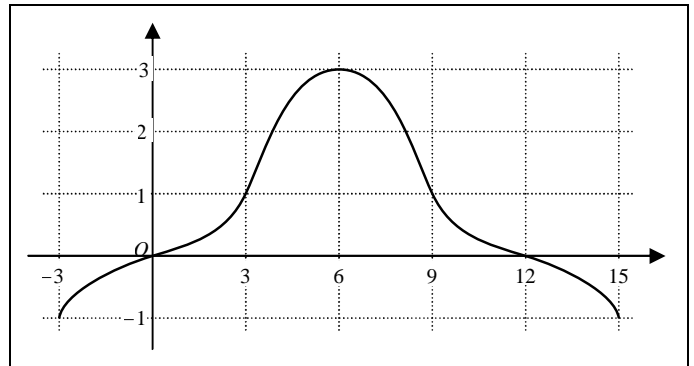
### Create Half of the Curve.

No need for helping lines since we've got the grid. Place anchor points at all four grid-intersections through which the curve passes, then set the point types (perhaps try straight or smooth) and adjust the handles until you have the appropriate shape.

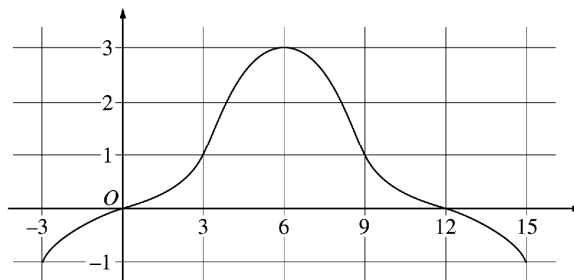


### Use Symmetry for the Other Half.

Duplicate the half just drawn, flip horizontally, and align with the first half.



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General Shortcut Keys		
	Windows	Macintosh
Cut	<b>Ctrl</b> + <b>X</b>	<b>⌘</b> + <b>X</b>
Copy	<b>Ctrl</b> + <b>C</b>	<b>⌘</b> + <b>C</b>
Paste	<b>Ctrl</b> + <b>V</b>	<b>⌘</b> + <b>V</b>
Select All	<b>Ctrl</b> + <b>A</b>	<b>⌘</b> + <b>A</b>
Undo	<b>Ctrl</b> + <b>Z</b>	<b>⌘</b> + <b>Z</b>
Redo	<b>Ctrl</b> + <b>Y</b>	<b>⌘</b> + <b>Y</b> or <b>⌘</b> + <b>⇧</b> + <b>Z</b>
Application Switching	<b>Alt</b> + <b>Tab</b> (hold <b>Alt</b> to display list of apps)	<b>⌘</b> + <b>Tab</b> (watch dock for list of apps)
Close Window	<b>Alt</b> + <b>F4</b> or <b>Ctrl</b> + <b>F4</b> (depending on context)	<b>⌘</b> + <b>W</b> (or <b>⌘</b> + <b>H</b> hides an application)
Misbehaving Programs	<b>Ctrl</b> + <b>Alt</b> + <b>Del</b> (Task Manager, “End Process”)	<b>⌘</b> + <b>Option</b> + <b>Esc</b> (“Force Quit”)

Word Shortcut Keys		
	Windows	Macintosh
Bold	<b>Ctrl</b> + <b>B</b>	<b>⌘</b> + <b>B</b>
Italics	<b>Ctrl</b> + <b>I</b>	<b>⌘</b> + <b>I</b>
Underline	<b>Ctrl</b> + <b>U</b>	<b>⌘</b> + <b>U</b>
Center Align	<b>Ctrl</b> + <b>E</b>	<b>⌘</b> + <b>E</b>
Hanging Indent	<b>Ctrl</b> + <b>T</b>	<b>⌘</b> + <b>T</b>
Move to Beginning of Line	<b>Home</b>	<b>Home</b>
Move to End of Line	<b>End</b>	<b>End</b>
Move Forward One Word	<b>Ctrl</b> + <b>→</b>	<b>⌘</b> + <b>→</b>
Move Back One Word	<b>Ctrl</b> + <b>←</b>	<b>⌘</b> + <b>←</b>
Move Down One Paragraph	<b>Ctrl</b> + <b>↓</b>	<b>⌘</b> + <b>↓</b>
Move Up One Paragraph	<b>Ctrl</b> + <b>↑</b>	<b>⌘</b> + <b>↑</b>
Move to Top of Document	<b>Ctrl</b> + <b>Home</b>	<b>⌘</b> + <b>Home</b>
Move to End of Document	<b>Ctrl</b> + <b>End</b>	<b>⌘</b> + <b>End</b>
New Page (not new section)	<b>Ctrl</b> + <b>Enter</b>	<b>⌘</b> + <b>Enter</b>
Page Setup	<b>Alt</b> + <b>F</b> , <b>U</b>	—

MathType Shortcut Keys		
	Windows	Macintosh
Parentheses	<b>Ctrl</b> + <b>9</b>	<b>⌘</b> + <b>9</b>
Absolute Value	<b>Ctrl</b> + <b>T</b> , <b> </b> (vertical bar)	<b>⌘</b> + <b>T</b> , <b> </b> (vertical bar)
Exponent/Superscript	<b>Ctrl</b> + <b>H</b>	<b>⌘</b> + <b>E</b>
Subscript	<b>Ctrl</b> + <b>L</b>	<b>⌘</b> + <b>L</b>
Fraction (full-size)	<b>Ctrl</b> + <b>F</b>	<b>⌘</b> + <b>F</b>
Fraction (small)	<b>Ctrl</b> + <b>T</b> , <b>⇧</b> + <b>F</b>	<b>⌘</b> + <b>T</b> , <b>⇧</b> + <b>F</b>
Square Root	<b>Ctrl</b> + <b>R</b>	<b>⌘</b> + <b>R</b>
Less Than or Equal To	<b>Ctrl</b> + <b>K</b> , <b>,</b>	<b>⌘</b> + <b>K</b> , <b>,</b>
Greater Than or Equal To	<b>Ctrl</b> + <b>K</b> , <b>.</b>	<b>⌘</b> + <b>K</b> , <b>.</b>
Not Equal	<b>Ctrl</b> + <b>K</b> , <b>+</b>	<b>⌘</b> + <b>K</b> , <b>+</b>
Approximately Equal	<b>Ctrl</b> + <b>K</b> , <b>~</b>	<b>⌘</b> + <b>K</b> , <b>~</b>
Congruent (Modulo)	<b>Ctrl</b> + <b>K</b> , <b>=</b>	<b>⌘</b> + <b>K</b> , <b>=</b>
Plus or Minus	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>=</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>=</b>
Minus or Plus	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>+</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>+</b>
Multiplication-type Dot	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>.</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>.</b>
Angle Symbol	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>A</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>A</b>
Degree Symbol	<b>Ctrl</b> + <b>⇧</b> + <b>K</b> , <b>D</b>	<b>⌘</b> + <b>⇧</b> + <b>K</b> , <b>D</b>
Thin Space	<b>Ctrl</b> + <b>Space</b>	<b>⌘</b> + <b>Space</b>
Em Space	<b>Ctrl</b> + <b>K</b> , <b>4</b>	<b>⌘</b> + <b>K</b> , <b>4</b>
Baseline Horizontal Ellipsis	<b>Ctrl</b> + <b>.</b> , <b>_</b>	<b>⌘</b> + <b>.</b> , <b>_</b>
Centered Horizontal Ellipsis	<b>Ctrl</b> + <b>.</b> , <b>-</b>	<b>⌘</b> + <b>.</b> , <b>-</b>
Greek Letters (Uppercase)	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> , <b>⇧</b> + <b>A</b> <b>B</b> <b>C</b> <b>D</b> <b>E</b> <b>F</b> <b>G</b> <b>H</b> <b>I</b>	
	Yields	A B X Δ E Φ Γ H I
	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> , <b>⇧</b> + <b>J</b> <b>K</b> <b>L</b> <b>M</b> <b>N</b> <b>O</b> <b>P</b> <b>Q</b> <b>R</b>	
	Yields	θ κ λ μ ν ο π ϑ ρ
Greek Letters (Lowercase)	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> , <b>⇧</b> + <b>S</b> <b>T</b> <b>U</b> <b>V</b> <b>W</b> <b>X</b> <b>Y</b> <b>Z</b>	
	Yields	Σ T Y ζ Ω Ξ Ψ Z
	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> , <b>⇧</b> + <b>A</b> <b>B</b> <b>C</b> <b>D</b> <b>E</b> <b>F</b> <b>G</b> <b>H</b> <b>I</b>	
	Yields	α β γ δ ε φ γ η ι
Greek Letters (Lowercase)	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> , <b>⇧</b> + <b>J</b> <b>K</b> <b>L</b> <b>M</b> <b>N</b> <b>O</b> <b>P</b> <b>Q</b> <b>R</b>	
	Yields	φ κ λ μ ν ο π ϑ ρ
	<b>Ctrl</b> / <b>⌘</b> + <b>G</b> , <b>⇧</b> + <b>S</b> <b>T</b> <b>U</b> <b>V</b> <b>W</b> <b>X</b> <b>Y</b> <b>Z</b>	
	Yields	σ τ υ ϖ ω ξ ψ ζ