Unit XI
Text, Graphics, and Equations

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For most practicing physicists, a significant portion of their time is spent in efforts to communicate about their work. This may take the form of lectures and other presentations, journal articles, books, dissertations, notes and memos to colleagues, grant proposals, or even handouts for students like this one! Twenty years ago, handwritten equations in a PhD dissertation were considered the norm, and even still acceptable a decade ago. Today, however, a grant proposal without computer generated graphics of various kinds suggests that the writer is simply behind the times, not a good starting point if you are trying to convince the reader to give you money for ground-breaking research!

Until fairly recently, the only way to achieve quality text with equations was to use TeX. TeX and UNIX appeal to similar individuals. They are both extremely powerful, idiosyncratic, and require frequent use to maintain your abilities. And although TeX is still quite influential for publication quality output, documents produced with fairly garden variety word processing packages now can produce quite acceptable equations and graphics without the steep learning curve. In this unit, you will get some practice producing a variety of graphic elements and combining them with text using Microsoft Word. As with Excel, we will use this not because it is the best possible package, but it is one that is available everywhere on campus, and is arguably the most popular microcomputer word processing program on the market today.

It is important that you actually practice these techniques, more so than with our usual unit. This unit is shorter and easier than usual, and you should take this time to make sure that each of you has an opportunity to practice on each element as you go along. And while some of this will be idiosyncratic to Word or to the Macintosh, it is becoming more and more the rule that these tasks are accomplished in very similar fashions on a variety of platforms.

Since all of your work will be in producing various elements of a Word document, all you need do is print out the final product and attach it to your activity guide. For your own reference, feel free to attach either handwritten notes, or better yet notes in your text. That way you can produce your own condensed set of instructions.

Guidebook Entry XI.1: Inserting Figures from Excel

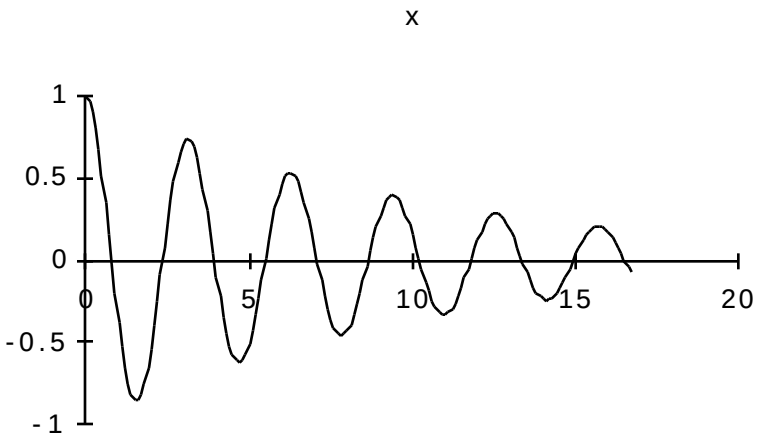
First, let's start Microsoft Word. To make start off with some text, try typing in anything. If you wish, use the following paragraph.

Often we will have graphic elements produced by one program (such as Excel, Mathematica, or any number of drawing or CAD programs), and wish to include them in a text document. The Macintosh platform has long been the leader in easy exchange of elements from one program to another, but other platforms are not far behind.

Use Excel to produce a graph of x(t) for a damped oscillator:

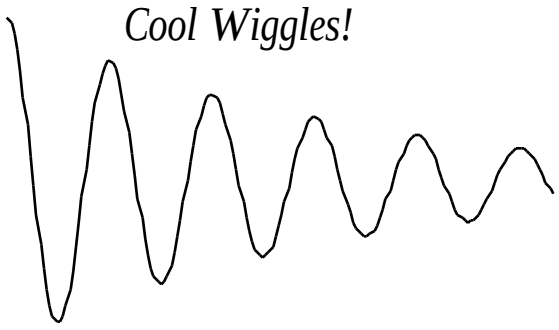
$$x(t) = e^{-0.1t}\cos(2t).$$

Mine looked like this:



To get this into your Word document, click in the chart window (if you have an imbedded chart, you need to double click on it first to get the chart window) so that the entire graph is selected. Use the copy command, then switch to Word, place the cursor where you wish to place the graph, and then do a paste operation. Use the paragraph tools to center the graphic.

You may not care for all the detail that Excel gives you. You can generally edit this away. Paste a second copy of the graphic in your document. Then double click on the second graphic, and this will open up a simple "Draw" program. Try clicking around with the various tools and the delete key, and see if you can get rid of the axes, and add text like I have to get something more like:



If you chance to erase an element that you wanted, such as a segment of the graph, you can reclaim it if you do it right away with an undo command (which has the keyboard equivalent of ⌘-z). But you can only undo the last thing you did, so don't be too hasty!

You also may wish to make this look more formal by giving it a caption. This is most easily done in Word, although you can also put the text in with the graphic. Try to get something like:

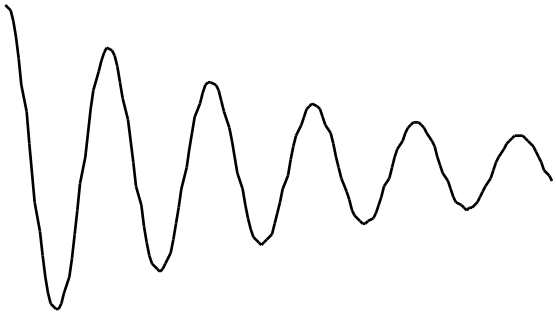
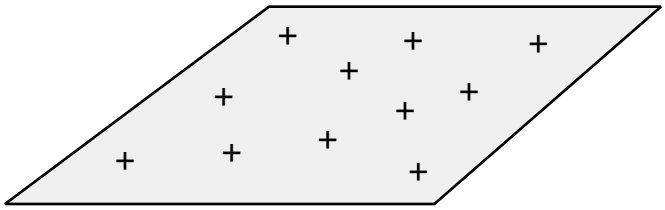


Figure 27: A typical example of some really cool wiggles.

Sometime we need to have graphic elements that are not available in a prefabricated format, and we need to generate them ourselves. There are many packages available for this purpose; the standard on campus for Macintoshes is SuperPaint. However, to get a feel for what one can do, and since we don't have network access yet, we'll use the simple "Draw" program bundled with Word to draw some electronic circuit elements.

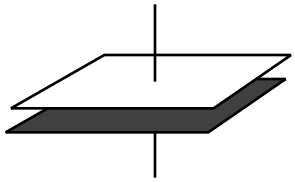
Guidebook Entry XI.2: Circuit Elements

Physicists make heavy use of simple schematic diagrams. Some of them are just idealized perspective sketches, such as this one of a charged plane:



Start the draw utility by using the Picture... command in the Insert menu, or by clicking on the triangle/square/circle tool on the toolbar at the top of your document window. Try making one like this--or better! I used the irregular polygon tool, and filled it with the dot pattern, and typed the +'s in by hand. One can adjust the dimensions of the polygon after it is finished to make it look more square.

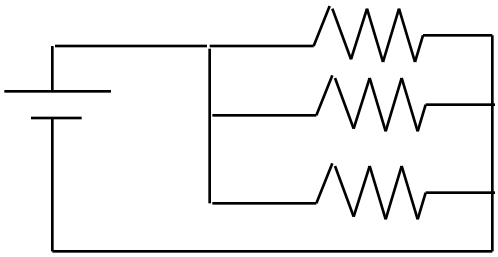
A very common use of schematic diagrams is for electronic circuit diagrams. We may, for example, want to show a parallel plate capacitor:



Try making a figure like this. I again used the polygon tool. To get the white plate opaque rather than transparent, I used the second of the possible white colors, and then made sure to move that object "to the front." Use of the duplicate tool is also helpful from producing top and bottom plates that are identical in dimensions.

One also often wants to make true electronic "schematics." There are custom programs that come with the graphic elements for resistors, capacitors, etc. already programmed. However, they are not very difficult to produce. For example, with a little effort you should be able to produce a passable resistor

using the line tool. Once you have this, select all of the elements, and group them together. Now you have a circuit element your can duplicate and use repeatedly. Try making your own resistor, and then try making a circuit diagram like this:



Most draw programs allow you to easily rotate objects, at least by 90º. In Word, this draw program is a bit to primitive, and you cannot rotate compound objects. So, you may have to draw separate horizontal and vertical versions--a minor inconvenience.

This gives you a taste of how one might go about creating some figures in your documents. It is easy to spend a great deal of time in this business, so it is important to match the level of effort to the importance of the figure!

Physics has always found the latin character set lacking, and has therefore made heavy use of Greek letters and other symbols. In the next activity, we learn a few tricks for finding and using special characters.

Guidebook Entry XI.3: Special Characters

The most common way to handle special characters is through the use of a different font. On the Macintosh, fonts are handled by the "system," which means the same sets of characters are available in all of your programs. Within a word processor, one can then take a sentence like:

The quick brown fox jumps over the lazy dog.

and generate a version of that in greek characters in the Symbol font. To do this, type the text, make sure it is correct, select it with the mouse, and then

choose the Symbol font from the font menu or from the font control at the top of the document window, to produce something like:

Τηε θυιχκ βροων φοξ φυμπσ οωερ τηε λαζψ δογ.

Virtually all Mac's come with Symbol; there are other Greek and character fonts, like Graeca:

The quick brown fox jumps over the lazy dog.

There are also special characters hidden in the various fonts. For example, Times is a very standard font, in fact the one you are reading right now. But hidden in Times are some special characters, such as µ, π, º, and ∆. It is convenient to use these when possible, so you don't have the nuisance of having to switch fonts. Try to find these characters by using the "Key Caps" utility in the apple menu. The keyboard that comes up changes when you depress the various combining keys such as option and shift. This is helpful if you know the degree symbol is somewhere, but you can't quite remember where.

Finally, there are a few special characters that are peculiar to physics, such as the script l or the reduced Planck constant h-bar (h). Some special purpose fonts include these; they also exist in the equation editor bundled with Word. To get these characters, enter the equation editor by selecting "Object..." from the Insert menu, and then selecting equation. You will get a double size scratchpad window with a variety of pull-down tool icons at the top. Click and hold on the one marked$\mathbf{F}_{centripetal} = m\mathbf{a}_{centripetal} = -m\frac{v^2}{r}\hat{\mathbf{r}}$ ∂ ∞ l and you can select the symbol of your choice. To insert this in your document, you can cut-and-paste, or you can simply close the window and it is automatically inserted where the cursor last was in the Word document. Stick a few in your document.

Finally, we need to get some experience with processing equations. This tends to be a tedious job, but it is much faster than it used to be.

Guidebook Entry XI.4: Equations!

At the end of the last Guidebook Entry, you learned how to enter the equation editor. Do that again.

Some equations are little more than typing a sentence. For example, it is very easy to enter an equation like

$$x(t) = A\sin(\omega t + \phi).$$

Greek characters can be obtained easily from the tool icon-menus in the upper right corner of the window. Try making this equation, and then pasting or inserting it in your document.

There are some advantages over just typing this in. For example, I just typed the same equation below by hand, switching to Symbol when appropriate:

$$x(t) = A\sin(\omega t+\varphi).$$

Notice that the equation editor does some subtle formatting. It places all variables in italics, but keeps characters like parentheses and arithmetic symbols in normal text. It also recognizes that sin is a function name, and therefore does not put it in italics. Most texts and journals follow this convention, and it is nice to have the equation editor take care of it for you in a consistent way (you have control of that, by the way, in the style menu, and can reset the default formates in the define... menu item).

Now, let's try something a little fancier. See if you can generate the equation

$$x(t) = \frac{A\sin\left(\frac{2\pi}{T}t+\phi\right)}{1+e^{-t/\tau}}.$$

Let me draw your attention to a minor subtlety. I used the parentheses tool instead of putting in those parentheses by hand. This allowed the size to match the size of the expression inside. Compare that result to just typing in standard parentheses:

$$x(t) = \frac{A\sin(\frac{2\pi}{T}t+\phi)}{1+e^{-t/\tau}}.$$

Finally, let's consider vectors. Most texts and journals use bolding to identify vectors, such as

$$\mathbf{F} = m\mathbf{a},$$

which can be selected from the Matrix-Vector command in the Style menu. However, you may prefer to emphasize this with vector arrows, such as

$$\vec{F} = m\vec{a}$$

I usually do the latter if I am going to duplicate a handout, since the bolding sometimes is difficult to discern in a mediocre copy. However, it is bad form to do both. The only exception is unit vectors, which are conventionally written like

$$\mathbf{F}_{centripetal} = m\mathbf{a}_{centripetal} = -m\frac{v^2}{r}\hat{\mathbf{r}}$$

Try making some equations of your own, especially including integral and differential expressions. You will have more practice in the homework.