Lab 2: Lines in Two Dimensions

In the first lab you learned how to use the NeXT workstation to solve simple problems in Mathematica and to submit your results through NeXTmail. In this lab we will use a Mathematica *notebook* to study lines in two-dimensional space.

Step 1

Log in to one of the NeXT workstations, just as you did in Lab 1.

The work you do in this Lab will come from a Mathematica notebook that has been prepared for your use. It is in the **/math235/notebooks** directory. To access it, you need to use the File Viewer window of the Workspace Manager application. If it is not now your active window, double-click on the Workspace Manager icon to activate it.

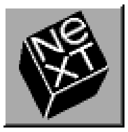


Figure 2.1 The Workspace Manager icon

In the File Viewer window, click on **math235** in the first column, then click on **notebooks** in the second column, and then click on **Lab2.ma** in the third column.

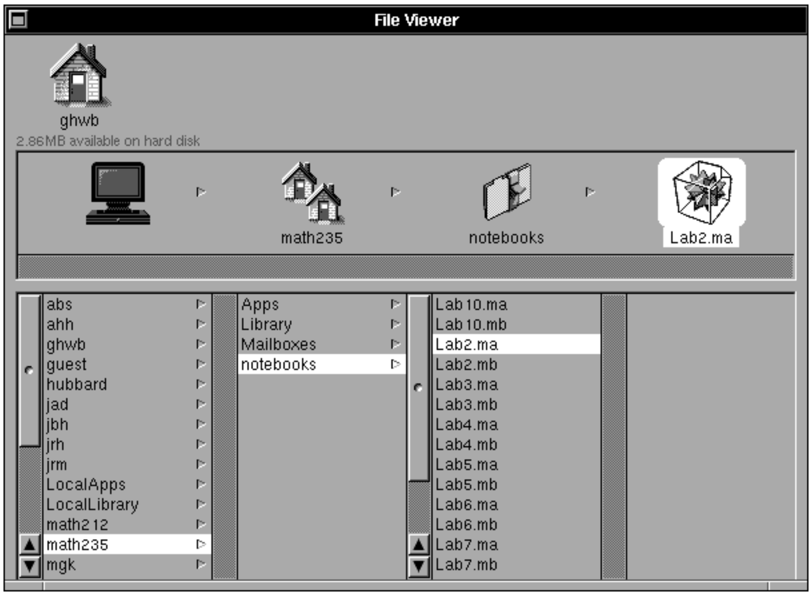


Figure 2.2 The File Viewer window showing the **Lab2.ma** file selected

The File Viewer window (Fig. 2.2) provides a wealth of information.[1] Its top row is called the *shelf*. It is usually used to hold icons of frequently used applications.

Figure 2.3 The shelf of the File Viewer

The icon at the far left of the shelf represents the user account that is currently logged in. In Fig 2.3 that account is **ghwb** (George Herbert Walker Bush's user name). Account icons are little houses, suggesting the location where all the user's files reside.

The other information shown on the shelf is a report on how much space is available on the NeXT's hard disk. Fig. 2.3 shows that this workstation's hard disk has 2.86 megabytes of space available (about 2,860,000 characters).

The second row of the File Viewer is called the *icon path*. It shows the path of subdirectories that leads from the root directory to the selected file.

Figure 2.4 The icon path in the File Viewer

The icon at the far left of the icon path is a little picture of a NeXT workstation; it represents the *root directory*.[2] On its right is a little arrow pointing to the next icon that represents the math235 account. It pictures two little houses.[3] This icon points to a directory icon labeled **notebooks**, and that points to the Mathematica icon that represents the **Lab2.ma** file. This icon path contains 4 icons. They represent the root directory file, the **math235** directory file, the **notebooks** directory file, and the **Lab2.ma** file.

The bottom part of the File Viewer is called the *browser*. It shows the contents of the root directory and the contents of each of the selected [4] subdirectories. The contents of the root directory are always shown in the first column. The contents of each selected directory are shown in the column below the directory's icon. For example, the contents of the **notebooks** directory are shown in the third column because the icon for that directory appears in the icon path above the third column.

[1] For more information, see Chapter 6 in the *User's Reference* manual, pages 71-101.
[2] All the directories on the NeXT are arranged in a hierarchical tree structure, with the root directory at the top of the hierarchy.
[3] Normally, this icon will be the same as the left-most icon on the shelf: the icon that represents the account that is logged in. But in this case, the user **ghwb** has accessed another user account: **math235**. The the icon shows two little houses: one representing the user's home account **ghwb**, and one representing the current account **math235**.
[4] On the NeXT, the things that are *selected* are always highlighted in reverse video on the screen. In Fig. 2.2, there are four things selected: the file names **math235**, **notebooks**, and **Lab2.ma**, and the Mathematica icon.

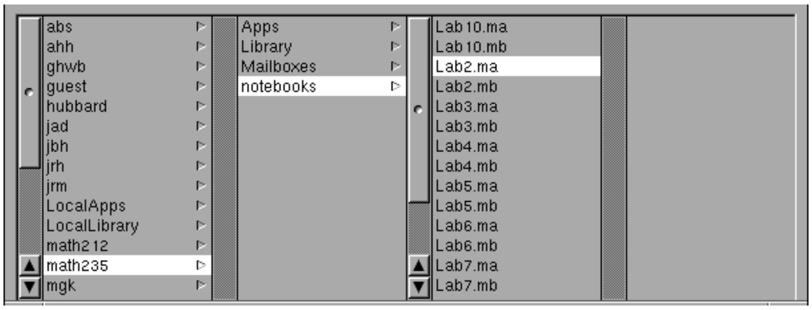


Figure 2.5 The browser in the File Viewer

Step 2

Now double-click on the **Lab2.ma** file icon to open the file.

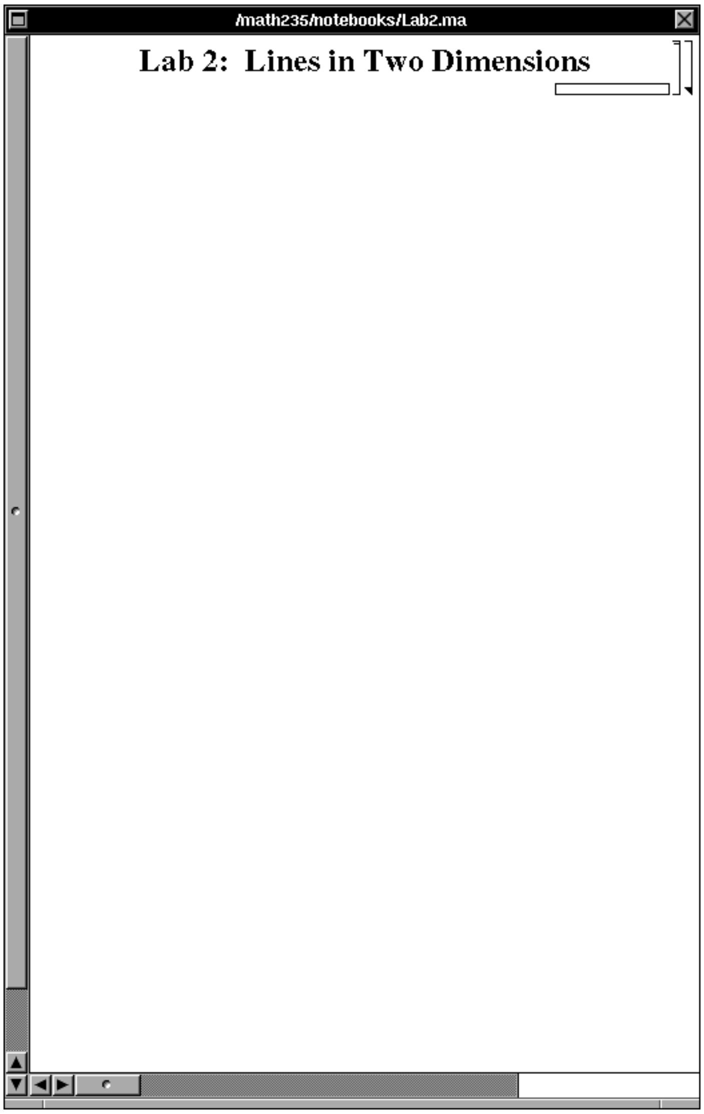


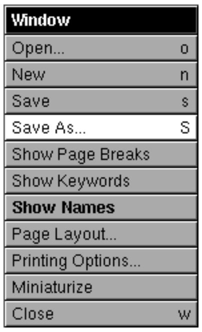
Figure 2.6 The Mathematica notebook Lab2

This sends a signal to the **Mathematica** icon on the dock which launches Mathematica and opens two windows. Click anywhere in the window on top. This activates Mathematica and loads the **Lab2.ma** file into the active window. Notice that the window's title bar shows the complete path of the file: **/Users/math212/notebooks/Lab2.ma** .[5]

This is a Mathematics *notebook*. It works like a textbook except that it contains Mathematica commands that you can execute.

Step 3

Make a copy of this file to save in your <u>own</u> directory, as you did in Lab 1. To do this, click on the **Window** command in the **Mathematica** menu, and then click on the **Save As…** command in the **Window** submenu.



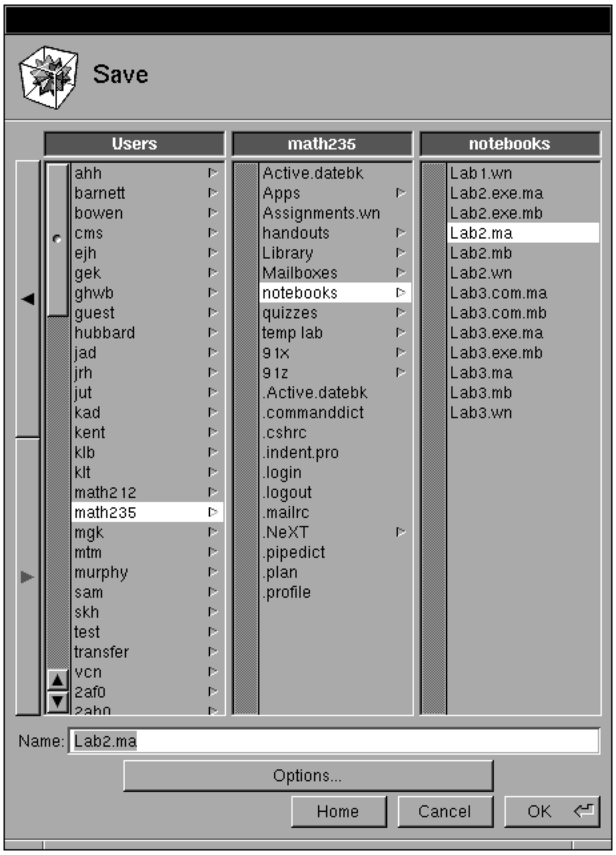


Figure 2.7 Figure 2.8 And enlarged Save window

Now enlarge your Save window by dragging one of its lower corners out away from the center of the window. Enlarge the window enough to see three columns, including the Users column.

Now scroll down the Users column (Fig. 2.8a) until you see your own user name. Click on your user name to select it. Then type **notebooks/Lab2.ma** (Fig. 2.8b).

[5] The slash character / is used to delineate subdirectories in the path designator. The root directory has no name.

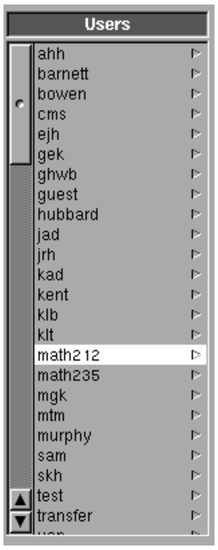


Figure 2.8a

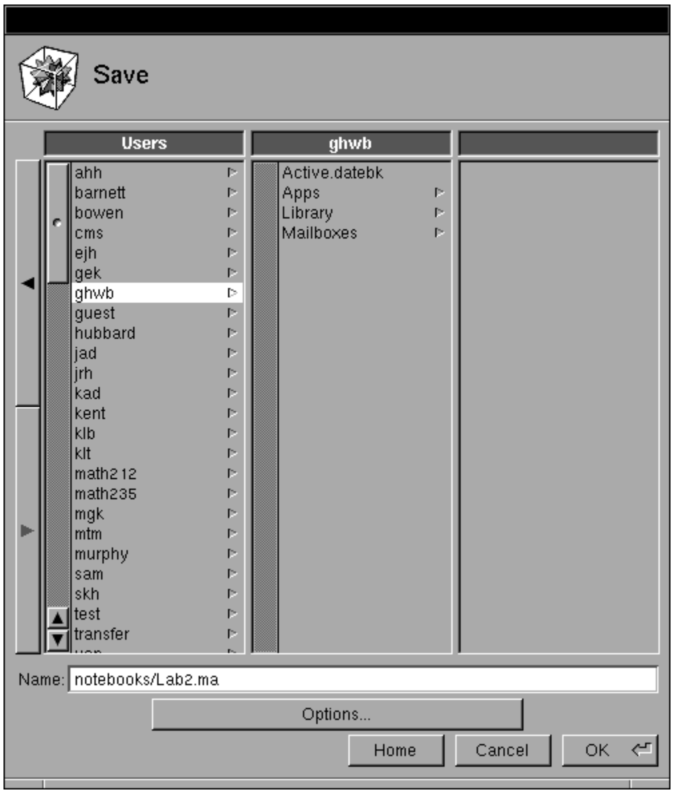


Figure 2.8b

Then press Return. The **Nonexistent path** panel pops up (Fig. 2.10) to tell you that the path /**ghwb**/**notebooks** does not exist. That is because your directory does not yet have a /**notebooks** subdirectory.

Figure 2.9 The Save panel

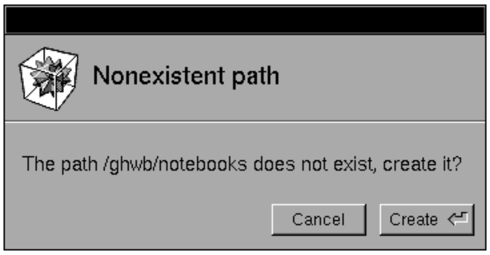


Figure 2.10 The Nonexistent path panel

Press Return to tell the NeXT that you <u>do</u> want to create this new path. That will then create the path and complete the copying of the Lab2 notebook into your directory.

To verify that the file was copied, double-click on the Workspace Manager icon (the NeXT cube at the top of the dock) to activate your File Viewer. Then click on your user name in the first column. The second column now shows your new notebooks directory (Fig. 2.11). Click on notebooks to reveal that directory's contents in the third column. Notice that both the **Lab2.ma** file and the **Lab2.mb** file were copied.

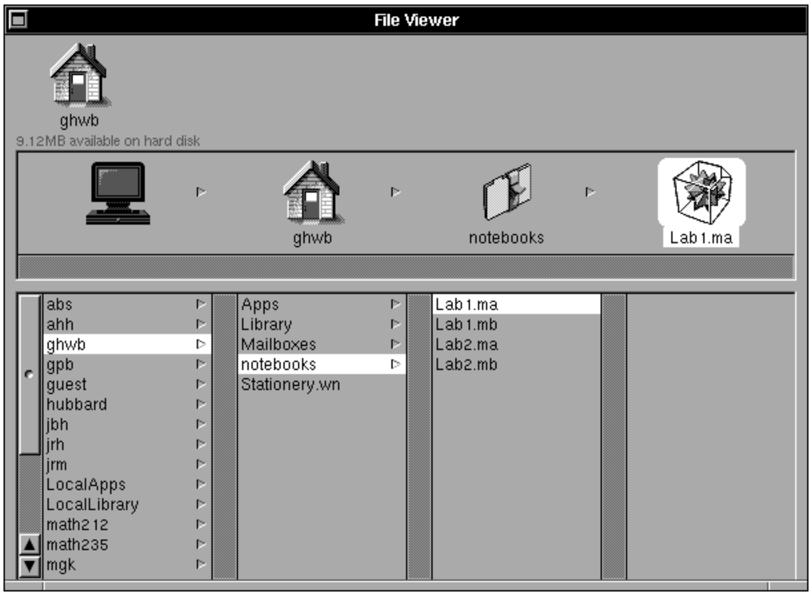
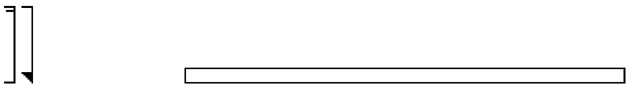


Figure 2.11 Verifying that the **Lab2** files were copied

Step 4

Now double-click on the Mathematica icon (in the dock) to bring your **Lab2.ma** window to the front (Fig 2.6). You see here only the notebook's title "Lab 2: Lines in Two Dimensions" and some markings to the right. The two bracket-like symbols are called *cell indicators*. The long narrow rectangle next to them is called a *group box*. It indicates that a subgroup of cells is hidden here.



cell indicators a group box

Figure 2.12 Symbols used in Mathematica notebooks

To reveal the hidden group, double-click on the rectangle.

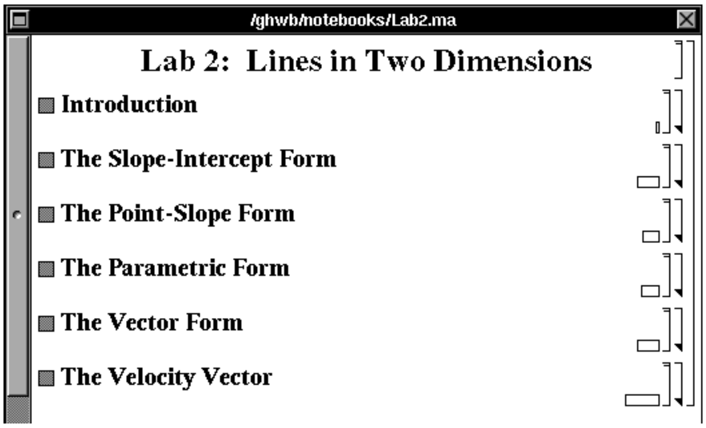


Figure 2.13 After opening the initial cell

Now you can see the 6 sections that comprise the Lab 2 notebook. Notice that each of these sections also has cell indicators and a group box. The size of the group box indicates the size of the hidden group. For example, the group hidden in the Velocity Vector section is about 40% larger than the group hidden in the Vector Form section.

Double-click on the group box for the Introduction section. This opens a single cell containing a brief paragraph that describes the Lab 2 notebook.

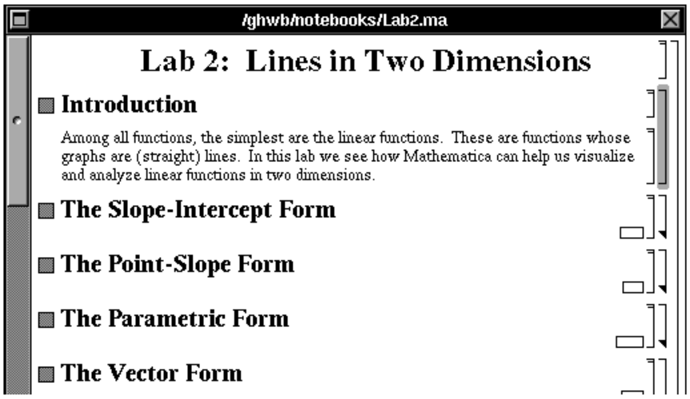


Figure 2.14 After opening the Introduction group

Before opening any more groups, close the Introduction group. To do this, double-click on the highlighted cell indicator.[6] This restores the notebook to its previous state (Fig. 2.13). Now double-click on the group box for the section entitled The Slope-Intercept Form.

[6] Notice that when you move the arrow pointer over the region in the notebook window were the cell indicators are, the pointer changes to a horizontal arrow pointing to a vertical line. You must allign that vertical line with the vertical line on the cell indicator before you double-click to close the cell. Be sure to get the right cell indicator— the one that spans both the **Introduction** title cell and its subsequent text cell (Fig. 2.14).

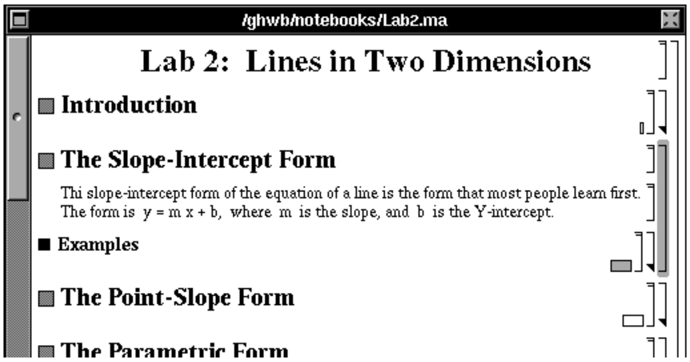


Figure 2.15 After opening the Slope-Intercept Form group

This reveals two cells: another text cell which describes the section, and a subsection named Examples. Subsections are marked on the left with little squares, similar to the larger squares that mark sections.

Step 5

Open the Examples subsection by double-clicking on its group box.

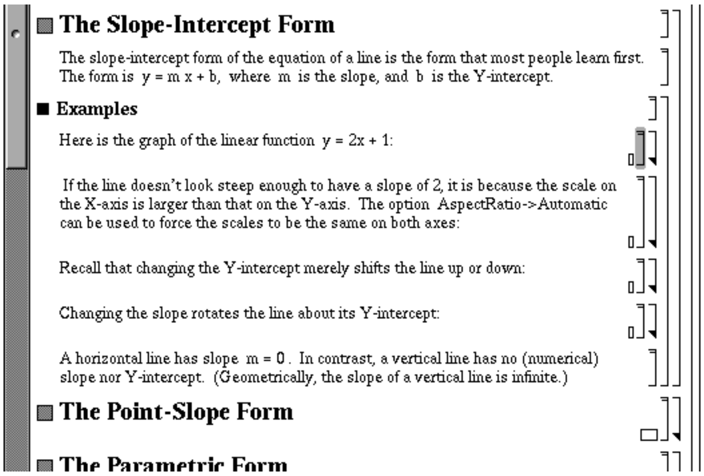
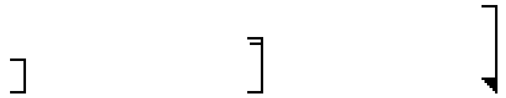


Figure 2.16 After opening the Examples subsection

The Examples subsection contains five subcells, the first four of which include closed subcells. Go ahead and click open all of these cells.

Notice (Fig. 2.17) the different types of cell indicators for the different types of cells: an ordinary *input cell* has a simple square bracket; a *text cell* has a square bracket with an extra horizontal line near its top; a closed cell group has a little black triangle at the bottom of its cell bracket.

Also notice (Fig 2.16) how the cell indicators are *nested* to show how their corresponding cells are nested.



input cell text cell closed cell group

Figure 2.17 Thee kinds of cell brackets

An *input cell* is a cell that contains Mathematica commands that can be executed. To execute the commands in an input cell, click on the cell indicator (or anywhere within the cell) and then press the Enter key.

Execute the first Plot command your see.[7] The result is the same as when you executed this command in Lab 1 (Fig. 1.11). The output appear in the notebook right after the input.

As you open more cells and execute more commands within your notebook, the text will begin to scroll out of view at the top. You may want to lengthen your window as you did in Step 11 in Lab 1. You should also get in the habit of closing cells[8] after you have finished with them. But you still will probably have to do some scrolling as you did in Step 8 of Lab 1.

Step 6

At this point, you should have five levels of cells open. The inner-most level includes the input cell you just executed, the cell containing the graph of the function plotted, and the output cell which contains only the label -Graphics- . The outer-most level of nesting is the original single cell for Lab 2 that contains everything else. Select the third-level cell by clocking on it. This cell encompasses all of the Examples subsection. Now double-click on this cell bracket to close the subsection. The result should look like Fig. 2.15 again.

Now move on to the next section, entitled The Point-Slope Form. After you have worked through its Example subsection and executed all its commands, open its Exercises cell.

To do these exercises, you will have to type your own ParametricPlot commands. These must be placed in new input cells between the existing cells.

To insert a new cell into the notebook, move the pointer to the spot between two cells where you want to create the new cell. Notice that the cursor changes to a vertical “I beam” when it is within a text cell and a horizontal “I beam” when it is between cells. When you have the right spot [9] and the pointer is a horizontal I beam, click on the mouse. This will produce a gray line separating the two existing cells (Fig. 2.18).

[7] Notice that while *Mathematica* is running, the message Running… appears on the window’s title bar and the cell indicator of the active input cell changes to a double bracket. You cannot perform any other activity with *Mathematica* hile this is going on.

[8] Double-click on a cell to close it.

[9] In this case, between the text cell “Note that…” and Exercise 2.

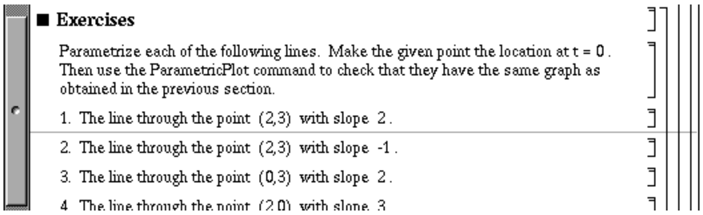


Figure 2.18 Preparing to insert a new cell

Now just type:

```
ParametricPlot[{2+t,3+2t},{t,-2,2}]
```

This produces a new input cell which you can then execute by pressing the Enter key.

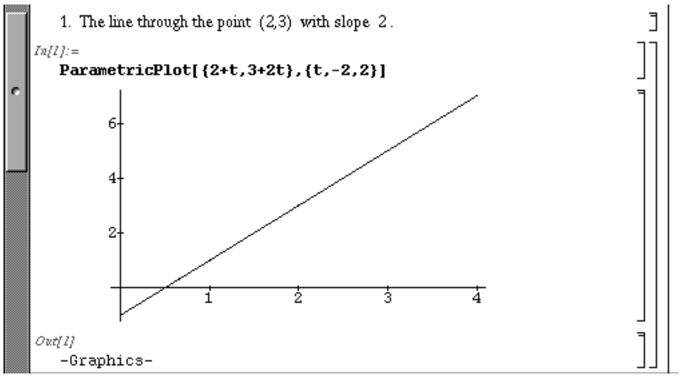


Figure 2.19 Exercise 1 for The Parametric Form

Insert each new cell directly after the exercise it responds to.

Step 7

Now work through the rest of the Lab 2 notebook in the same way. Work all exercises, inserting your own input cells. Answer any questions by appending to the existing text cells. Be sure to execute all Mathematica commands by clicking in the input cell and pressing the Enter key. Also be sure to open all hidden cells— some of them are nested pretty deep.

Most of the sections in our Lab notebooks will have the same general structure: an introductory text cell followed by an Examples subsection and an Exercises subsection. In each case, you should read the introductory text, then open the Examples subsection and work through it, and then open the Exercises subsection and work through it.

Step 8

After you finish working through the entire notebook and have completed all the exercises, close all the cells, and save [10] your modified file as you did in Step 12 in Lab 1. Then mail it to math235 just as you did in Step 12 in Lab 1.

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[10] As a shortcut, instead of using the Windows menu, you can click on the **Save button** in the upper right corner of the window. A Save panel will pop up, to which you can simply press the Return key to complete the save.