Lab 2: Integrals

This lab reviews the definite and indefinite integral and shows how to use *Mathematica* to integrate functions. It refers to Sections 7.1-7.3 in our textbook. Also see Chapter 7 in *A Guidebook to Calculus and Mathematica* by Crooke and Ratcliffe.

Step 1

Before accessing the Lab2 notebook, restructure your own account to allow for more efficient housekeeping. Create subdirectories named **labs**, **notebooks**, and **reports** in your account directory. To do this, click on your house icon to make your home directory the current directory. Then click on the File command in the Workspace main menu and execute the New Folder command in the File submenu.[1]

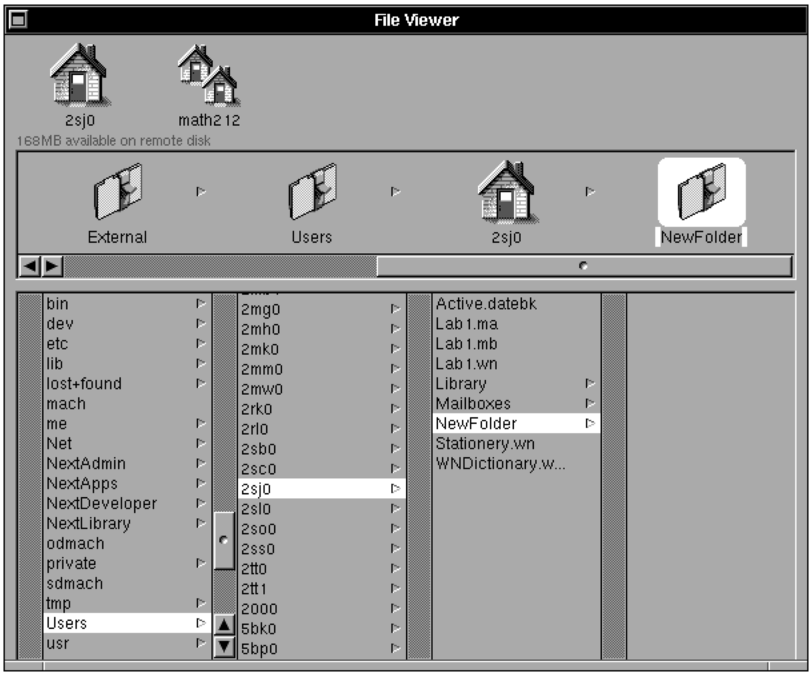

Figure 1 Creating a NewFolder

The new folder in your directory is automatically named **NewFolder**. To rename it **labs**, doubleclick on the name under the icon to select it (highlight it), and then type “labs”. When you press the Return key, the new name will replace the **NewFolder** name in your directory listing.

[1] Or just press Command-n to create a new folder.

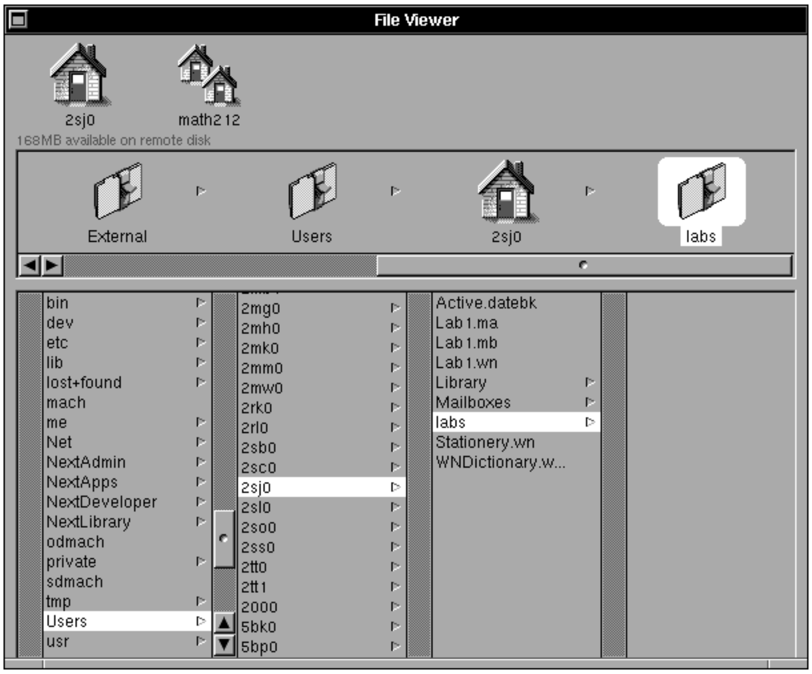

Figure 2 After renaming it **labs**

Create two more NewFolder subdirectories the same way, and rename them **notebooks** and **reports**.

Step 2

Now do some housekeeping. Your new subdirectories are for keeping your *Mathematica* labs, notebooks, and reports. These files currently are probably in your main directory.

To move your **Lab1.wn** lab report into your **reports** subdirectory, first drag[2] its *WriteNow* file icon up onto your shelf.[3]

[2] Recall that “dragging” the mouse means to hold the mouse button down while moving the pointer and then release the mouse button.
[3] Your “shelf” is the top row of your File Viewer that conatins your home directory’s house icon.

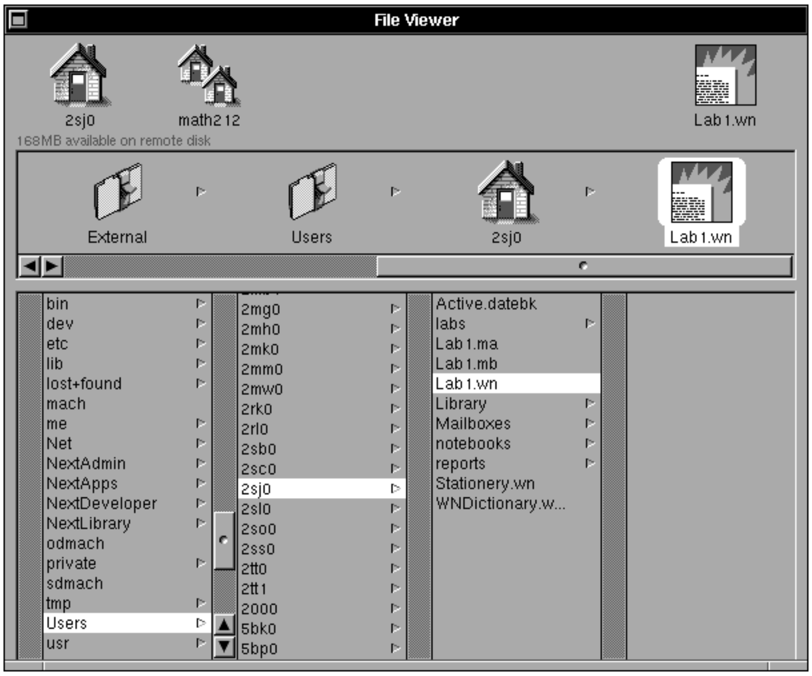

Figure 3 After dragging the **Lab1.wn** icon up to the shelf

Then select your **reports** subdirectory by clicking on that listing in File Viewer column for your home directory.

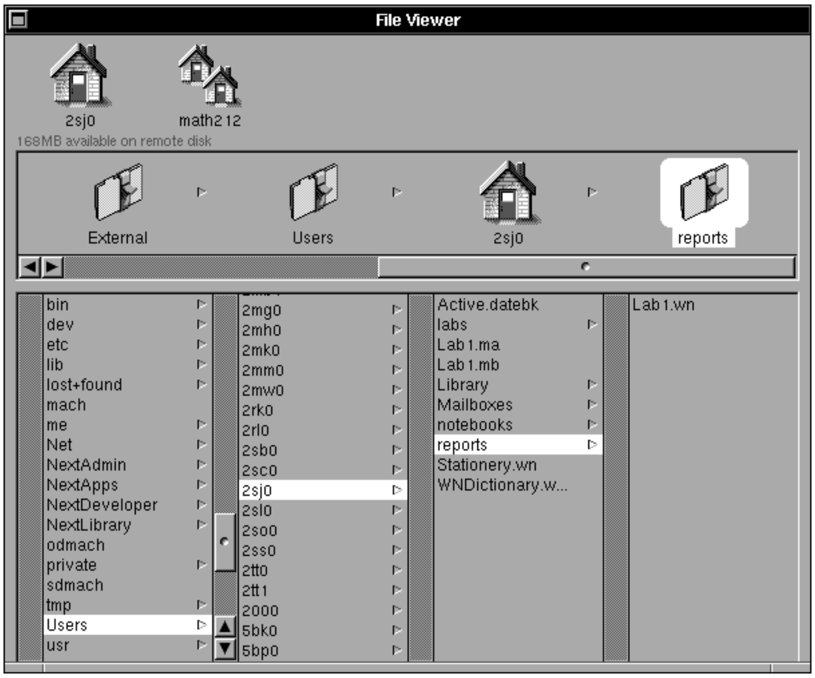

Figure 4 After selecting the **reports** subdirectory

Then drag the *WriteNow* file icon for your **Lab1.wn** report file down over the file folder icon for your **reports** subdirectory. When the *WriteNow* icon reaches the file folder icon, the folder will open to welcome the new file. Release the mouse key to drop the *WriteNow* icon into the file folder.

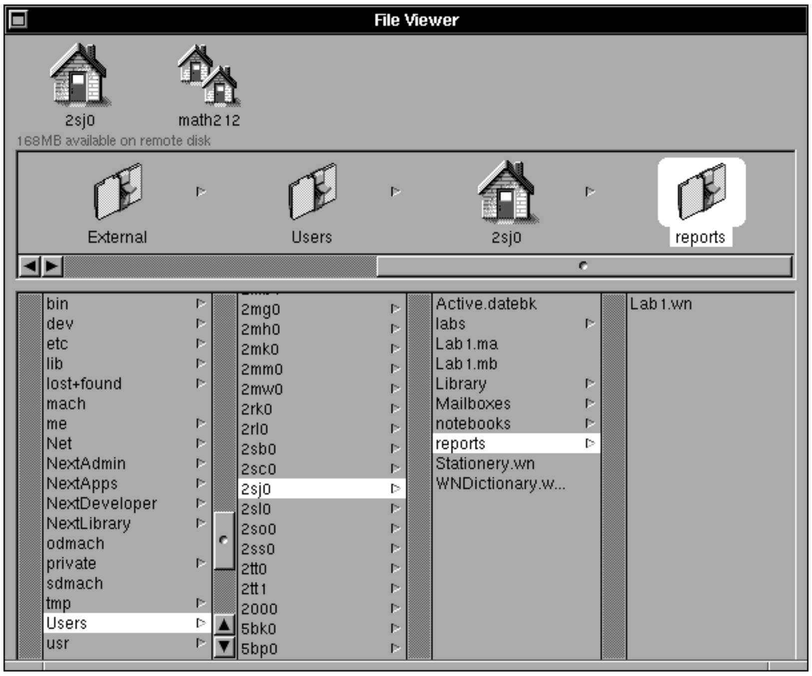

Figure 5 After moving the **Lab1.wn** file into the **reports** subdirectory

Now move your **Lab1.ma** and **Lab1.mb** notebook files into your **notebooks** subdirectory the same way. You can move them together by selecting both files at once. Drag across the two file names in in your home directory.

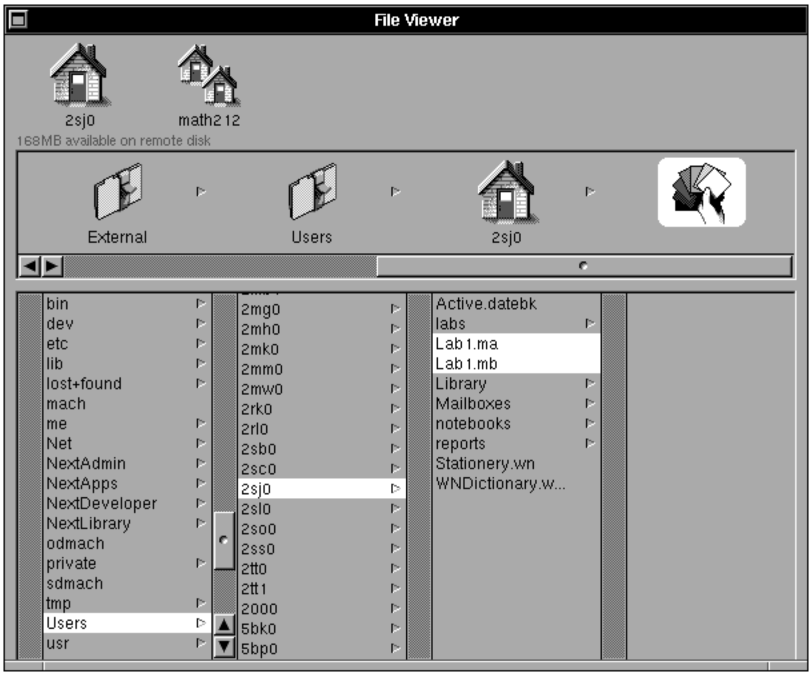

Figure 6 After selecting the **Lab1.ma** and **Lab1.mb** files together

The icon that represents the two files together is a hand holding some playing cards. Drag this hand icon up to your shelf. Then select your **notebooks** subdirectory and drag the hand icon over its file folder icon to move the two files together.

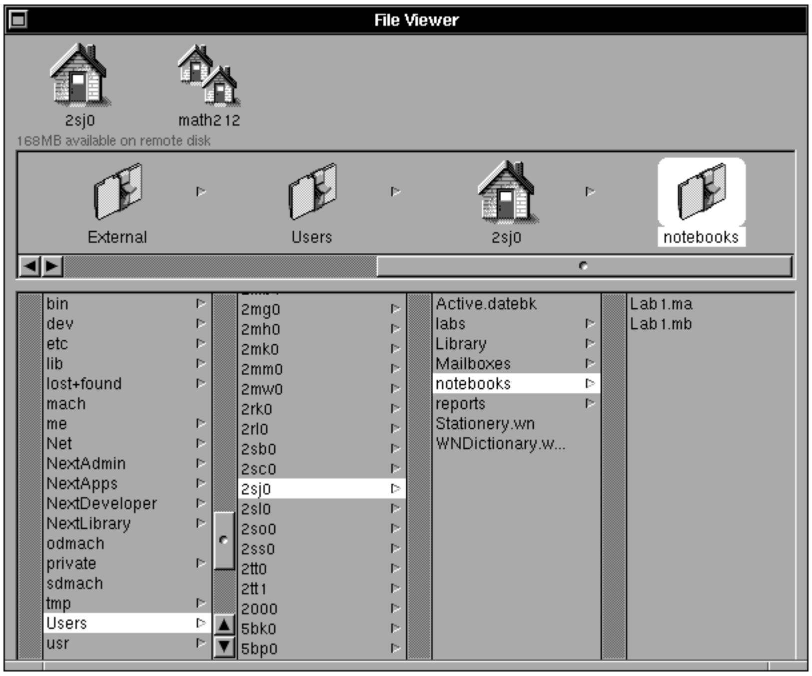

Figure 7 After moving the **Lab1.wn** and **Lab1.mb** files into the **notebooks** subdirectory

Step 3

Now copy the **Lab2.ma** and **Lab2.mb** notebook files into your own account. Click on the **math212** icon that should be on your shelf.[4] Then select the **notebooks** subdirectory and drag across the two file listings **Lab2.ma** and **Lab2.mb**. This produces a hand icon, as in Step 2 above. This hand icon represents the two files selected. Drag the hand up to your shelf. Click on your own house icon to select your home directory. Click on the **notebooks** subdirectory in your home directory. Then drag the hand icon down over that **notebooks** file folder icon to move the two notebook files into your own **notebooks** subdirectory.

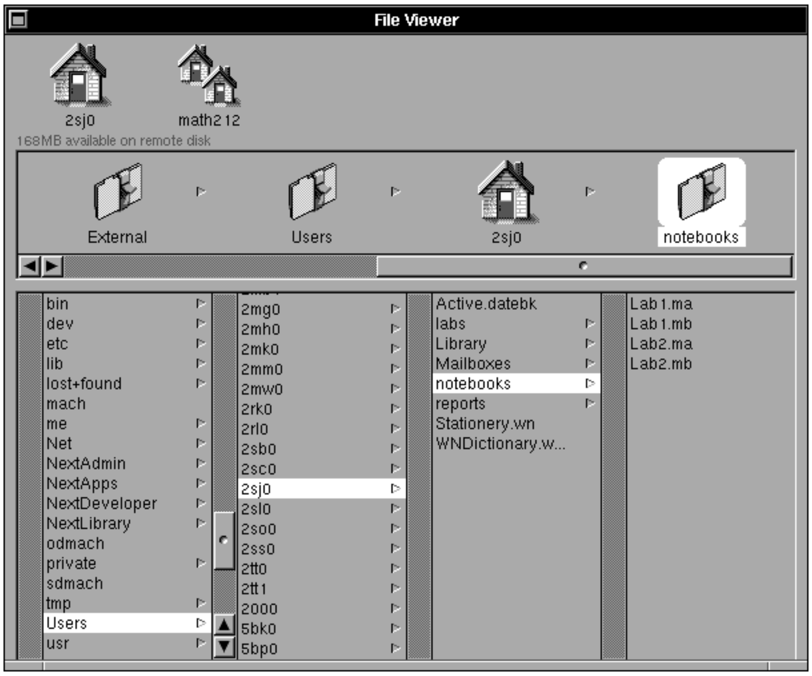

Figure 8 After moving the **Lab2.wn** and **Lab2.mb** files into the **notebooks** subdirectory

This is the standard method for copying and moving files on the NeXT. If you do this from one account to another, it will <u>copy</u> the files. If you do it between subdirectories in your own account, it will simply <u>move</u> the files without duplicating them.[5]

Step 4

Now open your copy of the **Lab2.ma** notebook[6] and double-click on the main cell rectangle to view the 4 main sections of this lab.

[4] The two-houses icon for the **math212** account. If you didn't put it on your shelf when you did Lab 1, do so now. The **math212** directory is located in the /**Net**/**newton**/**Users** directory of the NeXT network.

[5] To <u>copy</u> files from one subdirectory to another in your own account, do the same thing except hold the Alternate key down whijle you drag the icon into the file folder.

[6] Double-click on the **Lab2.ma** file name in your **labs** subdirectory. If the *Mathematica* window is blank, click in it.

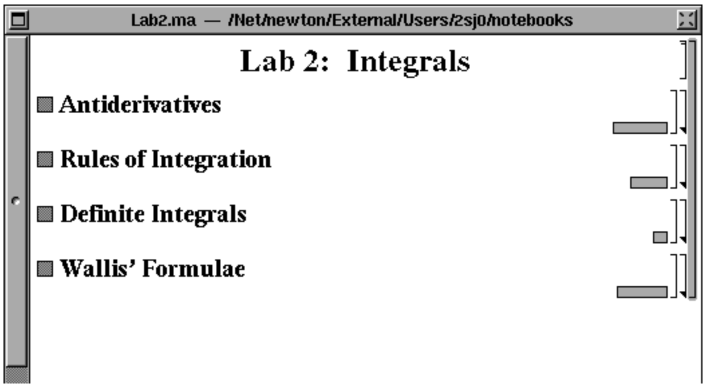

Figure 9 The main sections of **Lab2**

Begin working through this lab, just as you did Lab1. Be sure to open all subcells and execute all *Mathematica* commands in the order in which they appear.

Step 5

After you and your lab partner have finished the notebook, you will each write your own lab reports describing what you have learned.[7] Use the *WriteNow* word processor to do this, just as you did in Lab1.

When you open a new WriteNow window, it will look like this:

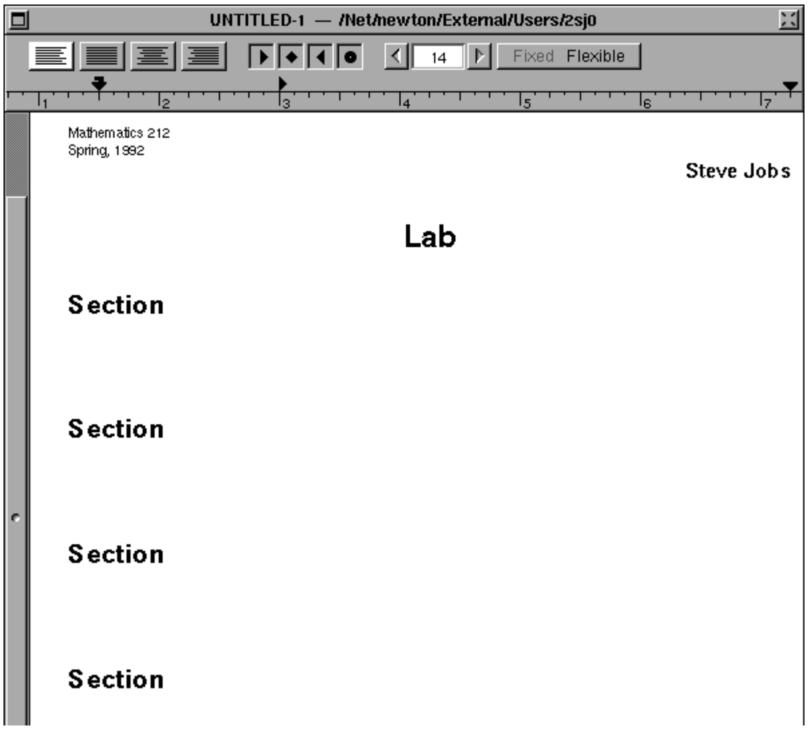

Figure 10 A new *WriteNow* window

[7] You may want to study the “sample” lab report for Lab1 in the **math212/reports** directory.

As you did in Lab1, you will have to change the name, the title, and the section subtitles. Just select[8] the text to be changed, and then immediately type the replacement text. As soon as you press any key, the selected text will be deleted.

As you write your lab report, remember to Save it every few minutes. The first time you execute the Save command, the Save panel will appear. Use this to tell the NeXT where you want to save your report.

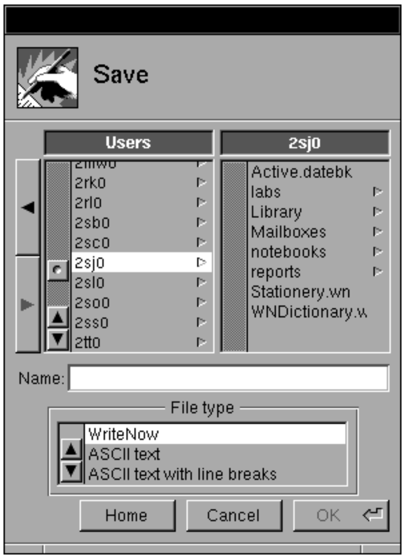

Figure 11 The **Save** panel

Type **reports/Lab2** in the text field labeled **Name:** and then press the Return key.[9] This saves your file in your **reports** subdirectory.

Now the title bar on your *WriteNow* window should show **Lab2.wn — /2sj0/reports** (except that <u>your</u> user name will be in place of Steve Job's). Notice that you did not have to type the **.wn** It is the default, inserted automatically by *WriteNow*.[10]

You can save your document simply by pressing Command-s.[11] Remember, when the little black X on the Close Button[12] is complete, then the active document in your window is identical to the file saved on disk. But when the X appears with its center missing (as it will as soon as you begin typing in your window), then the active document in your window is different from the current version saved on disk. Prudent users save their work every 2 or 3 minutes.

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[8] Drag across it.

[9] Notice the button labeled OK at the bottom right of the Save panel. Next to the OK label is a curved arrow. That represents the Return key. Most panels have a button with this symbol. It means that you can either click on the button with the mouse, or you can simply press the Return key on the leyboard. Among the various buttons, the one with the curved arrow is the default.

[10] Every system on the NeXT has its own default file type. It is .wn for *WriteNow* files. It is .ma for *Mathematica* source files and .mb for the accompanying binary files.

[11] Hold one of the green Command keys down and press the S key.

[12] The little gray square in the upper right corner of your window.

Step 6

Here are some ideas to consider when writing your report:

Antiderivatives

1. What does the **Integrate** command do?
2. What does it mean when *Mathematica* gives a different answer than in the textbook?
3. What can you do to reconcile this?
4. How does *Mathematica* indicate that it cannot do the integral?
5. When that happens, what does that probably mean?

Rules of Integration

1. Does *Mathematica* make integration tables obsolete? How?

Definite Integrals

1. What is the difference between an indefinite integral and a definite integral, and how does *Mathematica* distinguish them?

Wallis' Formula

1. What is a recursion formula?
2. How was the recursion formula discovered here?
3. What is a closed formula?
4. How was the recursion formula used to obtain the closed formula?
5. How did *Mathematica* facilitate finding the factorial formula?
6. How does the **Table** command allow you to check a formula?

Step 7

After you finish writing your Lab report, mail it to **math212** just as you did for Lab 1. Be sure that the *WriteNow* icon for your report is in the Send window before you click on the Deliver button.

Appendix: *Mathematica* Commands

Here are some of the *Mathematica* commands that are used in this lab:

`Integrate[ f[x], x ]`	Produces an antiderivative of **`f[x]`**.
`Simplify[ % + 1/18 ]`	Simplifies the expression **`% + 1/18`**, where **`%`** represents that previous output.
`Factor[%]`	Factors the previous output.
`// Simplify`	Simplifies the output of the current command.
`// Expand`	Expands the output of the current command.
`Clear[f]`	Cancels definitions for **`f`**.
`Integrate[ f[x], {x,a,b} ]`	Produces the definite integral of **`f[x]`** for **`a`** ≤ **`x`** ≤ **`b`**.
`I1[n_] := Integrate[ Sin[x]^n ,{x,0,Pi/2} ]`	Defines the sequence **`I1[0]`**, **`I1[1]`**, **`I1[2]`**, ... to be the numbers obtained by integrating (sin x)^n over the interval [0,pi].
`Table[ (n,I1[n]} ,{i,0,7} ]`	Produces the list of pairs: { (**`0,I1[0]`**), (**`1,I1[1]`**), (**`2,I1[2]`**), ..., (**`7,I1[7]`**) }.
`// TableForm`	Presents the output of the current **`Table`** command in tabular form.
`I2[n_] := ((n-1)/n)*I2[n-2]`	Defines the sequence **`I2[n]`** recursively.
`I3[n_] := (n!/(2^n*(n/2)!^2))*(Pi/2)`	Defines the sequence **`I3[n]`** explicitly as:

```
       n!      Pi
------------ --
 n         2
2  [(n/2)!]   2
```