Physics 220, Experiment 0, Spring 2009
An introduction to *MATHEMATICA*

Introduction: *Mathematica* is a sophisticated tool for doing mathematics. Not only does it do arithmetical calculations, plot graphs, and evaluate equations, but it will also do symbolic calculations for you as well, such as taking a derivative, integrating a function, or solving a differential equation. You can actually do your homework or your lab reports totally using *Mathematica*. In this exercise, you will begin to become familiar with how to use *Mathematica*.

The product of this "lab" will be one file that your group will send or save on the Q drive by the beginning of lab next week.

I. Running Mathematica on the Wittenberg network:
In the Start menu, go to Programs and choose Wolfram Mathematica, then Wolfram Mathematica 6.

Note the Startup Palette. Click on the "First five minutes with Mathematica" link and work through the instructions. This will give you an introduction to the kinds of things Mathematica can do and to Mathematica's notation and syntax.

Check with me after working through the "First five minutes" exercise.

II. Now work through the Mathematica notebook IntroMathematica_S09.nb. You'll find this notebook on the Q (class drive), under Q:\Physics\Physics220_S09. Copy it to your H drive so you can modify it. Do enough to give you the idea of how these commands work. It can also serve as a reference in working through the next exercise (what you'll actually hand in).

III. Create a new workbook and show how Mathematica can be used to do each of the following (these are all examples of math we'll need this semester). Make sure your names are somewhere in the notebook. For each part that has questions, answer the questions right in the notebook. For graphs, be sure to label axes and format the graph correctly.

Remember that highlighting a command and pressing F1 gives help on that command. Be careful about spaces!

1. Use **Solve** to find the exact solution of the system of equations x+y=5 and 2x+6y=23.

2. Use graphical methods to find all of the approximate solution(s) of the equation $e^{3x} = 5x + 27$. Then, based on clues from the graph, use FindRoot to find the numerical values of the solution(s). How many solutions are there, and what are they?

3. Use ElementData to plot atomic radius as a function of atomic number for atomic numbers from 1-80. (Hint: getting help (F1) on ElementData will show you a similar example.) What trends do you see? Bonus: can you figure out what units Mathematica is using for the atomic radius?

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4. Find the first and second derivatives with respect to x of $y(x) = Ae^{-x^2/2b^2}$. (A and b are constants.)

5. Find the partial derivative with respect to x of $\psi(x, y) = A \sin kx \sin qy$. (A, k, and q are constants.)

6. Evaluate the indefinite integral $\int \sin^2\left(\frac{\pi x}{a}\right) dx$. (a is a constant.)

7. Evaluate the definite integral $\int_0^a \sin^2\left(\frac{\pi x}{a}\right) dx$. Explain why the answer for the definite integral makes sense, given the answer to the indefinite integral in the previous question.

8. Make a two-dimensional graph of the data found in Table 3.6: atomic mass in u vs. the atomic number for the isotopes listed. (Note: "Graph A vs. B" means B is the independent variable and should go on the x axis. A is the dependent variable and should go on the y axis. Make a graph that shows the individual data points.)

When you are finished, your group should send me the notebook (or save it to the Q:\Physics\Physics220_S09 folder). Give the notebook a title incorporating your initials, names, etc. so your file is distinguished from others'.