Worksheet #1 – PHY102 (Spring 2011)

This worksheet introduces you to the use of *Mathematica*. *Mathematica* is a programming language developed by Stephen Wolfram which has many applications,*e.g.*, solving algebraic equations, differentiation, integration, making plots in two and three dimensions, etc. You will also solve a couple of simple problems in mechanics using *Mathematica*.

Getting Started

1. Logging in: A computer account has been set up on the linux computers in the computer lab in BPS1240. You will be handed a sheet of paper with your login instructions by the instructor. Sitting at a computer, you should be faced with a login prompt. Enter your username and password to log in.

2. Open a browser (e.g., Firefox) and access the group web-page http://www.pa.msu.edu/ pumplin/phy102Spring2011

3. Get to know the linux operating system and basic commands and actions you will need to know to be able to do to carry out the assignments in this course. Download the "Introduction to linux computing" help from the course home-page. You can print it out (print → print. It will come out on the printer in BPS1240) or read it online.

4. To start a command window, right-click on the mouse, then click on the "new terminal" option. Now follow the instructions on the hand out page to change your password to one you will remember, but which is still secure.

5. To start Mathematica enter "Mathematica &" on a command line and then press "enter" on your keyboard.

6. From the courses www page, download and save the "getting started" Mathematica notebook. Save it as YourNameOfChoice.nb This is a Mathematica notebook and Mathematica recognizes the ".nb" extension. Open the notebook (file → open). Read through the notebook

and try out some of the exercises. This is a handy reference which you will find useful later when you get into difficulties. It introduces some fairly advanced stuff which you don't need right now so don't spend too much time in it, just glance through, play a bit and see what's there. To run any of the commands, hit <Enter> while holding down one of the <Shift> keys; or use the <Enter> key of the numeric keypad. Then go on to the exercises below.

7. Exercises. Do not overwrite these exercises as you are doing them as part of the assignment is to hand them in.

   (a) open a new notebook and save it to a new name (e.g., week01.nb)

   (b) Type your name in the top. Make sure that it is typed in a "text" group and not a "command group" (see the "getting started" notebook). Save the notebook again (develop good habits!)

   (c) Type "2+4" (now you *do* want to be in a "command group"...format → Style → Input). Hold down the "shift" button in the key board and push "enter" (each time you want to get the result for what you have typed, you have to type "shift+enter"). In the output the screen will give you back the result.

   (d) Type "10/2" to check that you'll get 5 in the output.

   (e) To find the roots of an equation (e.g. $x^2 - 1$), type "Solve[x^2-1 == 0,x]". In the output you'll get +1 and -1 as the two roots.

   (f) Copying: using the mouse, highlight "Solve[x^2-1 == 0,x]" that you typed above. Let go of the mouse button. Move the mouse down the page to a region below where you have typed. Click the middle mouse button if you have a three button mouse, click the left and right mouse buttons together (this takes some dexterity!) if you have a two-button mouse. This pastes the highlighted text. Alternatively, highlight then use edit → copy and edit → paste as familiar to microsoft windows users.

   (g) Deleting: to edit and delete text you have typed, use the mouse and arrow and delete keys in the usual way. To delete a whole group (including that pesky output you generated when you made a syntax error) highlight the group by clicking on the blue bracket

at the right-hand side of the notebook. When the bracket is highlighted hit delete.

(h) Factorize the expression $x^2 - 1$ to get the roots. In order to do that type "Factor[x^2-1]", and check if you get (x+1)(x-1).

(i) Mathematica has extensive plotting tools. For example plot the function sin(x). To do this type "Plot[Sin[x],{x,0,6.28}]".

(j) Help??? Mathematica has an extensive online help library. Try looking up the sin(x) function to make sure you have the right format.

(k) Here is an example how you can perform differentiation using Mathematica: suppose $f(x) = x^n$; then $\frac{df}{dx} = nx^{n-1}$. To check it type "D[x^n, x]" and see the output.

(l) Likewise, you can perform integration on $f(x) = x^n$. Type "Integrate [x^n, x]" and assure yourself that you indeed get back $\frac{x^{n+1}}{1+n}$.

Assignment #1.

1. **Examples**. Hand in the results of the Mathematica operations you experimented with above.

2. **Problem 1**. The displacement of a particle undergoing one dimensional motion under constant acceleration is given by the equation $x(t) = ut + \frac{1}{2}at^2$. Choose values of u and a that you think are physically reasonable. Find and plot $x(t)$ and $v(t)$ over a reasonable range of time (this depends on your choice of u and a). Note, the format used by Mathematica is somewhat different from ordinary mathematics. For example, in mathematica you can write u times t as $u\,t$ or as $u * t$; but if you just write ut, Mathematica will think that is a single variable.

   You can define the position simply as x and plot it using "Plot[x,{t,0,5}]", or you can define a function x[t] and plot it using "Plot[x[t],{t,0,5}]". Try it both ways.

In plotting, you can use "Plot[x[t],{t,0,5}]" or "Plot[Evaluate[x[t],{t,0,5}]" after defining x[t]. Try both. What is the difference? (Look up Evaluate in help to find out.) Type a brief answer into your notebook (don't forget to set the style!).