Name: _____, _____

PHYSICS 401 : SPRING SEMESTER 2018

Project #1: Tinkering with Java

Please note: For all future project assignments, please PRINT your name above, last name first, comma, then first name. Use this assignment sheet as your cover sheet and staple this to the front of your work. Answer questions, do not just hand in graphs without stating which part of the assignment you are doing.

First, download needed softwares:

A) Java

1)Go to Oracle (just google "Java Development Kit"), download the latest version `jdk-9.0.4-****` and install it in your computer. (This is a big file, may take some time.) Add the address of the `bin` folder of JDK (usually at `c:\Program Files\Java\jdk-9.0.4\bin` or `c:\Program Files(x86)\Java\jdk-9.0.4\bin` to your PATH environment variable. (The PATH variable is usually in the Control Panel: system: advanced system settings: Environment Variables. Scroll down and highlight the variable Path, click Edit, and add the above, or your specific path to the Path variable list. Or, enter "envi" at the search box on the lower left corner will bring up "Edit the system environment variable". Click that then "Environment Variables".) Restart your computer for the environmental varible to take effect.

2)Download the Java file "FallingFileApp.java" from my website to your Java working directory. Both are just text files and can be open and edited by Notepad. Their extensions just prevent them from being open by the Browser.

3)Start the Command Prompt in the accessories, or run it by type in "`cmd`" at the run command line. Change directory to your Java working directory.

4)On the command line, type

```
javac  FallingFileApp.java
```

After it is done, type `dir`, to see that the Java compiler `javac` has produced the class file "FallingFileApp.class".

5)Now on the command line, type

```
java  FallingFileApp
```

Note, *do not* include the suffix `.class` to execute the class file. On the Command window, you will see the output "All done!", "final time = ...", etc.. Type `dir` to see that you now have a new output file `output.txt`. You can use Notepad to open, view and modify the Java, Gnuplot and .txt files but not the class file.

Congratulation! You have just ran your first Java program by hand!

B) Gnuplot (Only do this if you don't have a graphic program to plot column data and produce a printable graph. However, don't use the ploting program from Excel.)

1) Google "gnuplot" and download the free plotting program "Gnuplot" (download the binary version for Window) unzip and just drag the "wgnuplot" icon and the menu file "wgnuplot.mnu" to your desktop. Double click the icon to start gnuplot and change directory to your java working directory.

2) On the Gnuplot command line, type `plot sin(x)` to see how it works. Next, type `plot output.txt` to see your Java output. Type `set grid`. Type `replot` and see how the graph now looks. Type `set xlabel"t"`. Type `set ylabel"y"`. Type `set title"Free Fall"`. Type `replot` to see your rudimentry graph.

3) Use Notepad to open the Java file `FallingFileApp.java`. From the given initial position and velocity, what is the exact solution $y = f(t)$ as a function of time? Change $t \to x$, and type `replot f(x)`. You now have a comparison between the numerical output and the exact solution.

4) To produce a printable file, type in commands

```
set term postscript portrait color

set output "freefall.ps"

set size 1, 0.6

replot

set output "end.ps"
```

and go back to Window mode by typing

```
set term window

set size 1,1

replot
```

There is now a `freefall.ps` file in your directory. Double click and see whether your computer can open it. If not, download a simple Postscript Viewer from the web, (say Rampant Logic PS viewer) to view it. (The Rampant Logic PS viewer will automatically convert a *.ps or *.eps files into a pdf file which can then be printed.

C) Download the needed chapters of the textbook from
`http://www.opensourcephysics.org/document/ServeFile.cfm?ID=7375`

D) Tinkering Hand-in this part of the assignment.

1)Use Notepad to open and examine the Java file `FallingFileApp.java`. The variables for the vertical motion are fairly obvious. Since there are 30 data points on the graph, there must be a number 30 somewhere in the file. Find that number and change it to something larger so that the last data point is closest to $y = 0$. What is that number and what is the final time now? What is the exact final time corresponding to an initial vertical velocity of $vy_0 = 6$ (m/s)? (When you save a file and you don't want the automatic *.txt extension, save it with quots, as "FallingFileApp2.java", or as any file "*.*". Also, ALWAYS save a working copy of your code BEFORE modifying it.)

2) The statement

```
fout.write(t + "   " + y);
```

is the write statement which outputs the two numbers t, y separated by two blank spaces and

```
fout.newLine();
```

does a carriage return so that the next write will start on a new line. The plus sign here simply means "and", *i.e.*, write out the value of t AND two blank spaces AND the value of y. From the gnuplot graph, one sees the initial starting point is missing. How would you copy and move these two statements so that the starting point is also output and plotted? (Be careful to copy each statement exactly as it is written, especially the final semi-colon. This is how each statement in Java must end.) Hand in a copy of this graph.

3) Interchange the two program lines

```
y = y + vy * dt;

vy = vy - g * dt;
```

to

```
vy = vy - g * dt;

y = y + vy * dt;
```

re-run the Java code, and just enter the commond "replot" at gnuplot. How's the calculated results now compare with the exact solution? From these two cases, how would you devise a more accurate algorithm using the the same time step dt? Hand in a graph showing the result of your new algorithm.

4) Now modify the Java file by adding in the horizontal motion with constant horizontal velocity $vx0 = 6.$ and initial position $x0 = 0$. Using your best algorithm from 3), output the trajectory x, y, plot and compare it with the exact analytical result. Hand in a plot of this result.

Be sure to number your responses 1) to 4) corresponding to the question asked.

Use the minimum number of page of paper (double side, double column, etc.), to do the assignment.

E) Optional Still not tired and have time to spare? Download the "Eclipse IDE" and use it to compile and run your Java code. (What's Eclipse? Find out and find out how to use it on Youtube.)