CSC 130 Scientific Programming SP15

Programming Assignment 3 – simulating a falling object / pgm3.c
Due: Thursday, February 19, before class

This homework programming assignment must be your own (individual) work as defined in the course syllabus and discussed in class.

Problem:
Write a C program to simulate a falling object. The program should ask for the initial height of the object, in feet. The output of the program should be the time for the object to fall to the ground, and the impact velocity, in ft/s and miles/hour.

Your program should use Euler's method to numerically solve the differential equations describing the motion of a falling object. In Euler's method, the state of the object at some small future time is calculated using the values at the present time. This small future timestep is typically called delta time, or **dt**. Thus the position (**p**) and speed (**v**) of the object in the next timestep **t + dt** is written as a simple function of the position and speed at the current timestep **t** (**g** is the acceleration due to gravity):

$v(t+dt) = v(t) + g * dt$
$p(t+dt) = p(t) + v(t+dt) * dt$

You should actually start out with the velocity as zero, and the position at the initial height of the object. Then your position (above the ground) would be:

$p(t+dt) = p(t) - v(t+dt) * dt$

And you would integrate until the position becomes less than or equal to zero.

The input/output formats for your program should look like this:

```
Program to calculate fall time and impact speed of
a falling object dropped from a specific height.
Enter initial height in feet: 100

Falling time = 2.492224 seconds
Impact speed = 80.249613 feet/sec
Impact speed = 54.715645 mph
```

Part of this assignment is to determine an optimum value for **dt**. Clearly, the value of the time step that you use in the simulation will be important. If the timestep (**dt**) is too large, then the

results will not be accurate. However, if the time step is too small, then the program run time will be excessive. For this assignment, you must determine the value of delta time that is as large as possible but at the same time, results in an answer that is accurate to 5 significant figures – i.e., further decreases in the time step no longer change the result past the 5th digit to the right of the decimal place. Turn in your program configured with this value of **dt**.

Accuracy and precision is important for this assignment. You should use a **double** float data type for all real numbers. Also assume the effect of gravity does not vary with distance from the earth, the rate of acceleration is 32.2 feet per second per second, and the resistance of passing through the atmosphere is non-existent.

Using symbolic constants for gravity **G = 32.2** and delta time **DT = .000???????** makes sense.

Name the C source code file **pgm3.c**. You must include the following program identification comment block at the start of your C source code file and add the correct relevant information. The pledge must be present.

```
/*****************************************************************************
 * Program 3: pgm3.c – simulating a falling object
 *
 * Programmer: information that you must provide
 *
 * Due Date: information that you must provide
 *
 * CSC130 Spring 2015
 *
 * I pledge I neither gave nor received unauthorized aid on this program.
 *
 * Description: information that you must provide
 *
 * Inputs: information that you must provide
 *
 * Output: information that you must provide
 *
 *****************************************************************************/
```

For this assignment

- Submit the C source code (pgm3.c) file for grading as a Blackboard assignment
- Turn in the printed C source code before class begins on the due date
- The make utility Makefile is require for this program
    - output should be named pgm3.exe
    - clean target should delete *.o and *.exe files

Remember the class policy on late submissions – no late submissions are allowed unless prior arrangement is made with the instructor.