PHYS580 Lab 2, Aug 29, 2019

Assignment:

Go to the course home page (https://www.physics.purdue.edu/phys580), download the starter Matlab program for Lab 2, and save it to your ITaP career account storage area on drive W:\ (ideally, create a new Lab2 directory there). Make sure to create a backup copy of the sample program before you start modifying it for the assignment. (Or use it as guidance to write corresponding programs in your chosen language.) You will work on projectile motion today. The provided program computes the cannon shell trajectory using the isothermal air density model discussed in class.

1. First, for a cannon shell projectile, take a fixed angle of projection of 45˚, and an initial velocity of 700 m/s, and graphically compare trajectories for the following different models: (a) gravity only, no air drag, (b) air drag with constant air density, (c) air drag with the isothermal model of air density, and (d) air drag with the adiabatic model, using $\gamma = 1.4$. Set $B_2/m = 4\times10^{-5}$ (in 1/m units) at ground level.
   In the adiabatic model, $|F_{drag}| = B_2 (1-a\, y/T_{grd})^{1/(\gamma-1)} v^2$, where a is the rate of temperature decrease per rise from sea level. Use $a = 6.5\times10^{-3}$ K/m, and $T_{grd} = 293$ K. [Can you derive/justify this form of F_{drag} ?] Give some arguments for why the comparative shapes of the 4 trajectories, and the corresponding ranges, may be expected.

2. Second, for each of the cannon shell projectile models you implemented in (1), program some reasonable procedure that i) computes the angle of projection that gives maximal range and ii) obtains that maximum range. [Using the bisection method is advised.] Take the same parameters as in (1), and compute the optimal angle to within 1/10 of a degree in each case. In addition, estimate the corresponding accuracy of the computed maximum range. In view of these results and the numerical technique employed, is your choice of Δt justified?