Homework assignment 2

2.1 Compare the exact solution for the velocity as a function of time without air resistance with the numerical results in Figure 2.1 and show that they agree.

2.3 Estimate the effect of the Stokes term ($-B_1 v$ term). This term, neglected in all of the previous discussions, represents *viscous drag*, that is, the dragging of air by the moving bicycle due to the viscosity of air. The viscosity, η, is usually, defined for a fluid contained between two parallel plates of area A by

$$F = \eta A \frac{\partial v}{\partial z}$$

Where F is the drag force and z is the transverse coordinate. As a rough approximation, let us replace $\frac{\partial v}{\partial z}$ by $\frac{v}{h}$ where h is the height of the bicycle plus the cyclist. For air, $\eta \simeq 2\times10^{-5}\,\mathrm{Pa\cdot s}$.

2.2.0. Derive Eq. (2.16) from Eq. (2.15). Page 26, Giordana and Nakasishi (2nd edition).

2.2.1 By modifying sample code 2.1.5, plot the trajectory of a cannon shell without air resistance, for firing angle 30°, 35°, 40°, 45°, 50°, 55°, initial speed 700 m/s, $B_2/m = 4\times10^{-5}\,\mathrm{m}^{-1}$ (basically the left figure in Figure 2.4 in Giodarno pg. 29, second edition).

2.8

In our model of the cannon shell trajectory we have assumed that the acceleration due to gravity, g, is a constant. It will, of course, depend on altitude. Add this to the model and calculate how much it affects the range.

Include the adiabatic approximation in your code.