Name: PHY401 (Fall 2005), 09/09/05

Homework Assignment #2

(*Due Date*: Monday, September 19, 12:40 pm, in class)

2.1 *Baseball Trajectory (cf. Exercise 2.13 in the textbook)* *(7 pts.)*
Construct a FORTRAN program to calculate the 2-D trajectory of a baseball (mass 0.2 kg, radius 5 cm) including a drag force (but without spinning) on sea level with drag coefficient C=0.5 and initial speed v_0=110 mph.

(a) Calculate and plot the trajectories and ranges (using a linear interpolation) in still air for various launch angles Θ_0 in steps of 1° and determine the launch angle that gives the maximum range.

(b) Repeat part (a) (using Θ_0=40° only) for a head wind of 25 mph, and for a tail wind of 25 mph.

(c) Implement a speed-dependent drag coefficient,

$$C(v) = 0.1 + \frac{0.4}{1 + \exp[(v - v_d)/\Delta]} \tag{1}$$

with v_d=160 mph and Δ=10 mph, and calculate the trajectories for fixed launch angle, Θ_0=40°, for v_0=160 and 210mph, and compare to results for constant C=0.5.

2.2 *Table Tennis Ball with Spin (cf. Exercise 2.24 in the textbook)* *(3 pts.)*
Modify your code of the previous problem (but save it under a new name!) to describe the trajectory of a horizontally launched (smooth) table tennis ball (radius 1.9 cm, mass 3 g, initial height=1.5 m) with initial speed v_0=3 m/s. Include both a drag force and a Magnus force, $\vec{F}_M = S_0\,\vec{\omega} \times \vec{v}$, with the axis of rotation out of the vertical plane of motion, S_0/m=0.04 (SI units) and ω=$\pm 2\pi \cdot 10$ rad/s. Calculate and plot the trajectories for all three cases (no spin, "topspin" and "slice").