Physics 121MA/Math 122PH
Fall 2001 Project 5 Name ____________________

Instructions: We encourage you to work with others on this project. You should write your solution neatly using complete sentences that incorporate all symbolic mathematical expressions into the grammatical structure. Include enough detail to allow a fellow student to reconstruct your work, but you need not show every algebraic or arithmetic step. It is important that you do your own writing, even if you have worked out the details with other people. All graphs should be done carefully on graph paper or drawn by a computer. This project is due at the beginning of class on Friday, October 12.

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1. A projectile is launched from the origin with some initial velocity $\vec{v}_0 = \langle v_{0x}, v_{0y} \rangle$. Assume a drag force proportional to the velocity. In symbols,

$$\vec{F}_D = -b\vec{v}$$

where b is a constant with units N·s/m.

   (a) Show that Newton's second law leads to an equation of motion for the projectile

$$\vec{F}_{\text{net}} = m\vec{a} = -b\vec{v} + m\vec{g}.$$

   (b) Write as separate scalar equations the x- and y-components of the equation in (a).

   (c) Using the fact that $a_x = dv_x/dt$, solve the x-component equation from (b) for v_x as a function of time. Your answer should include the parameters m, b and v_{0x}.

   (d) Using the fact that $a_y = dv_y/dt$, solve the y-component equation from (b) for v_y as a function of time. Your answer should include the parameters m, b and v_{0y} as well as g.

   (e) Using your results from (c) and (d), solve for $x(t)$ and $y(t)$.

   (f) Draw a sample trajectory $y(x)$ using the following parameters: $v_0 = 30$ m/s; $\theta_0 = \pi/6$; $m = 1$ kg; and $b = 0.2$ N·s/m. Compare the trajectory with the zero-friction case you studied in Chapter 4. (Plot the two trajectories–with and without friction–and see how the horizontal range is affected by friction.)