Section 2.1

Problem 2.A: Phun/Matlab exercise. Set up a "falling body" scene to demonstrate air resistance, and email your completed scene file to dgary@njit.edu. To set up the scene,

- Start with New Scene from the File menu.
- Click the "Options" menu item along the top, then in the options window click "Simulation." Set the Air friction strength to 4.00, then close the window.
- Place a circle object (ball) on the screen. Make sure gravity and air resistance are on.
- When you start the simulation, the ball will just fall off the bottom of the screen. To follow the ball, click on it, choose the "Selection…" menu item at left, and check "Follow with Camera."
- You will do some quantitative measurements. Click on the ball to select it, and display the Information window from the left menu. Drag this window to somewhere else on the screen, and it will stay open. Pay special attention to the Velocity *y*-value. This is v_y.
- Also choose "Show sim-info" from the File menu, and pay attention to the Simulation time value. This is the time *t*.
- Set the ball's density by clicking on it and selecting "Material…" from the menu at left. Set the density to 0.05 kg/m^2. To do this, click on the number, delete it, and type in 0.05.

You are now ready to do some experiments. Start the simulation and watch the velocity grow rapidly at first, then settle down to a constant terminal velocity. Write down the terminal velocity. Reset the simulation to t=0 (the "fast reverse" button), then run the simulation forward, stopping after about 1 s, 2 s, 3 s, … up to about 10 s. Each time, write down the exact time and exact *y* velocity, then resume from where you stopped. Using Matlab, plot v_y vs. *t*, and overplot the two functions given by Eq. 2.33 and Eq. 2.57 of the text. For Eq. 2.33, you need the time constant τ. You can try getting it from Eq. 2.34, but I find that it does not quite work—you need to use $g \sim 8$ m/s^2 to get it to work. Based on your overplot of the two functions, which drag force does Phun use, linear or quadratic? Turn in your measurements (table of *t* and v_y values) and your printed Matlab plot.

Problem 2.B: Phun/Matlab exercise. Let's look at horizontal drag in Phun. Set the problem up by creating two planes, one at a 15 degree angle. Again, set the air friction strength to 4.00. Place a ball object on the incline, with a mass of 0.5 kg. Open both the Sim-info window (to get the simulation time) and the Information window (to get the x velocity, v_x.). Turn OFF air resistance and try the simulation. Note that when the ball reaches the flat surface, v_x stops changing. The purpose of the incline is only to get the ball rolling on the flat surface with a constant velocity. Reset the simulation and start it again, but this time stop it just after the ball reaches the flat surface. Note the velocity and time. These are your initial velocity v_{xo}, and initial time t_o. With the simulation still stopped, turn ON air resistance, and then resume the simulation. Stop it five or six times as it slows down, and write down the value of v_x and *t* each time. In Matlab, plot your measurements and overplot the functional form for horizontal motion with linear drag. You'll have to take account of the fact that your initial t_o value is not zero! Try several values of τ until you get a good match. Turn in your measurements and your printed Matlab plot with the best-fit τ.