

Freefall with Air Resistance

Introduction

In this lab we will try to determine the functional form of the air resistance. When we model air resistance we usually assume that the air resistance is proportional to the velocity or velocity squared. For velocities in the range of we can derive from fluid mechanics that the air resistance is

$$F_r = \frac{1}{2} c_w \rho A v^2$$

where c_w is a dimensionless drag coefficient, ρ is the air density, v is the velocity and A is the cross-sectional area. The drag coefficient is a function of velocity but is approximately 0.2 for velocities below the speed of sound.

Lab

1. Take the laptop, Pasco interface, and a sonic range finder and go over to the gym where we can drop a ball from 10 meters or more. Get three or four balls from the demo closet and drop each ball while recording the position, velocity, and acceleration as a function of time.
2. Return to the lab and measure the diameter and mass of each ball.
3. Now use the results from last week and try to determine if the drag force is proportional to the velocity or the velocity squared. If neither works then try some other form like the square-root of the velocity.
4. There are a number of ways to compare your data to theory. One simple way is to plot the theory and data on the same graph and vary the parameters until you get a “good” fit. Some programs like Excel and MatLab allow you to do a non-linear least-square fit.