

## **Drag Force Lab**

### (Effects of Air Resistance)

#### **Abstract:**

In this lab we will investigate the problem of how air resistance modifies kinematic motion of objects moving through it. We will also see a hint of how physical theories are constructed and tested and how pitfalls can appear in the construction of new models.

#### **Theory:**

We have already studied the special case of kinematics without air resistance -- that is, pure motion not affected by any medium. Obviously, kinematics described like this cannot possibly be correct because air resistance is a real effect that produces measurable responses such as terminal velocity and projectile motion that is not parabolic. We also know from studying friction that resistive forces are extremely complicated on the microscopic level and difficult to deal with in any way that is not purely phenomenological (phenomenological -- describing something purely in a way that is descriptive rather than based on first principles (first principles -- classical physics derived directly from  $F = ma$  ( as opposed to quantum physics derived from the Schrodinger equation)))

So how do you account for the effect of air resistance?

#### **Procedure:**

- a) Set up the air track as shown in class to and balance it. Construct sails for the carts to produce a larger air resistance.
- b) Put a photogate exactly in the middle of the air track (100 cm) and set the program for “*one gate time*” with the sampling rate being the length of the cart.
- c) Give the cart a “relatively fast” shove and let the computer continually record velocities as the cart continues to pass through the photogate. You should have a data set that can be put in the form of a table reading velocity vs.  $x$ , where  $x$  will be described as just 1, 2, 3, 4, etc... In actuality, one will be 2 meters, and two will be 4 meters and so on. For your table, just write next to your axis  $x$  (one unit is equal to two meters).
- d) Now plot the complete set as velocity vs. distance. Describe the line (i.e. curved, straight, sine wave, etc.)? Print a copy of this graph.
- e) Using your brains and/or Logger Pro line analysis, try to fit your data to an equation or equations. Which equation(s) worked? Record line equations, slopes,  $m$  and constants,  $b$
- f) Determine the transition velocity where air resistance goes from exponential drag to linear drag.
- g) Now for the interesting part: Does this really experimentally confirm the theory found on the class website for drag forces? Using your critical thinking skills, come up with an alternate model or theory explaining the results of this experiment?