Lab: Motion with Changing Acceleration

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1 Procedure

The objective of the lab was to investigate the impact air resistance has on a free-falling object, we dropped two objects. One was a ball which acted as a control, as the ball drops with little to no air resistance. We also dropped a paper cone, in which air resistance greatly impacts the time it takes to reach its terminal velocity—free-fall. We made sure to measure the mass of the paper cone, $m = 0.005$ kg, to use in calculations later on

To collect data, we utilized the app Tracker to measure both the y-position in increments of Δt, 8.08 seconds. The app allowed us to track the velocity and the change in velocity—acceleration—for each t-step.

We then graphed the data, graphing both position v. time and velocity v. time to determine value of the acceleration due to gravity, g.

2 Data and Calculations

Upon finding the best regression model to use, we used the velocity model of the cone to determine the terminal velocity, v_{term}.

We can model the situation with:

$$F_{\text{net}} = ma = mg - F_{\text{air}}$$

where F_{air} is the air resistance. We have two possible models of F_{air}:

$$F_{\text{air}} = kv \qquad\qquad F_{\text{air}} = kv^2$$

where k is some constant.

We can determine k for both models by using v_{term}, the value of v as t approaches ∞:

$$\begin{aligned} ma &= mg - k_1 v \\ \lim_{t\to\infty} ma &= \lim_{t\to\infty} mg - k_1 v \\ 0 &= \lim_{t\to\infty} mg - k_1 v \\ -mg &= k_1 v_{\text{term}} \\ \frac{-0.005 \times 9.8}{v_{\text{term}}} &= k_1 \end{aligned} \qquad \begin{aligned} ma &= mg - k_2 v^2 \\ \lim_{t\to\infty} ma &= \lim_{t\to\infty} mg - k_2 v^2 \\ 0 &= \lim_{t\to\infty} mg - k_2 v^2 \\ -mg &= k_2 v_{\text{term}}^2 \\ \frac{-0.005 \times 9.8}{v_{\text{term}}^2} &= k \end{aligned}$$

3 Conclusions