PH132 Physics II: Train Project - Measuring the Time Constant for your Train

Part 1:Planning your Analysis

The combined mechanical and electrical model reveal for a constant applied voltage a similar mathematical equation to that of the charging RC circuit, $Q_{max} - RC\frac{dq}{dt} - q(t) = 0$ with solution, $q(t) = Q_{max}(1 - e^{-t/RC})$. Here the time constant is RC.

Previous Model

Start with the simplified version of your model by writing it in terms of the steady state velocity, $v_{ss} = B$, your trains time constant, A, and the velocity as a function of time, $v(t)$, and the acceleration, $\frac{dv}{dt}$ (From Electrical and Combined Model Submission).

Constant Voltage Velocity Model (25 pts.)

Show how you arrive at a solution for the velocity vs. time, $v(t)$ for a constant applied voltage.

Using natural log to extract the constant in the exponent (25 pts.)

From your solution, show that by taking the natural log of one minus the measured velocity at a given time over the steady state velocity versus time, ($ln\left(1 - \frac{v(t)}{vss}\right)$ vs. t) you can create a plot of your data with a straight line whose slope is related to your time constant.

Part 2: Analyzing your data.

Data Plots (30 pts)

Show $ln\left(1 - \frac{v(t)}{vss}\right)$ vs. t plots for each of your constant applied voltages. (30 points)

ANALYSIS (20 pts)

Make a plot of A verse Voltage and list your average A value.
Analysis: Is the A value a constant for your train? (10 points)