**2.003 Fall 1999 Homework Assignment 1**

1. An elevator is designed to move between floors as follows: starting at rest it accelerates to a speed of 3 feet/second in 1 second, then moves at a constant speed until it decelerates to rest in 1 second. Would it be reasonable to design the structure supporting the winch motor (and hence the elevator) without considering dynamic forces? That is, does dynamics matter in this situation? Provide a quantitative justification for your answer. Work in SI units.

2. Referring to the Pinewood Derby, answer the following questios:

(a) In SI units, how much energy is available to move the racecar?

(b) A typical Derby car is 6 inches long. If there were no friction of any kind, what would be the maximum speed (in SI units) a race car could attain if all its weight were concentrated at the front end of the car?

(c) What would be the maximum speed if all its weight were concentrated at the rear end of the car?

(d) In case (c) how long does it take the car to reach the bottom of the inclined section of track?

3. Consider adding a viscous friction retarding force 'bv' to the previous model. With such a retarding force which increases with velocity, the speed of the car, even on an inclined track of infinite length, is limited by the speed at which the retarding force just balances the accelerating force. If this limiting speed is twice the velocity obtained in 2(c), what is the value (in SI units) of the viscous friction parameter 'b'?

4. The two MATLAB scripts which follow permit you to integrate the equation of motion for a racecar on a long incline with angle 'alpha', subjected to a viscous friction force. Study the programs and experiment with them , using the Pinewood Derby parameters and the friction parameter 'b' obtained in 3, above.

(a) Plot a graph of the racecar speed vs. time for a car starting at rest, over the time period obtained in 2(d).

(b) With a long incline the speed of the car is asymptotic to the limiting speed described in 3, above. Use the scripts to determine how long it takes for the speed to reach 99.9% of the limiting speed.