



Figure 1: $M = 900 \text{ Kg}$, $b = 44.145 \text{ N}\cdot\text{s}^2/\text{m}^2$

The cart in Figure 1 rests on a ramp which is inclined 30 degrees with respect to the horizontal. At $t=0\text{s}$, the cart is released from rest (i.e. with no initial velocity). As indicated, the air resistance is proportional to the velocity squared.

- a.) Using the principals of basic mechanics, draw a free-body diagram of the cart clearly showing all the forces acting on the body including inertial forces.
- b.) Find the system model (i.e. the differential equations governing the dynamic behaviour of system). Is the system model linear or non-linear?
- c.) Analytically determine:
 - the initial acceleration of the cart
 - the final or steady-state velocity of the cart.
 Note that it is not necessary to solve the system model.

Using MATLAB/SIMULINK, determine the velocity and acceleration profiles of the cart as a function of time. Compare the initial acceleration and the steady-state velocity of the cart obtained analytically in c.) with the value provided by SIMULINK.

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If the ramp is only 30 meters long (i.e. the angle of inclination is 30 degrees for 30 meters and 0 degrees afterwards) determine the velocity and acceleration of the cart.