Homework Set #3

1. (F&C 2.1) Find the velocity $\dot{x}$ and the position $x$ as functions of the time $t$ for a particle of mass $m$ which starts from rest at $x = 0$ and $t = 0$, subject to the following force functions

   (a) $F_x = F_0 + ct$
   (b) $F_x = F_0 \sin(ct)$
   (c) $F_x = F_0 e^{ct}$

2. (F&C 2.2) Find the velocity $\dot{x}$ as a function of the displacement $x$ for a particle of mass $m$ which starts from rest at $x = 0$, subject to the following force functions

   (a) $F_x = F_0 + cx$
   (b) $F_x = F_0 e^{-cx}$
   (c) $F_x = F_0 \cos(cx)$

3. An automobile driver traveling down an 8% grade slams on his breaks and skids 30 meters before hitting a parked car. A lawyer hires an expert who measures the coefficient of kinetic friction between the road and the tires to be $\mu_k = 0.45$. Is the lawyer correct to accuse the driver of exceeding the 25 MPH speed limit? Explain. (Assume that an 8% grade means that the road raises 8 meters vertically for every 100 meters traveled horizontally.)

4. (F&C 2.6) A particle of mass $m$ moves along a frictionless, horizontal plane with a speed given by $v(x) = \alpha/x$, where $x$ is the displacement from the origin and $\alpha$ is a positive constant. Find the force $F(x)$ to which the particle is subjected.

5. (F&C 2.15) Show that the terminal speed of a falling spherical object is given by

   $$v_t = \sqrt{\left(\frac{mg}{c_2}\right) + \left(\frac{c_1}{2c_2}\right)^2 - \left(\frac{c_1}{2c_2}\right)}$$

   when both linear and quadratic terms in the drag force are taken into account.