PHYS 374 Homework 2----Due September 25

1. Consider an extended object falling under gravity and in the presence of air resistance. The force of air resistance is given by $F_R = -a v - b v$ with a, b as constants.
   a) Find an expression for the terminal velocity.
   b) Find an expression for the time constant describing the exponential approach of the system to the terminal velocity.

2. For the system considered above suppose that *b* is small so that the system is nearly linear.
   a) Find a condition for what is meant by "small" for *b*
   b) Find an approximate expression for the terminal velocity including first order corrections in *b*
   c) Find an approximate expression for the time constant describing the exponential approach including first order corrections in *b*.

3. Consider an extended object of 1.89 kg fall near the surface of the earth. The air resistance is given by $F_R = -a v \dfrac{\exp(v/v_0)}{\log(1+v/v_1)}$ where a = 1.22 kg-m/s, v_0 = 17.4 m/s and v_1 =12.9 m/s.
   a) Find the terminal velocity.
   b) Suppose that at t=0 the velocity is .98 v_T where v_T is the terminal velocity. Find an approximate but very accurate expression for v valid for $t>0$.

   (Hint: For this problem you must use numerical analysis. Use Mathematica)

4. Consider a conservative one dimensional system consisting of a particle of mass, *m*, moving in a potential. For the following potentials, determine the frequency of small amplitude oscillations near the minimum.
   a) $U(x) = U_0\left(1 - e^{-(x/l)^2}\right)$
   b) $U(x) = U_0\left[\cos(x/l) + \cos(2x/l)\right]$
   c) $U(x) = U_0\left[\sin(x/l)\right]$