Physics 235, Homework Set 02

1. A particle moves in a medium under the influence of a retarding force equal to $-mk(v^3+a^2v)$, where k and a are positive constants. Show that for any value of the initial speed the particle will never move a distance greater than $\pi/2ka$ and that the particle comes to rest only when the time approaches infinity.

2. Show directly that the time rate of change of the angular momentum about the origin for a projectile fired from the origin is equal to the moment of the gravitational force (its torque) about the origin.

3. A particle of mass m = 1 kg is subjected to a one-dimensional force

$$F(t) = kte^{-\alpha t}$$

where k = 1 N/s and α = 0.5 s^{-1}. If the particle is initially at rest, calculate and plot with the aid of a computer the position, speed, and acceleration of the particle as a function of time.

4. Consider a particle moving in the region $x > 0$ under the influence of the potential

$$U(x) = U_0\left(\frac{a}{x}+\frac{x}{a}\right)$$

where U_0 = 1 J and a = 2 m. Plot the potential, find the equilibrium points, and determine whether they are maxima or minima.

5. Which of the following forces are conservative?
   a. $F_x = ayz + bx + c, F_y = axz + bz, F_z = axy + by$
   b. $F_x = -ze^x, F_y = \ln z, F_z = e^x + y/z$
   c. $\vec{F} = (a/r)\hat{r}$

   In these equations a, b, and c are constants. For the conservative forces, find the potential energy U.