PHYS 3201 — Assignment #2

Due: 9/4/20

1. Find the velocity $\dot{x}$ as a function of displacement x for a particle of mass m, which starts at rest at $x = 0$, subject to the following force functions.

   (a) $F_x = F_0 + cx$

   (b) $F_x = F_0 e^{-cx}$

   (c) $F_x = F_0 \cos cx$

   where F_0 and c are positive constants.

2. Find the potential energy function $V(x)$ for each of the forces in Problem #1.

3. A particle of mass m is constrained to lie along a frictionless, horizontal plane subject to a force given by $F(x) = -kx + kx^3/A^2$ where k and A are positive constants. The particle is projected from $x = 0$ to the right with initial kinetic energy T_0. Find (a) the potential energy function $V(x)$ for this force; (b) the kinetic energy, and (c) the total energy of the particle as a function of its position. (d) Find the turning points of the motion and the condition the total energy of the particle must satisfy if its motion is to exhibit turning points.

4. Given that the velocity of a particle in rectilinear motion varies with displacement x according to

   $$\dot{x} = bx^{-3}$$

   where b is a positive constant, find the force acting on the particle as a function of x.

5. A particle of mass m moves under a force $F = -cx^3$ where c is a positive constant. Find the potential energy function. If the particle starts from rest at $x = -a$, what is its velocity when it reaches $x = 0$? Where in the subsequent motion does it instantaneously come to rest?

6. A block of wood is projected up an inclined plane with initial speed v_0. If the inclination of the plane is 30° and the coefficient of sliding friction is $\mu_K = 0.1$, show that the total time for the block to return to the point of projection is $0.381 v_0$ s.