PH103 Physics-I: Tutorial-3

Spring semester 2020

1. A particle of mass m moves in one dimension along the positive x-axis. It is acted on by a constant force directed toward the origin with magnitude B, and an inverse square law repulsive force with magnitude A/x^2. Find the potential energy function V(x).

2. The interactions between meson and fermions, subatomic particles, are described by Yukawa potential given by

$$V_{Yukawa}(r) = -g^2 \frac{e^{-\alpha m r}}{r},$$

where g, α are constants, r is the radial distance to the particle and m is the mass of the particle. Show that the force acting between these particles is conservative.

3. A bead of mass m slides without friction on a smooth rod along the x-axis. The rod is equidistant between two spheres of mass M. The spheres are located at x = 0, y = ±a as shown in figure-1, and attract the bead gravitationally. (a) Find the potential energy of the bead. (b) The bead is released at x = 3a with velocity v_0 toward the origin. Find the speed as it passes the origin.

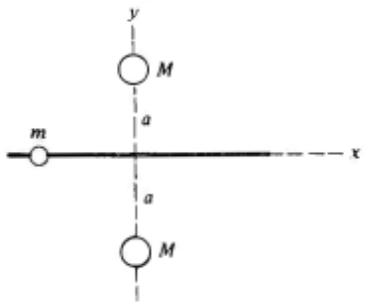

Figure-1

4. A simple way to measure the speed of a bullet is with a ballistic pendulum. As illustrated in figure-2, this consists of a wooden block of mass M into which the bullet is shot. The block is suspended from cables of length l, and the impact of the bullet causes it to swing through a maximum angleϕ, as shown in figure-2. The initial speed of the bullet is v, and its mass is m. (a) How fast is the block moving immediately after the bullet comes to rest? (Assume that this happens quickly) (b) Show how to find the velocity of the bullet by measuring m, M, l and ϕ.

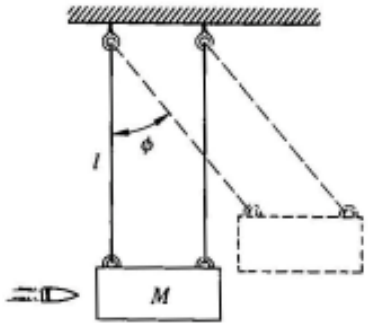

Figure-2

5. A bead of mass slide without friction on a vertical hoop of radius R. The bead moves under the combined action of gravity and a spring attached to the bottom of the hoop. For simplicity, we assume that the equilibrium length of the spring is zero, so that force due to the spring is (–kr), where r is the instantaneous length of the spring as shown in figure-3. The bead is released at the top of the hoop with negligible speed. How fast is the bead moving at the bottom of the hoop?

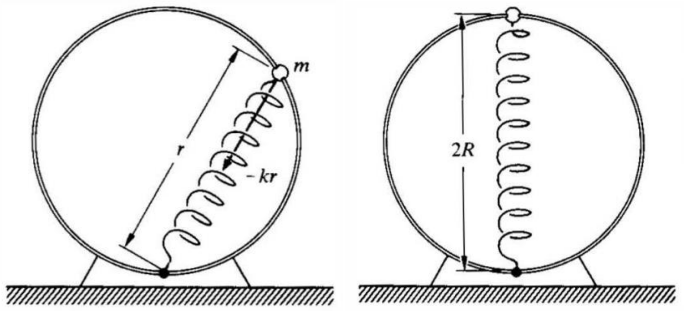

Figure-3