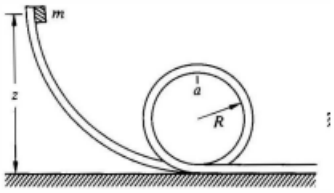
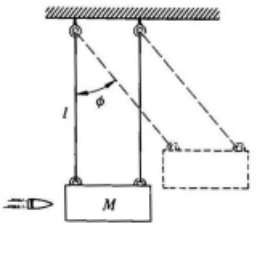
INDIAN INSTITUTE OF TECHNOLOGY PATNA

PH103 : Physics Tutorial 4

1. A small block of mass m starts from rest and slides along a frictionless loop-the·loop as shown in the figure. What should be the initial height z, so that m pushes against the top of the track (at a) with a force equal to its weight?



2. A simple way to measure the speed of a bullet is with a ballistic pendulum. As illustrated, 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 angle ϕ, as shown. 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.



3. if $\vec{F} = (2xy+z^2)\hat{e_x}+x^2\hat{e_y}+2xz\hat{e_z}$ N, then show that it is conservative. Calculate the amount of work done by this force in moving a particle from (0,1,2) to (5,2,7)m

4. Sand drops vertically (from a negligible height) at a rate σ kg/s onto a moving conveyor belt.
   (a) What force must you apply to the belt in order to keep it moving at a constant speed v?
   (b) How much kinetic energy does the sand gain per unit time?
   (c) How much work do you do per unit time?
   (d) How much energy is lost to heat per unit time?

5. Assume that a cloud consists of tiny water droplets suspended (uniformly distributed, and at rest) in air, and consider a raindrop falling through them. What is the acceleration of the raindrop? Assume that the raindrop is initially of negligible size and that when it hits a water droplet, the droplet's water gets added to it. Assume that the raindrop is spherical at all times and also assume that the raindrop falls with constant acceleration at large times, we may write $\frac{d^2r}{dt^2} = bg$ where $r(t)$ is the instantaneous radius of the rain drop
   Provided ρ is the mass density of the rain drop and λ is the average mass density of the water droplets in space.