Physics 271, Sections H1 & H2 — Thursday, Oct 9, 2014
Problems #5 — Kinetic Energy & Work

1) A box, with mass m, moves on a frictionless path as shown in fig. 1. This path is an inclined plane followed by a circular path with radius r. The point which inclined plane meet the ground is smoothened, so that there is no collision, i.e. the velocity does not change suddenly and there is no energy loss. We release the box from height H on the inclined plane.

a) How much work the normal force does on the box? How about the gravitational force, mg?
b) Find the velocity of the box at points A, B, and C.
c) Find the normal force on the box, at the points A, B, and C.
d) Find the condition so that the box leaves the path at point C.
e) Find the condition so that the box leaves the path at a point P between B and C. The angle of P is given, θ.

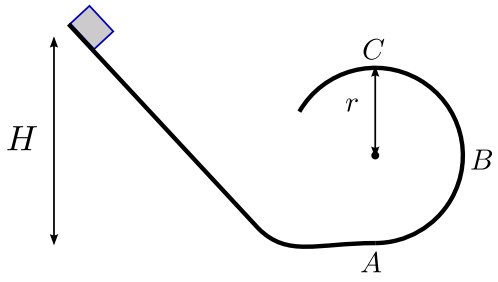

Figure 1: The path.

2) You are standing on a level with height h, and there is a frictionless pulley at the end. You are pulling a rope horizontally, with constant force T. This rope is connected to a box with mass m on a level with height zero, using a frictionless pulley. Check fig. 2. Initially, at time $t = 0$, the mass is at a horizontal distance L from pulley.

a) If there is no friction between the box and ground, and you use constant force T to pull the rope, what will be the velocity of the box when it reaches the point right below the pulley?
b) If the coefficient of kinetic friction is μ_k, again, find the velocity of the box when it reaches the point underneath the pulley?
c) On above parts, 'a' and 'b', what assumption we need to make so that the box stays on the ground the whole time?

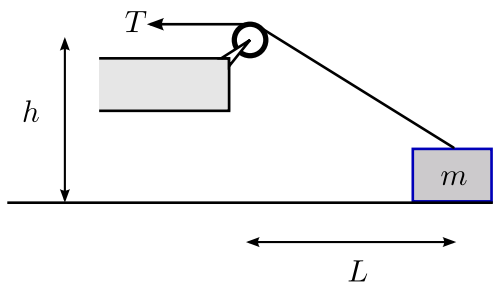

Figure 2: The levels.

3) There is a small box, with mass $m = 0.10$ kg, on a horizontal table. Using a force in horizontal direction you make the box moves on the table in a path given by $\mathbf{r}(t)$.
a) If $\mathbf{r}(t) = \left[t^2\hat{\mathbf{x}} + (t^3 - 3t^2)\hat{\mathbf{y}}\right]$ cm, how much work this force have done between $t = 0$ and $t = 5$ sec. [fun] Discuss how one can solve the problem if there is also friction in the problem.
b) If the path is, instead, $\mathbf{r}(t) = \left[(t^3 - 3t^2)\hat{\mathbf{x}}\right]$ cm, find how much work the force have done, if the coefficient of kinetic friction is $\mu_k = 0.5$.