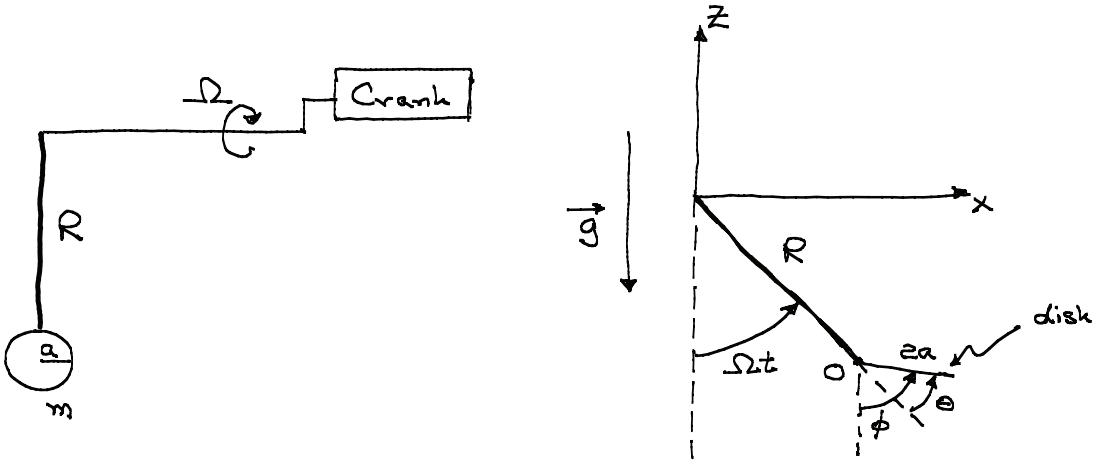
Phys 503 Classical Mechanics I **Fall 2013**

Homework Assignment #4 **Due Tuesday, October 29**
(50 points) **(at lecture)**

4.5 (10 points) Challenge problem. A bar of length R is attached to a crank that rotates the bar with constant angular velocity Ω, as shown in the drawing on the left below. A solid disk of negligible thickness is attached to the end of the bar in such a way that it is free to swing about the axis about which the bar rotates. The disk has radius a and mass m. A side view of the bar and the disk, looking along the axis of rotation toward the crank, is shown in the drawing on the right below.



(a) Derive the relevant moment of inertia, I, of the disk about its center of mass.

(b) Give the Lagrangian of the disk in terms of the angular coördinate ϕ shown in the drawing on the right.

(c) Find the equation of motion of the disk in terms of the angular coördinate θ shown in the drawing on the right.

(d) Assuming that $g \ll R\Omega^2$ and $a \ll R$, show that the equation of motion for θ predicts small oscillations about $\theta = 0$.