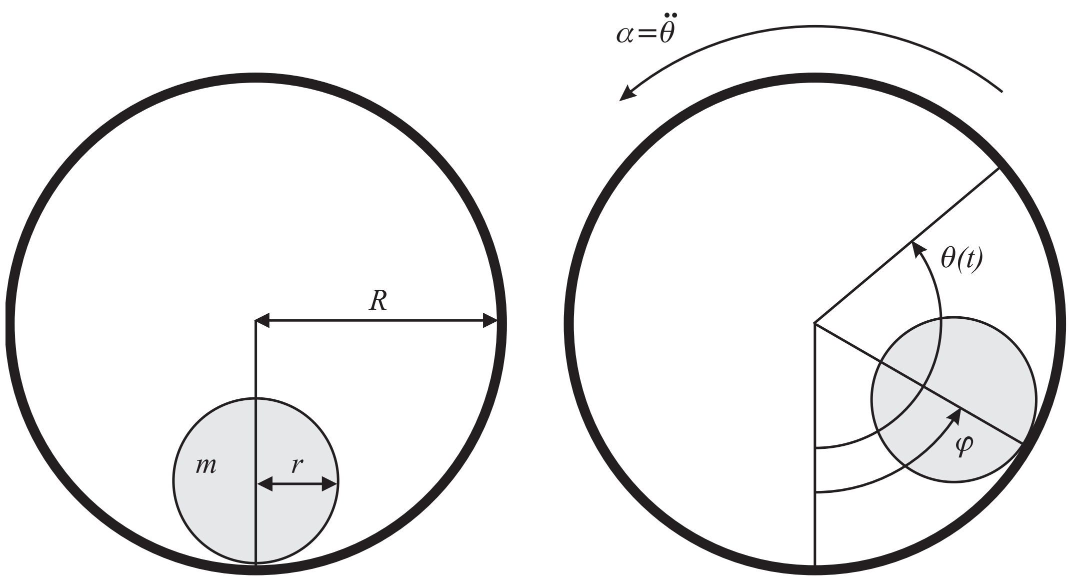
Kungl Tekniska Högskolan **2010 10 04**
Mekanik

Rigid Body Dynamics, SG2150

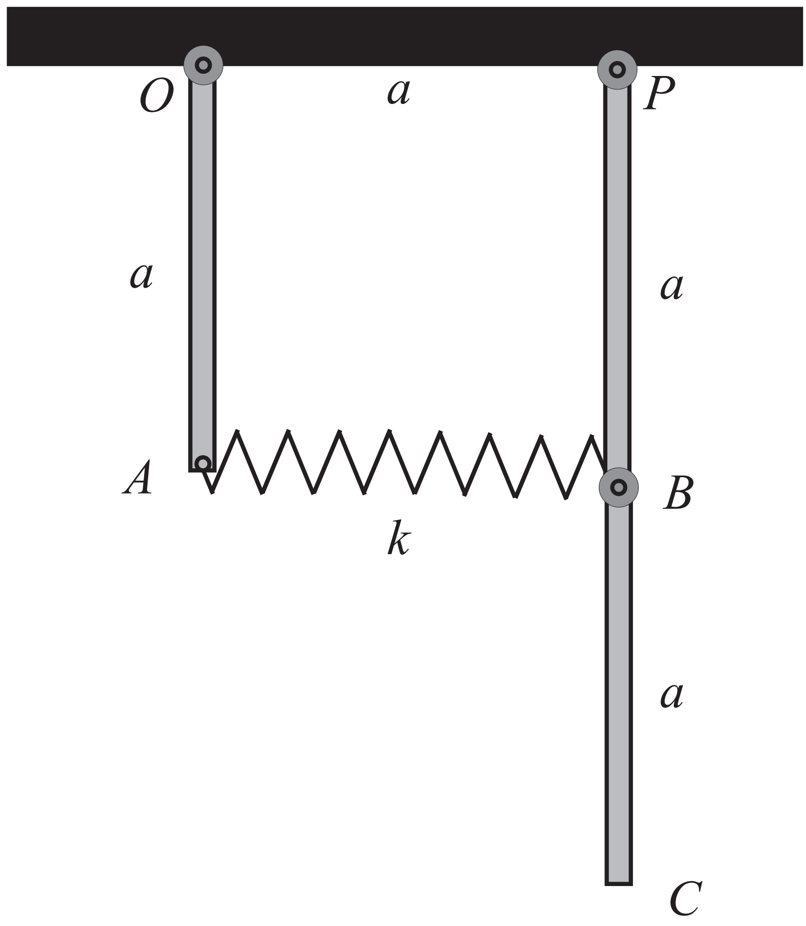
Hand in assignments 3, HT 2010, due Thursday 14 October

1) A homogeneous, straight, circular cylinder of mass m and radius $r(< R)$, rolls in a horizontal straight, circular cylindrical drum. The drum, which has radius R, and is rough on the inside can rotate about its fixed horizontal axis. Initially the drum and the cylinder are at rest with the cylinder in equilibrium at the bottom of the drum. By means of a controlled motor the drum is then given a constant angular acceleration α.
a) Find the equation of motion for the deflection angle φ of the cylinder using the Lagrange method with time dependent constraint. (Note that the drum has a prescribed motion and only supplies a time dependent constraint; it has no equation of motion.)
b) Calculate the deflection angular velocity $\dot{\varphi}$ as a function of the angle φ.
c) Because of the angular acceleration α of the drum the cylinder acquires a new equilibrium deflection angle. Calculate the value φ_0 of this angle.
d) Assume that the cylinder performs small oscillations about the new equilibrium. Find the angular frequency of these.



Don't miss problem 2 on next page!

2) A system consists of three equal homogenous rods OA, PB, and BC, of length a and mass m. Three rods are arranged according to the figure so that they all can swing in the same vertical plane about hinges of negligible friction at O, P, and B. O and P are fixed while B connects two of the rods. OA is thus a single physical pendulum, while PBC is a double pendulum. The end point A and the hinge at B are connected by a light straight spring of stiffness k and natural length a. the distance OP is also a, so that the equilibrium position of the system is as shown in the figure below. Introduce the dimensionless parameter $\epsilon = (ka)/(mg)$ and find the angular frequencies for small oscillations about the equilibrium in terms of ϵ.



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