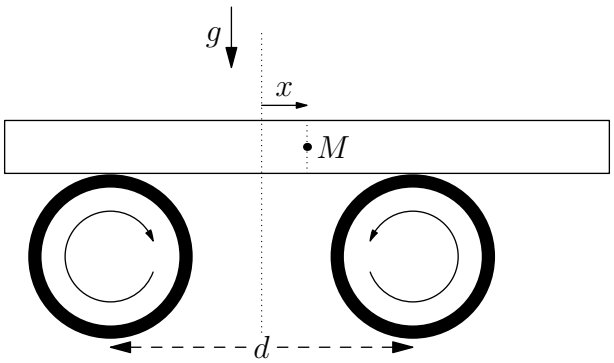
J10M.3 - Slab on Rotating Rollers

Problem

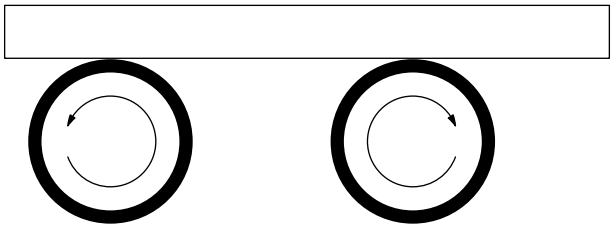


A uniform rigid slab of mass M is supported by two rapidly counter-rotating parallel horizontal rollers, with axes a distance d apart, with surfaces that brush past the slab in the directions shown in the figure. The coefficient of kinetic friction between each roller and the slab is μ_k.

At time $t = 0$, the center of mass of the slab is initially displaced horizontally by $x(0) = x_0$ (where $|x_0| < d/2$) relative to the midpoint between the rollers, and the slab is initially at rest, $\dot{x}(0) = 0$.

a) Write down the equation of motion for $x(t)$, and solve it for $t > 0$ with the given initial conditions.

Now consider the case where the directions of the rollers are reversed, as shown below:



b) Calculate $x(t)$ for $t > 0$ for the same initial conditions, in this second case.