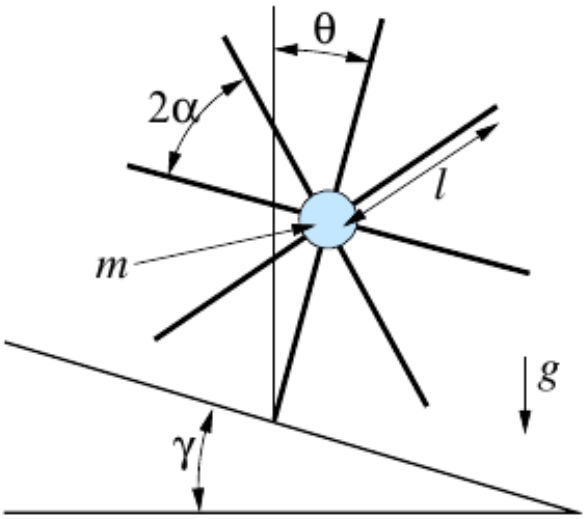
# Rimless Wheel

## The Rimless Wheel (Passive Dynamics I)

0.0/8.0 points (graded)

For this problem, you should be able to compute all of the quantities in closed form (no numerical simulations should be necessary).




(a) If we assume that the wheel is started in a configuration directly after a transfer of support, then forward walking occurs (i.e., the system takes a step) when the system has an initial velocity $\dot{\theta}\left(0^{+}\right) > \omega_1$. When the next foot touches down the conversion of potential energy into kinetic energy yields the velocity before touchdown $\dot{\theta}\left(t^{-}\right)$. Derive the expressions for $\omega_1$ and $\dot{\theta}\left(t^{-}\right)$ in terms of $g, l, \alpha, \gamma, \dot{\theta}\left(0^{+}\right)$. Type in your answers below. Please write $\alpha$, $\gamma$, and $\dot{\theta}\left(0^{+}\right)$ as "alpha", "gamma" and "thdot0" respectively.

$\omega_1 =$

$\dot{\theta}\,(t^-) =$

Submit You have used 0 of 3 attempts

## The Rimless Wheel (Passive Dynamics II)

0.0/2.0 points (graded)

(b) Write down a condition of the form $\gamma > f\,(\alpha, g, l)$ such that $\omega_1$ is non-existent when this condition holds. Type in your answer for $f\,(\alpha\, g, l)$ below (as before, write $\alpha$ as "alpha"\). Think about what this condition means physically.

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## The Rimless Wheel (Gait Design)

0.0/7.0 points (graded)

(c) Consider a rimless wheel with $m = 1$ kg, $g = 9.8$ m/s$^2$, $\alpha = \frac{\pi}{8}$ rad, and $\gamma = 0.08$ rad. For what leg length $l$, is the steady-state rolling speed of the system (measured when the pendulum is vertical over the stance feet: $\theta = 0$) equal to 4.0 rad/s? **The tolerance for this answer will be 0.001.**

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# The Rimless Wheel (Terrain Stability)

0.0/8.0 points (graded)

(d) Consider a rimless wheel with $m = 1$ kg, $l = 1$ m, $g = 9.8$ m/s$^2$, and $\alpha = \frac{\pi}{8}$ rad rolling down a slope, $\gamma = 0.16$ rad. Some time after reaching the rolling steady state, the terrain shallows to $\gamma = 0.02$ rad for a distance $d$, then returns to (and remains at) $\gamma = 0.08$ rad. You may assume that the shallow slope begins and ends precisely at a position of touchdown (not somewhere between steps). What is the largest value of $d$, subject to these constraints, for which the system will be at a rolling fixed point when $\gamma = 0.08$ as $t \to \infty$? **The tolerance for this answer will be 0.001.**

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