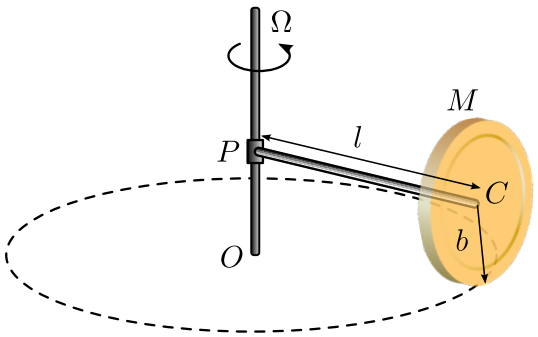
Tutorial 6 **Rotation** 23 August 2024

P1.



A wheel of mass M and radius b is mounted on an axle of length l. This is pivoted to a vertical rod, about which the wheel rolls with angular frequency Ω.

(a) Find the instantaneous angular velocity $\vec{\boldsymbol{\omega}}$ of the wheel.

(b) What is the condition for rolling without slipping?

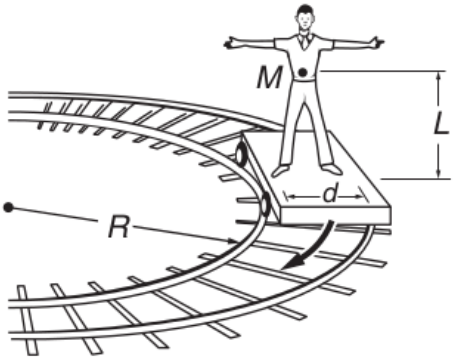
(c) Calculate the angular momentum vector of the wheel with respect to the pivot O.

(d) Calculate the instantaneous angular momentum of the wheel with respect to its center of mass C.

(e) List all the physical forces on the wheel and find the torques due to these forces about O.

(f) Find the contact force at the ground and compare it to the weight of the wheel.

P2.



A man of mass M stands on a railroad car which is rounding a turn of radius R at speed v. His center of mass is at a height L above the car and his feet are distance d apart.

Fig from K and K problem 6.6

(a) Consider an inertial frame with the origin at the instantaneous CM of the man

i. What are the forces acting on the man

ii. What is the net torque acting on the man

iii. What is the angular momentum of the man

iv. When will he topple over

(b) Now consider a frame with the origin at the centre of the circle. Answer the same question given above, in this frame.

P3.

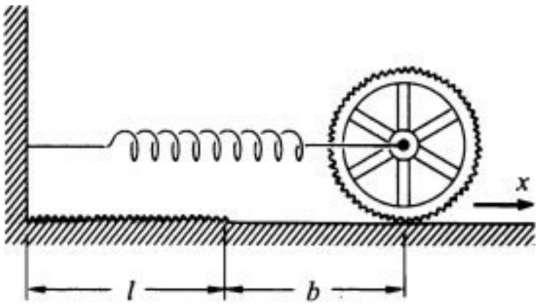


Fig from K and K problem 6.40

A wheel of radius R and mass M is equipped with fine teeth that can mesh with fine teeth on a horizontal surface of length l. For $x > l$ the ground is smooth. The wheel is attached to the wall with a spring of unstretched length l and spring constant k.
The wheel is pulled out to a distance $l + b$ from the wall and released.

(a) How close to the wall will the wheel reach on its first trip towards the wall?

(b) How far from the wall will it go on its first trip away from the wall?

(c) Describe the subsequent motion of the wheel.

Point to note: when the wheel hits the gear track, a collision occurs. Is this elastic or inelastic?