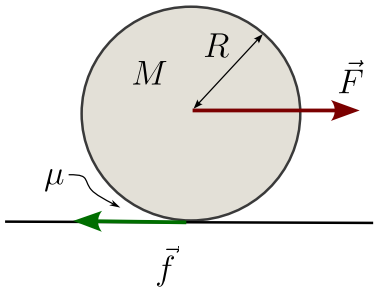
Tutorial 4 **Rolling Dynamics, Angular momentum** 20 August 2024

P1.



A solid disc of mass M and radius R is pushed on a surface with coefficient of friction μ. Determine the limits on $\vec{F}$ for the disc to

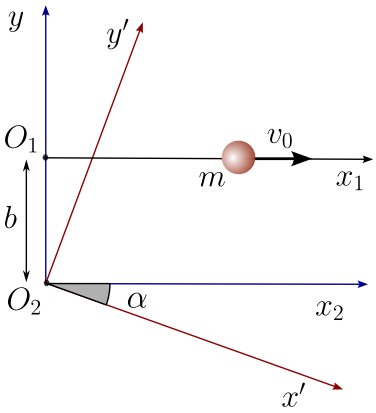
(a) roll without slipping,

(b) roll and slip

P2. A disc of mass M and radius R is set spinning with angular velocity ω and them gently placed on a horizontal surface with coefficient of friction μ. Describe the motion of the disc.

In particular find the time range in which it rolls and slips, and that in which it rolls without slipping.

P3.



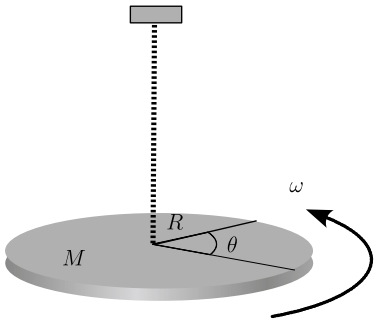
A particle of mass m moves with uniform velocity $\vec{v} = v_0\hat{i}$. Consider the three Cartesian reference frames shown and calculate its angular momentum

(a) About the point O_1 in the x_1-y frame

(b) about the point O_2 in the x_2-y frame

(c) About the point O_2 in the rotated x'-y' frame.

P4.



A disc of mass M and radius R is suspended by a rope at its center. When the disc is rotated about he vertical axis, the rope gets twisted. It resists this twisting by supplying a restoring torque proportional to the angle of the twist: $\tau = -k\theta$, where k is a constant.
Suppose the disc is rotated by an angle θ_0 and released from rest at $t = 0$. It will perform twisting (torsional) oscillations about the initial $\theta = 0$ position. Find the angular frequency and time period of these oscillations.