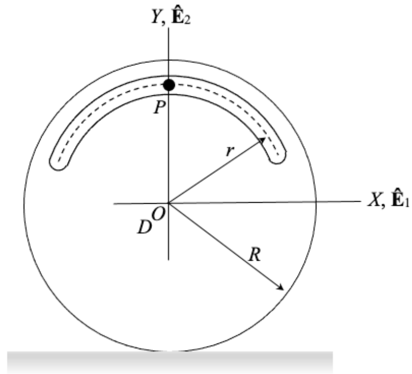
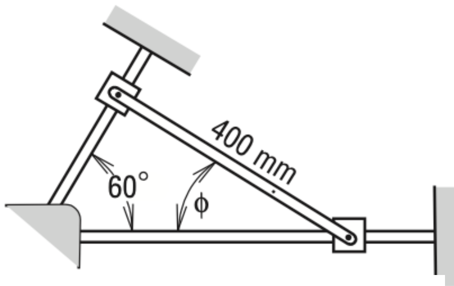
ESO209A: Dynamics: **Tutorial 13**
(Week: 3 - 9 Nov. Based on L12-L20)

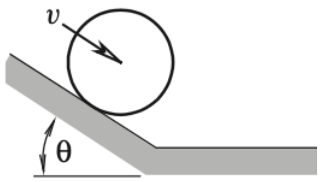
(1) A disc D of radius $R = 0.3\,\mathrm{m}$ rolls on a horizontal plane without slipping such that $\mathbf{v}_O = -\,3\hat{\mathbf{E}}_1$ m/s and $\mathbf{a}_O = -\,6\hat{\mathbf{E}}_1$ m/s^2. Point P moves in a circular slot of radius $r = 0.2$m. At the instant shown in the figure, an observer sitting on the disc and rotating with it records the velocity and acceleration of point P to be $2\hat{\mathbf{E}}_1$ m/s and $-10\hat{\mathbf{E}}_1$ m/s^2, respectively. Determine the absolute velocity and acceleration of P.



(2) The system lies in the vertical plane. The bar is released from rest at $\phi = 70°$. Determine the angular acceleration of the bar at the instant of release. Friction between the collars and their guides is negligible, as is the mass of the collars.



(3) The sphere rolls without slipping down the incline. At the instant it contacts the ground, its speed was v_0. The coefficient of restitution is ε. Derive expressions for the velocity of its center and its angular velocity at the instant



(4) The Earth-scanning satellite is in a circular oribit of period τ. The angular velocity of the satellite about its y- or *pitch*- axis is $\omega = 2\pi/\tau$, and the angular rates about the x- and z- axes are zero. Thus the x- axis of the satellite always points to the center of the Earth. The satellite has a *reaction-wheel attitude-control* system consisting of the three wheels shown, each of which may be variably torqued by its individual motor. The angular rate Ω_z of the z-wheel relative to the satellite is Ω_0 at time $t = 0$, and the x- and y- wheels are at rest relative to the satellite at $t = 0$. Determine the axial torques M_x, M_y and M_z that must be exerted by the motors on the shafts of their respective wheels in order that the angular velocity $\boldsymbol{\omega}$ of the satellite will remain constant. The moment of inertia of each reaction wheel about its axis is I. The x and z reaction-wheel speeds are harmonic functions of the time with a period equal to that of the orbit. Plot the variations of the torques and the relative wheel speeds Ω_x, Ω_y and Ω_z as functions of the time during one orbital period.