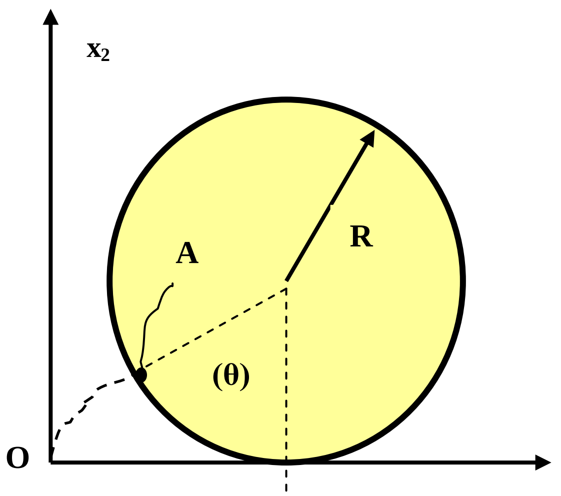
Homework Assignment: # 3

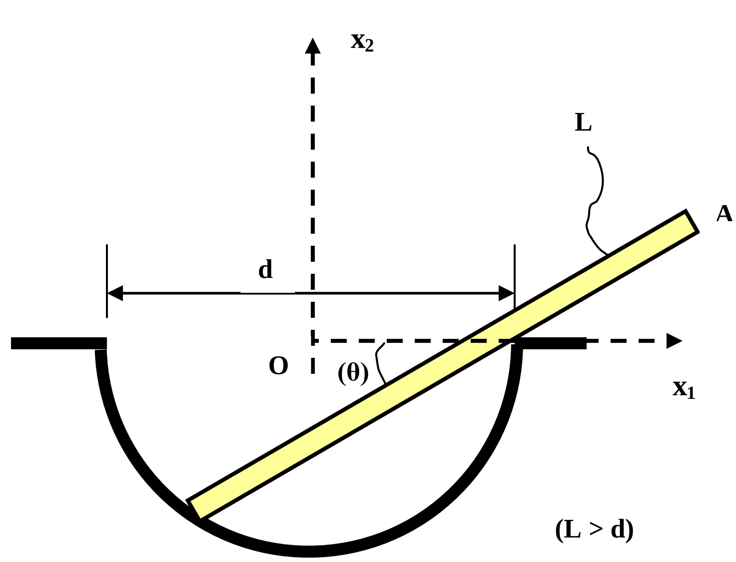
1. Write the position vectors of point **A**, $\underline{\mathbf{r}}_{A/O}$, in terms of the variables shown in the parenthesis.

(a).

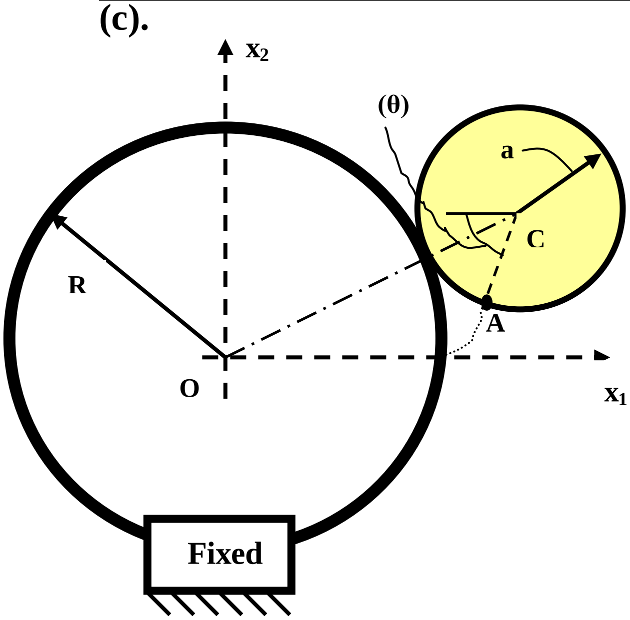


(Rolling & Non-Slipping)

(b).

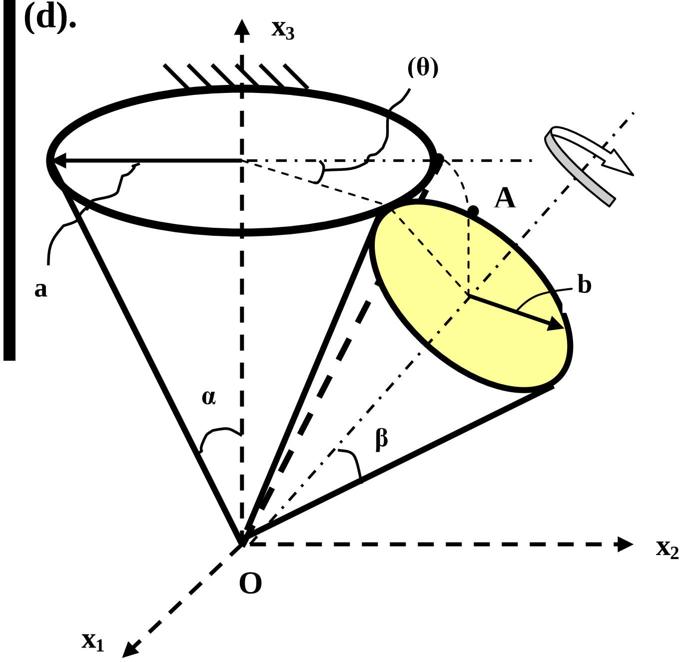


(c).



(Rolling & Non-Slipping)

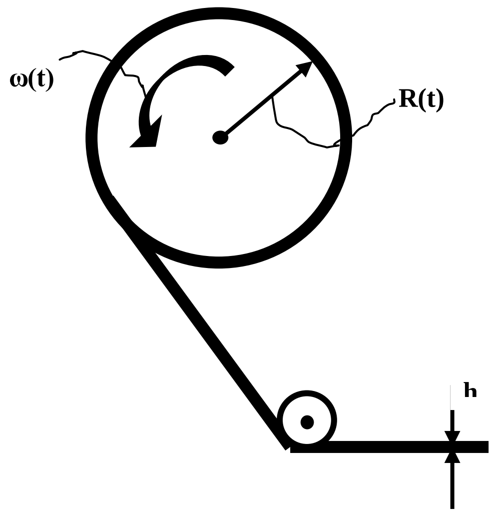
(d).



(a, b, α, β are given; Rolling & Non-Slipping)

2. Determine the velocity and acceleration vectors of parts **(a)**, **(b)**, and **(c)** in Problem **1** in terms of the parameter **θ** and its derivatives.

3. A tape is pulled off the spool at a constant speed "v". The tape's thickness is "h". Determine the angular velocity "ω" of the spool at any time, starting from a fixed spool radius of "R_0"? If a counter is connected to the spool such that its speed is proportional to the angular velocity of the spool, $\dot{N} = k\omega$, determine the equation for the counter number "N" as a function of time in the form of $N = C - \sqrt{C^2 - Kt}$, where "C" and "K" are constants related to the characteristics of the tape and the machine.



4. Let $\underline{\underline{T}}^t$ be the transform matrix that transforms Cartesian components of a vector into the Spherical components. First obtain $\underline{\underline{T}}^t$, and then show that the Spherical components of the velocity and acceleration vectors are:

$$\begin{Bmatrix} X_\theta \\ X_\varphi \\ X_R \end{Bmatrix} = \underline{\underline{T}}^t \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} \quad \Rightarrow \quad \underline{\underline{T}}^t = ?$$

$$\begin{Bmatrix} v_\theta \\ v_\varphi \\ v_R \end{Bmatrix} = \underline{\underline{T}}^t \dot{\underline{\underline{T}}} \begin{Bmatrix} 0 \\ 0 \\ R \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ \dot{R} \end{Bmatrix}$$

$$\begin{Bmatrix} a_\theta \\ a_\varphi \\ a_R \end{Bmatrix} = \underline{\underline{T}}^t \ddot{\underline{\underline{T}}} \begin{Bmatrix} 0 \\ 0 \\ R \end{Bmatrix} + 2\underline{\underline{T}}^t \dot{\underline{\underline{T}}} \begin{Bmatrix} 0 \\ 0 \\ \dot{R} \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ \ddot{R} \end{Bmatrix}$$

5. Problems **2.18**, **2.26**, ans **2.33** of Advanced Dynamics by Ginsberg, **1995**.