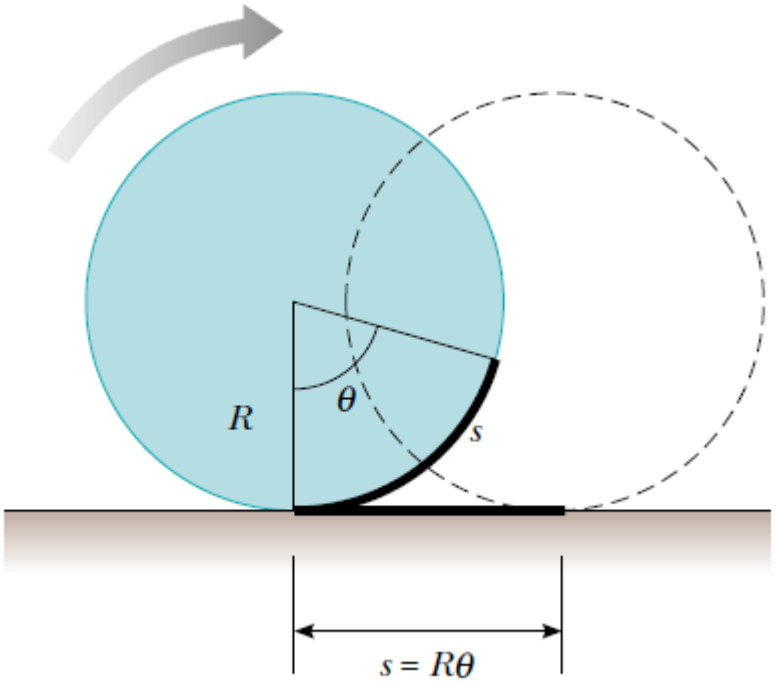
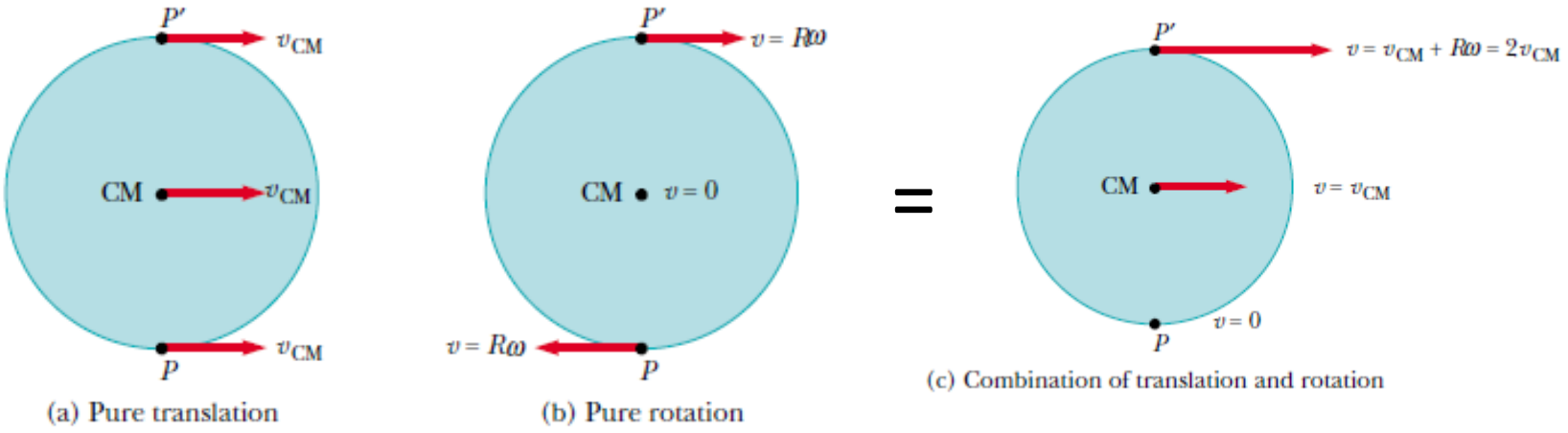
# Rolamento, torque e momento angular



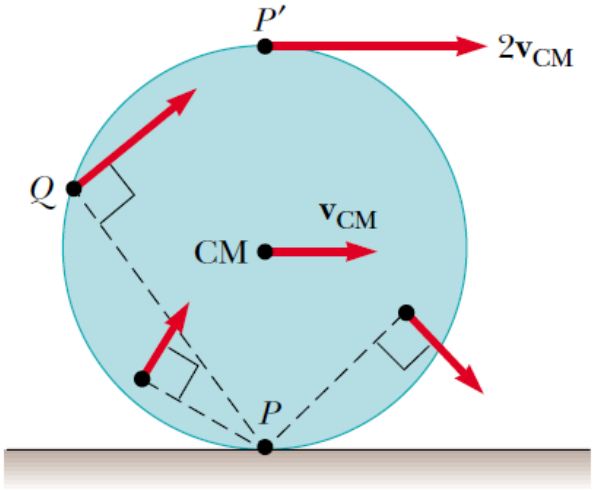

$$\frac{ds}{dt} = v_{CM} = R\frac{d\theta}{dt} = R\omega$$

$$a_{CM} = \frac{dv_{CM}}{dt} = R\frac{d\omega}{dt} = R\alpha$$

# Rolamento=Translação + Rotação




$$E = \frac{1}{2} M v_{CM}^2 + \frac{1}{2} I_{CM} \omega^2$$




Todos os pontos do objeto rolando movem-se na direção perpendicular ao eixo que passa pelo ponto de contato instantâneo P

Se descrevermos o rolamento como rotação pura ao longo de um eixo que passa por P.

$$K = \frac{1}{2} I_P \omega^2$$

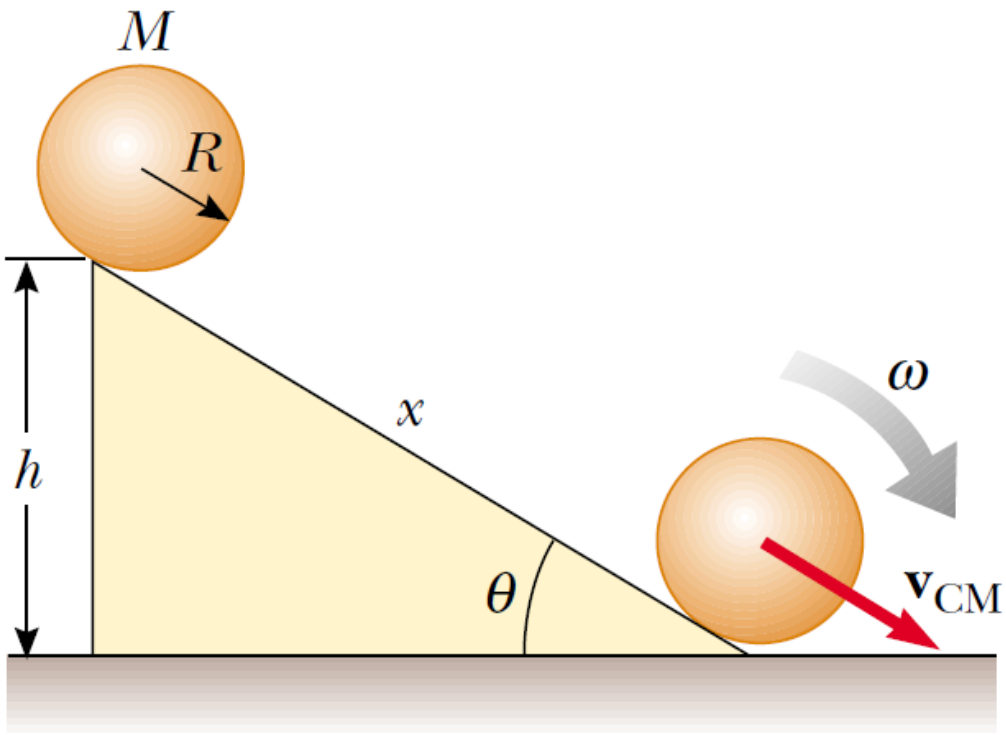
Usando o teorema dos eixos paralelos:

$$I_P = I_{CM} + MR^2$$

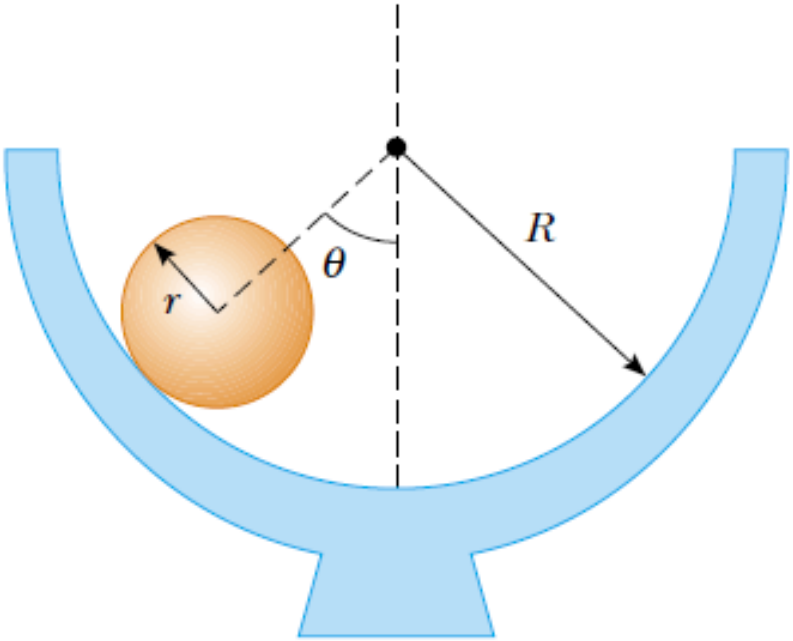
$$K = \frac{1}{2} I_{CM} \omega^2 + \frac{1}{2} MR^2 \omega^2$$

$$K = \frac{1}{2} I_{CM} \omega^2 + \frac{1}{2} M v_{CM}^2$$

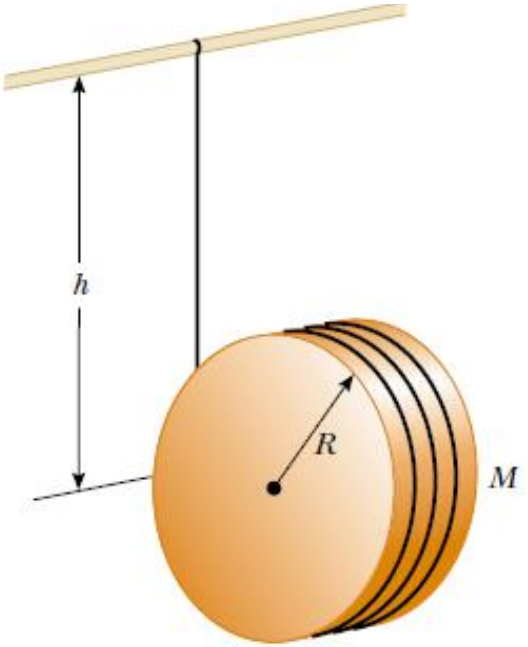
Para a esfera sólida mostrada na figura abaixo, calcule a velocidade linear do centro de massa no final do plano inclinado e o módulo da aceleração liner do centro de massa.



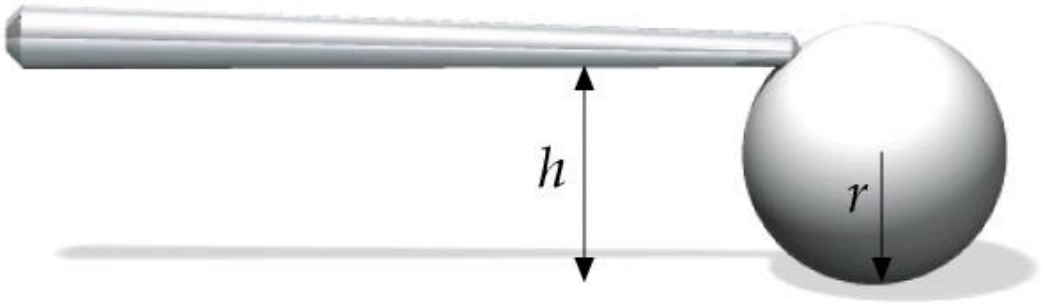
A uniform solid sphere of radius $r$ is placed on the inside surface of a hemispherical bowl with much larger radius $R$. The sphere is released from rest at an angle $\theta$ to the vertical and rolls without slipping (Fig. P10.76). Determine the angular speed of the sphere when it reaches the bottom of the bowl.



A string is wound around a uniform disk of radius $R$ and mass $M$. The disk is released from rest with the string vertical and its top end tied to a fixed bar (Fig. P10.77). Show that (a) the tension in the string is one third of the weight of the disk, (b) the magnitude of the acceleration of the center of mass is $2g/3$, and (c) the speed of the center of mass is $(4gh/3)^{1/2}$ after the disk has descended through distance $h$. Verify your answer to (c) using the energy approach.



# Jogo de Sinuca




**Um taco atinge uma bola de bilhar em um ponto a uma distância d acima do centro da bola. Determine o valor de d para que a bola role, sem deslizar.**

**Vamos aplicar a Segunda Lei de Newton à bola (rotação e translação). (o peso e a normal na polia, não geram torque)**

$$\tau_{ext} = I\alpha = Fd$$
$$F = ma_{cm}$$

**Com**

$$a_{cm} = R\alpha$$

$$\frac{F}{m} = R\frac{Fd}{I}$$

$$d = \frac{I}{mR} = \frac{(2/5)mR^2}{mR}$$

$$d = \frac{2R}{5}$$