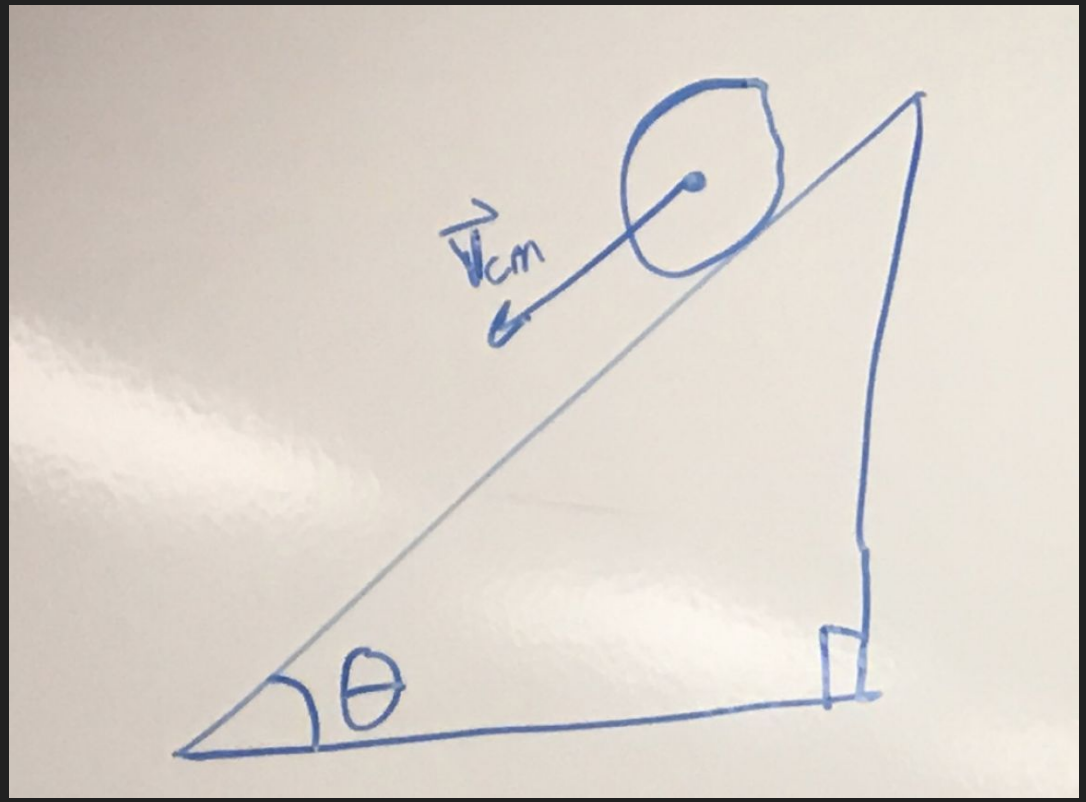
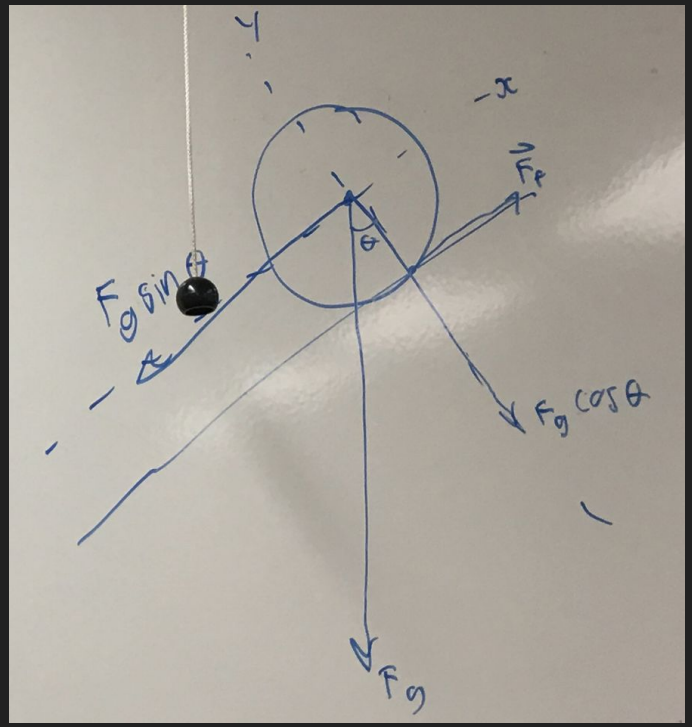
Acceleration of Rotating Objects

By Anshu Sharma


$\vec{v}_{cm}$
θ



$$\Sigma F = Ma = F_g \sin(\theta) - F_f$$

$$\vec{\tau}_f = \vec{r} \times \vec{F}_f = R\vec{F}_f \sin(90^\circ) = R\vec{F}_f = I\vec{\alpha}$$

$$R^2\vec{F}_f = I\vec{\alpha}R = I\vec{a}$$

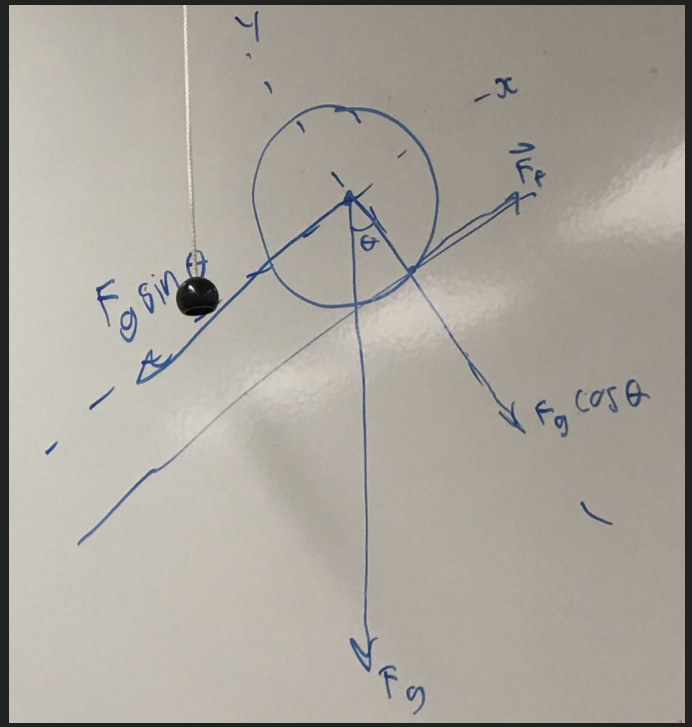
$$\Sigma F = Ma = F_g \sin(\theta) - \frac{Ia}{R^2}$$

$$Ma = Mg\sin(\theta) - \frac{\beta M R^2 a}{R^2}$$

$$Ma + \frac{\beta M R^2 a}{R^2} = Mg\sin(\theta)$$

$$Ma(1+\beta) = Mg\sin(\theta)$$

$$a = \frac{g\sin(\theta)}{1+\beta}$$



$$\Sigma\vec{\tau} = \vec{R} \text{ x } \vec{F}_g = I\vec{\alpha} = (MR^2 + \beta MR^2)\vec{\alpha}$$

$$R^2 Mg\sin(\theta) = (MR^2 + \beta MR^2)a$$

$$\frac{R^2 Mg\sin(\theta)}{(MR^2 + \beta MR^2)} = a$$

$$\frac{g\sin(\theta)}{1+\beta} = a$$

Conclusion and Sources

- Shows the relation between translational and rotational forms of Newton’s laws
- Shows how theoretical results are reflected in experiments (and vice versa)
- Shows the importance of frames of reference
    - Translational example can be considered to be from object’s reference frame

Sources:

Contact point as pivot: https://vimeo.com/120637886 (When I looked this up about a year and a half ago, I found this on Youtube as well, but I couldn't nd it there now.)
Center of mass as pivot: Physics for Scientists and Engineers, Vol. 1: Mechanics, Oscillations andWaves, Thermodynamics (4th edition) by Paul A. Tipler