UF | UNIVERSITY of FLORIDA

Pre-Health Post-Baccalaureate Program
PHY2053 Study Guide & Practice Problems

Topics Covered:

Torque
Rotational Dynamics
Rolling Motion

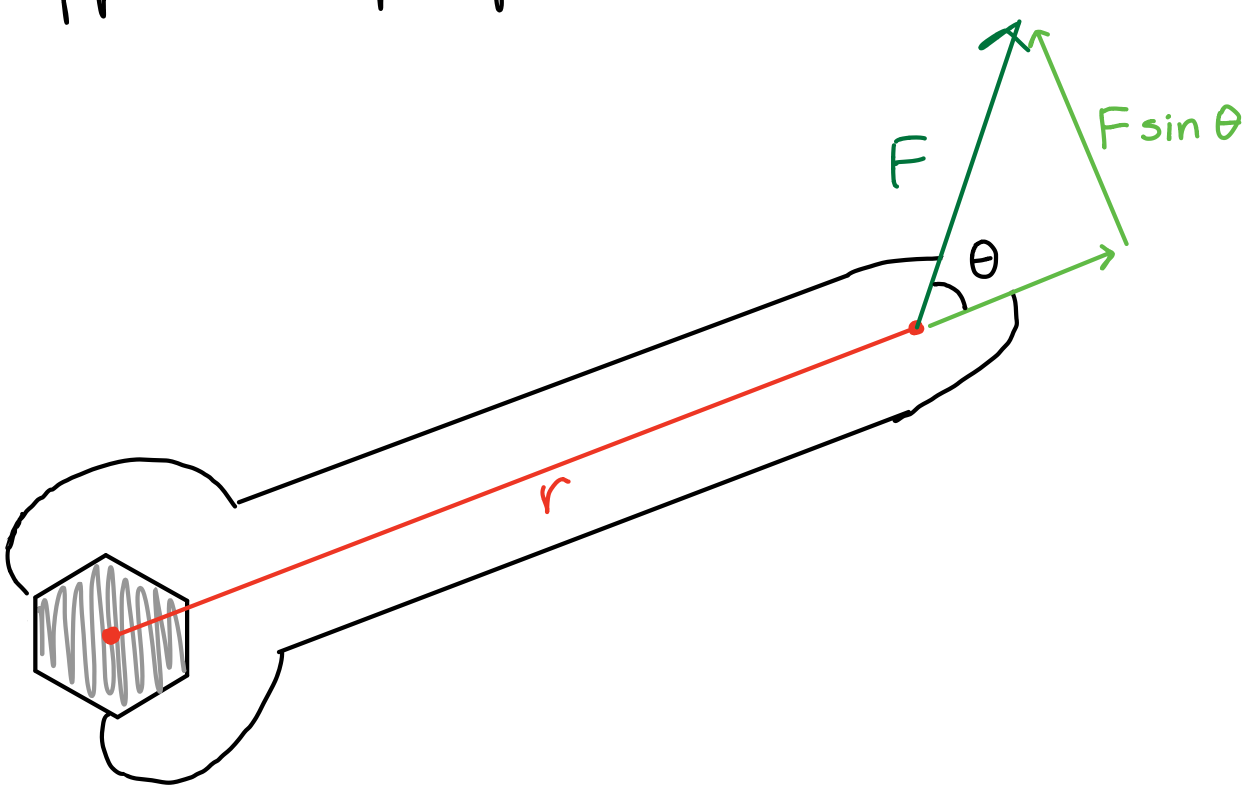
Created by Isaac Loy

Torque

- Torque is the rotational equivalent to force
- Torque is represented by τ (tau), and is given by the equation:

$$\tau = rF_{\perp} = rF\sin\theta$$

Where r is the radius, and F is the force that is applied perpendicular



→ Because Newton's second Law states $F = ma$, and because torque is the rotational equivalent to force, we can create an equation that is its rotational equivalent. Newton's second Law for Rotational Motion gives the equation:

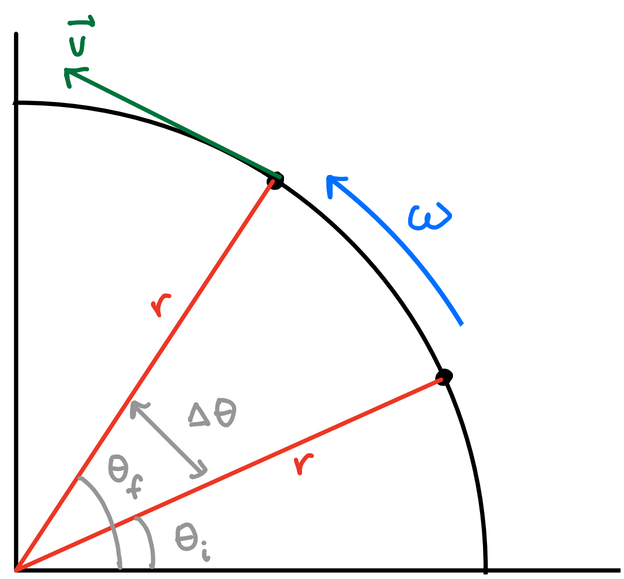
$$\tau = I\alpha$$

Where I is the moment of inertia about the object's rotation and α is the angular acceleration

→ Moments of intertia for common shapes will be given on exams

Circular Motion

→ Just as we related a projectile's distance, velocity, and acceleration with time in earlier modules, we can do the same with an object's angular displacement, angular velocity, and angular acceleration if the object is in circular motion.



→ Equations are the rotational equivalent to the projectile kinematics equations

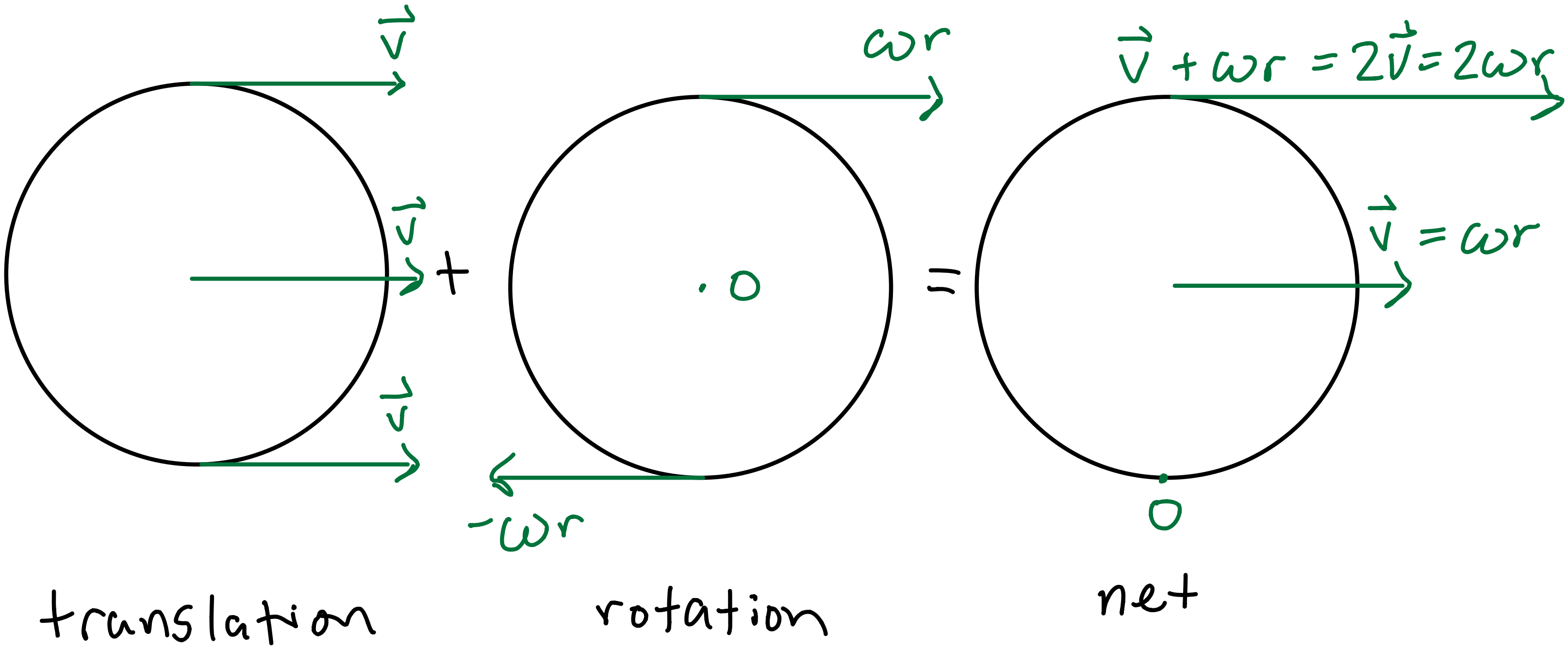
$$\Delta\theta = \theta_f - \theta_i = \omega \Delta t = \frac{1}{2}\alpha(\Delta t)^2 + \omega_i t$$

$$\omega = \frac{\Delta\theta}{\Delta t} = \alpha \Delta t = \frac{\vec{v}}{r} = (2\pi \text{ rad}) f$$

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{\vec{a}}{r}$$

Rolling Motion

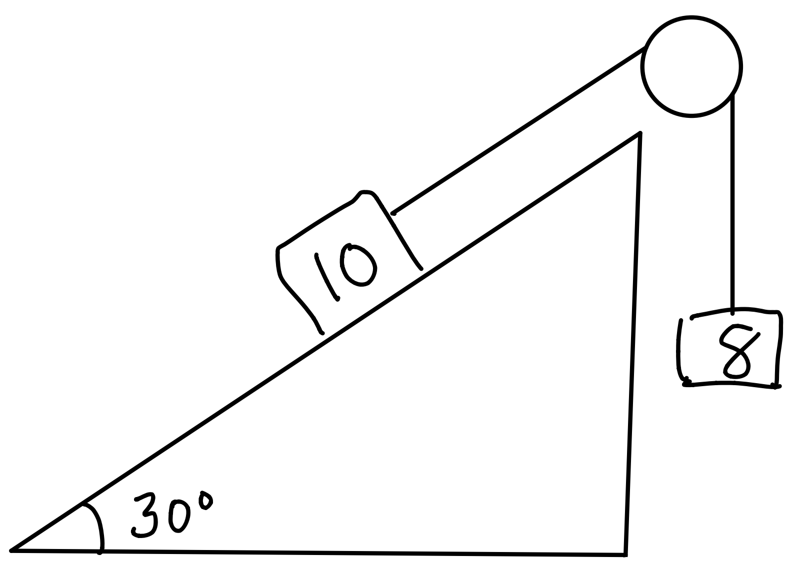
→ Rolling motion is a combination of translational and rotational movement



① The pulley system shown below uses a frictionless, 5 kg, 50 cm-diameter solid disk to connect an 8 kg hanging mass with a 10 kg mass on a 30° incline ramp.

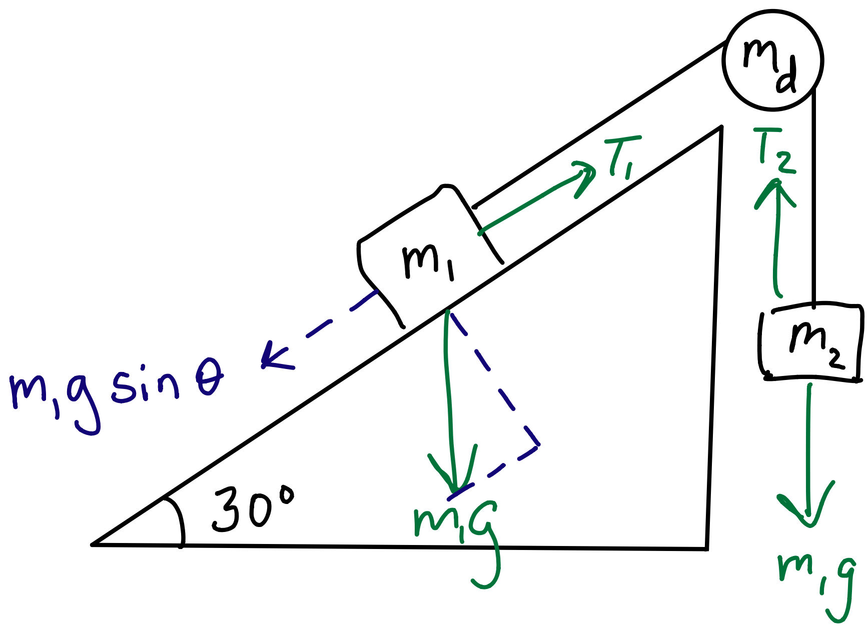
a) Draw a FBD for the system.

b) Find the acceleration of the 8 kg mass.



Solution

① a)



b) $\tau = I\alpha = I\frac{\vec{a}}{r} = \frac{1}{2}mr^2\frac{\vec{a}}{r}$

$$\sum \tau = \tau_1 - \tau_2$$

$$-I\alpha = \tau_1 - \tau_2$$

$$-\left(\frac{1}{2}m_d r^{\cancel{2}}\right)\left(\frac{a}{\cancel{r}}\right) = rT_1 - rT_2$$

$$-\frac{1}{2}m_d \cancel{r} a = \cancel{r}T_1 - \cancel{r}T_2$$

$$-\frac{1}{2}m_d a = (m_1 a + m_1 g \sin\theta) - (m_2 g - m_2 a)$$

$$-\frac{1}{2}m_d a = m_1 a + m_1 g \sin\theta - m_2 g + m_2 a$$

$$-\frac{1}{2}m_d a - m_1 a - m_2 a = m_1 g \sin\theta - m_2 g$$

$$a\left(-\frac{1}{2}m_d - m_1 - m_2\right) = m_1 g \sin\theta - m_2 g$$

$$a = \frac{m_1 g \sin\theta - m_2 g}{-\frac{1}{2}m_d - m_1 - m_2}$$

$$a = \frac{-2g(m_1 \sin\theta - m_2)}{m_d - m_1 - m_2}$$

$$a = \frac{-2(9.8)(10 \sin 30° - 8)}{5 - 10 - 8}$$

$$a = -4.52 \text{ m/s}^2$$