Problem 1
A 32 kg wheel is modeled reasonably well as a thin hoop of radius 1.3 m (meaning all the mass is concentrated at this radius spread uniformly around). This hoop rotates around a stationary axle at 350 rev/min CCW. With a constant CW angular acceleration \( \alpha \) it is brought to rest in 14 s.

- What was the angular acceleration?
- What is the rotational inertia \( I \) of the wheel?
- What was the net torque on the wheel while slowing down?
- What was the net work done on the wheel to bring it to rest.

Problem 2
What role does the center of mass (COM) play with rotation?
A few ideas that will be useful
1. You can think of the force due to gravity as being applied at the object’s COM.

2. The potential energy due to gravity \( U_g \) is assessed by thinking of the object as a point at its COM.

3. Total Kinetic energy must include both translational and rotational K:
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K = K_{\text{translation of COM}} + K_{\text{rotation about COM}}
\]

4. Rolling: Newton’s 2nd law for rotation about an object’s COM is valid even if the COM is accelerating.

Today we’ll work with ideas 1 and 2. The problem below provides a nice review of rotation as we incorporate these new ideas about how work and energy play into rotation.

A rod of mass \( m \) and length \( L \) hangs from its end from a frictionless pivot. It is rotated CCW and held so that it makes an angle \( \theta \) with respect to the downward pointing vertical.

NOTE: Your answers below can only contain \( m \), \( g \), \( L \), and \( \theta \).

- Taking \( y_{\text{com}} \) of the ruler to be where \( y = 0 \) when the ruler hanging straight down, what is the potential energy \( U_g \) of the ruler at the start?

- What is the torque on the ruler as a function of \( \theta \)?

- Show that the rotational inertia of a rod about its end is \( I_{\text{rod about end}} = \frac{1}{3}ML^2 \).

- Using conservation of energy \( (E = K_{\text{rotation}} + U_g) \) what is the speed of the tip of the rod as it passes through dead vertical at the bottom?

- Show that you get the same result using the Work-Kinetic Energy Theorem \( W_{\text{net}} = \Delta K \). In this approach, gravity is the force that delivers \( W_{\text{net}} \) by means of a torque on the rod that varies with \( \theta \).