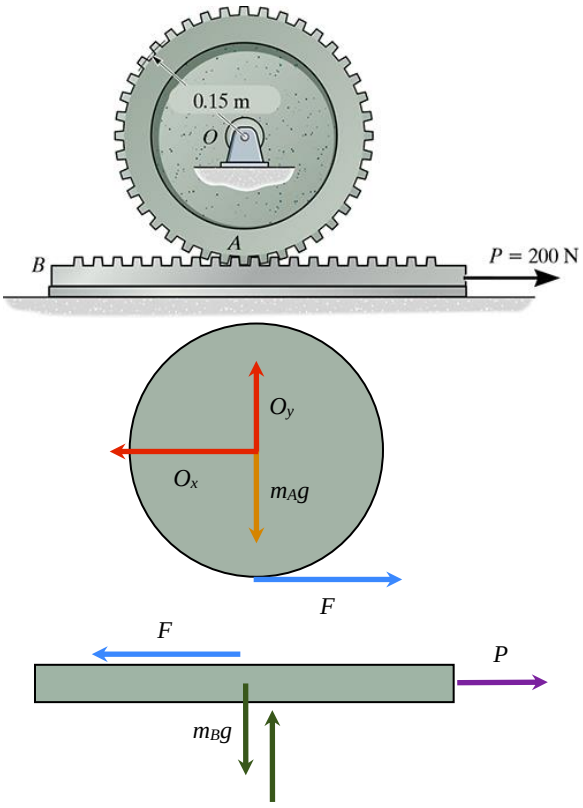
Quiz 16: Chapter 19

Due: Friday 21 Mar 25

Examine the solved problem below. There are four errors. Your task is to locate and identify any mistakes, then correct them and calculate the proper result. If the same error occurs more than once, only count it as a single error, even if you have to correct it in more than one instance.

Each correctly identified error is worth 4 points, and the re-calculated results are worth 4 points as well. You must save your work in pdf format and submit via the Quiz 16 Assignment in the Chapter 19 folder of the in the Quizzes folder of the Online Classroom in Blackboard. Please do not use any other file format than pdf.

Gear A has mass $m_A = 30\text{kg}$ and a radius of gyration about its center of mass O of $k_O = 125\text{mm}$. Gear rack B has mass $m_B = 20\text{kg}$ and is subjected to a force $P = 200\text{N}$. Determine the time required for the gear to obtain an angular velocity $\omega = 20\frac{\text{rad}}{\text{s}}$, starting from rest. Assume the contact surface between the gear rack and the horizontal plane is smooth.



A) Sketch the free body diagrams for the gear and the rack.

See diagrams on the right

B) Write the angular impulse-momentum statement for Gear A:

$$I_O\omega_i + \sum M_O\Delta t = I_O\omega_f$$
$$0 + (Fr)t = \tfrac{1}{2}m_Ak_O^2\omega$$

C) Write the linear impulse-momentum statements for Rack B:

$$m_Bv_{i)x} + \sum F_x\Delta t = m_Bv_{f)x}$$
$$0 + (P - F)t = m_Bv_x = m_B\left(\frac{\omega}{r}\right)$$
$$m_Bv_{i)y} + \sum F_y\Delta t = m_Bv_{f)y}$$
$$0 + (N - m_Bg)t = 0$$

D) Solve the system for t:

$$Ft = \tfrac{1}{2}m_Ak_O^2\left(\frac{\omega}{r}\right)$$
$$Pt = Ft + m_B\left(\frac{\omega}{r}\right) = \left[\tfrac{1}{2}m_Ak_O^2 + m_B\right]\left(\frac{\omega}{r}\right)$$
$$t = \frac{1}{P}\left[\tfrac{1}{2}m_Ak_O^2 + m_B\right]\left(\frac{\omega}{r}\right)$$
$$t = \frac{1}{(200\text{N})}\left[\tfrac{1}{2}(30\text{kg})(0.0125\text{m})^2 + (30\text{kg})\right]\left(\frac{20\frac{\text{rad}}{\text{s}}}{0.150\text{m}}\right) = 20\text{s}$$