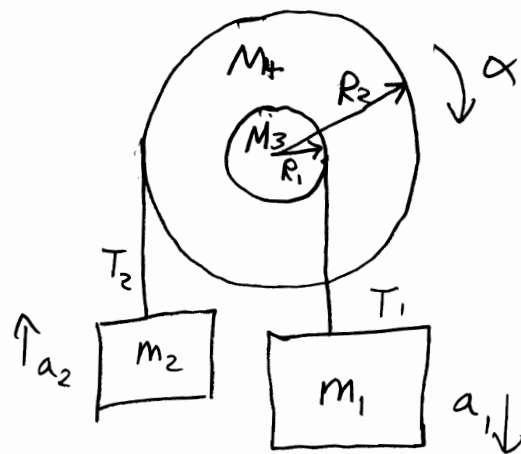


Example: Find the algebra boo-boo!
(Hint: check the units!)

Problem: find the acceleration of block m_1 .

Solution:



$$\textcircled{1} \quad \Sigma \tau = I \alpha$$

$$\textcircled{2} \quad T_1 R_1 - T_2 R_2 = \left(\frac{1}{2} M_3 R_1^2 + \frac{1}{2} M_4 R_2^2 \right) \alpha$$

$$\textcircled{3} \quad \Sigma F_1 = m_1 a_1$$

$$\textcircled{4} \quad m_1 g - T_1 = m_1 a_1$$

$$\textcircled{5} \quad \Sigma F_2 = m_2 a_2$$

$$\textcircled{6} \quad T_2 - m_2 g = m_2 a_2$$

$$\textcircled{7} \quad a_1 = \alpha R_1, \quad a_2 = \alpha R_2$$

$$\textcircled{8} \quad \Rightarrow \alpha = \frac{a_1}{R_1}, \quad \Rightarrow a_2 = \frac{a_1 R_2}{R_1}$$

$$\textcircled{9} \quad T_1 = m_1 g - m_1 a_1$$

$$\textcircled{10} \quad T_2 = m_2 \frac{a_1 R_2}{R_1} + m_2 g$$

$$\textcircled{11} \quad (m_1 g - m_1 a_1) R_1 - \left(m_2 \frac{a_1 R_2}{R_1} + m_2 g \right) R_2 = \left(\frac{1}{2} M_3 R_1^2 + \frac{1}{2} M_4 R_2^2 \right) \frac{a_1}{R_1}$$

$$\textcircled{12} \quad R_1 \left[m_1 g R_1 - m_1 a_1 R_1 - m_2 \frac{a_1 R_2^2}{R_1} - m_2 g R_2 \right] = \left(\frac{1}{2} M_3 R_1^2 + \frac{1}{2} M_4 R_2^2 \right) a_1$$

$$\textcircled{13} \quad -(m_1 R_1^2 + m_2 R_2^2) a_1 + (m_1 R_1 - m_2 R_1 R_2) g = \left(\frac{1}{2} M_3 R_1^2 + \frac{1}{2} M_4 R_2^2 \right) a_1$$

$$\textcircled{14} \quad (m_1 R_1 - m_2 R_1 R_2) g = \left(\frac{1}{2} M_3 R_1^2 + \frac{1}{2} M_4 R_2^2 + m_1 R_1^2 + m_2 R_2^2 \right) a_1$$

$$\textcircled{15} \quad a_1 = \frac{R_1 (m_1 - m_2 R_2)}{\frac{1}{2} M_3 R_1^2 + \frac{1}{2} M_4 R_2^2 + m_1 R_1^2 + m_2 R_2^2} g$$