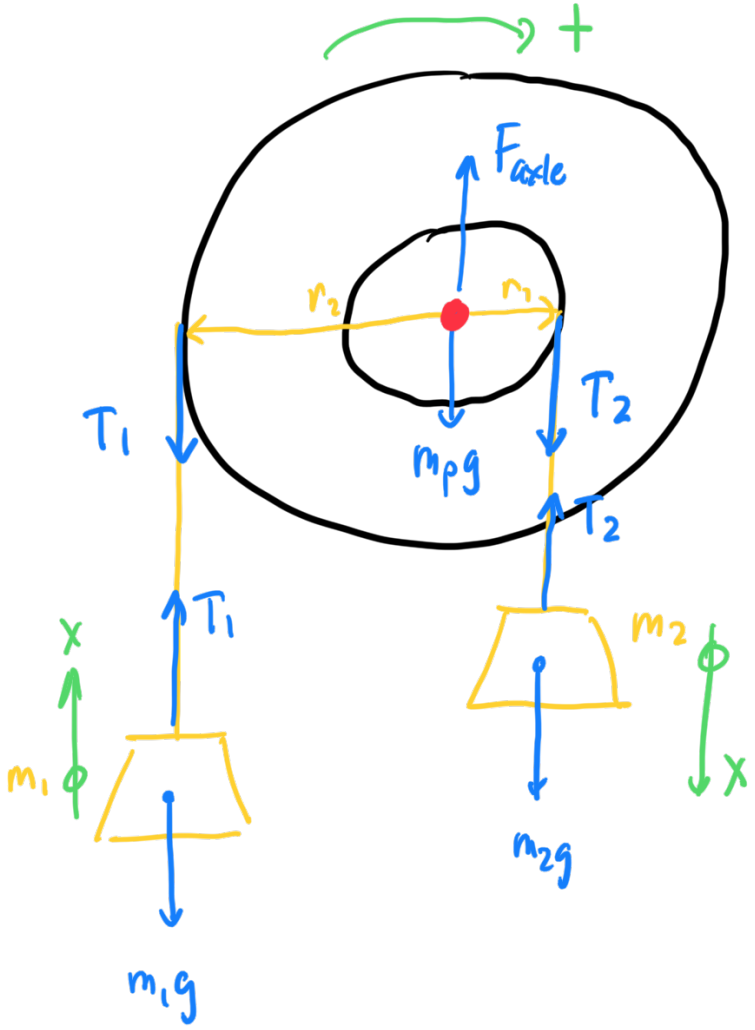
Assignment 7 - Question 9



m_1 : $T_1 - m_1 g = m_1 a_{1x}$

m_2 : $m_2 g - T_2 = m_2 a_{2x}$

$T r_2 - T_1 r_1 = I \alpha$

pulley:

Relationships between a_{1x}, a_{2x}, and α:

$$a_{1x} = r_1 \alpha$$
$$a_{2x} = r_2 \alpha$$

$$T_1 - m_1 g = m_1 r_1 \alpha \quad (1)$$
$$m_2 g - T_2 = m_2 r_2 \alpha \quad (2)$$
$$T_2 r_2 - T_1 r_1 = I \alpha \quad (3)$$

multiply equation (1) by r_1, and multiply equation (2) by r_2:

$$T_1 r_1 - m_1 r_1 g = m_1 r_1^2 \alpha \quad (1)$$
$$m_2 r_2 g - T_2 r_2 = m_2 r_2^2 \alpha \quad (2)$$
$$T_2 r_2 - T_1 r_1 = I \alpha \quad (3)$$

Add all three equations together:

$$m_2 r_2 g - m_1 r_1 g = (m_1 r_1^2 + m_2 r_2^2 + I) \times \alpha$$

$$\alpha = \frac{m_2 r_2 g - m_1 r_1 g}{(m_1 r_1^2 + m_2 r_2^2 + I)}$$

For my problem, I had:

$m_1 = 1.0$ kg

$m_2 = 2.2$ kg

$r_1 = 0.53$ m

$r_2 = 0.20$ m

$I = 2.1$ kg·m^2

$g = 9.80$ m/s^2

$$\alpha = \frac{(2.2)(.2)(9.8) - (1.0)(.53)(9.8)}{((1.0)(.53)^2 + (2.2)(.20)^2 + 2.1)}$$

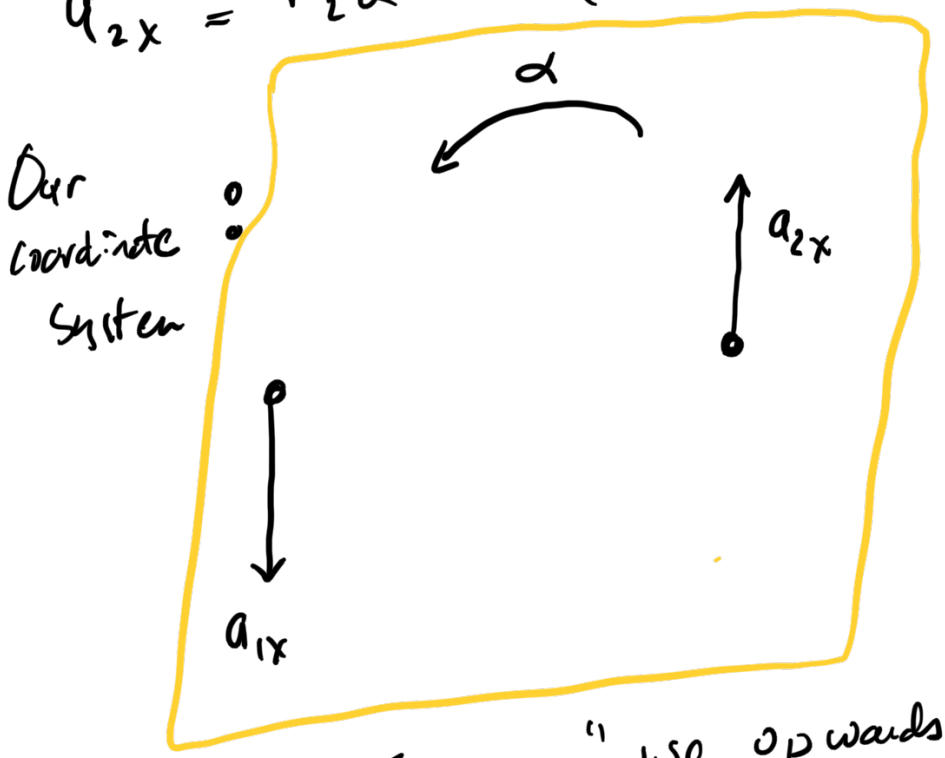
$= 0.8820$

$$= \frac{\qquad}{2.4689}$$

$$\alpha = -0.357 \text{ rad/s}^2$$

$$a_{1x} = r_1 \alpha = (0.53)(-0.357) = -0.189 \text{ m/s}^2$$

$$a_{2x} = r_2 \alpha = (.20)(-0.357) = -0.0714 \text{ m/s}^2$$



WebAssign says "use upwards as the positive direction". So, in their coordinate system →

$$a_{1x} = -0.189 \text{ m/s}^2 \quad (\text{down}$$

$$\ddot{a}_{2x} = + 0.0714 \text{ m/s}^2 \quad (\text{up}$$