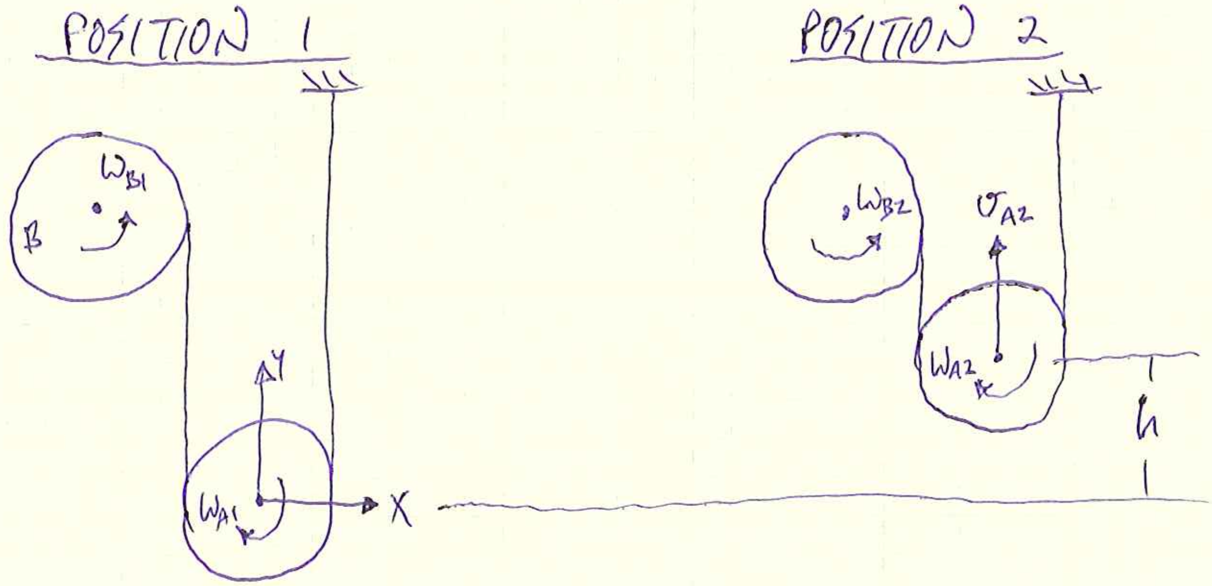
PROB. 17-30

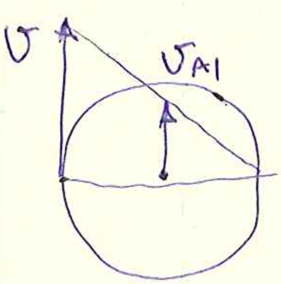
$W_A = W_B = 14^{LB}$, $r = \frac{5}{12}$ ft, $\omega_{B1} = 30 \frac{RAD}{s}$ ↻

a) FIND DISTANCE h FOR A WHEN $\omega_{B2} = 5 \frac{RAD}{s}$



CONSERVATION OF ENERGY: $T_1 + V_1 = T_2 + V_2$

$$T_1 = \frac{1}{2} I_B \omega_{B1}^2 + \frac{1}{2} m_A v_{A1}^2 + \frac{1}{2} I_A \omega_{A1}^2$$



$$v = r\omega_{B1}, \quad v_{A1} = \frac{1}{2} v = \frac{1}{2} r \omega_{B1}$$

$$v_{A1} = r\omega_{A1} = \frac{1}{2} r \omega_{B1}, \quad \omega_{A1} = \frac{1}{2}\omega_{B1}$$

$$I_A = I_B = \frac{1}{2} m r^2 = \frac{1}{2}\left(\frac{W}{g}\right) r^2$$

$$T_1 = \frac{1}{2}\left[\frac{1}{2}\left(\frac{W}{g}\right) r^2\right]\omega_{B1}^2 + \frac{1}{2}\left(\frac{W}{g}\right)\left(\frac{1}{2} r \omega_{B1}\right)^2 + \frac{1}{2}\left[\frac{1}{2}\left(\frac{W}{g}\right) r^2\right]\left(\frac{1}{2}\omega_{B1}\right)^2$$

$$T_1 = \frac{1}{4} r^2 \omega_{B1}^2 \left(\frac{W}{g}\right)\left(1 + \frac{1}{2} + \frac{1}{4}\right) = \frac{7}{16} r^2 \omega_{B1}^2 \left(\frac{W}{g}\right)$$

$$V_1 = 0$$

$$T_2 = \frac{1}{2} I_B \omega_{B2}^2 + \frac{1}{2} m_A v_{A2}^2 + \frac{1}{2} I_A \omega_{A2}^2 = \frac{7}{16} r^2 \omega_{B2}^2 \left(\frac{W}{g}\right)$$

$$V_2 = V_g = Wh$$

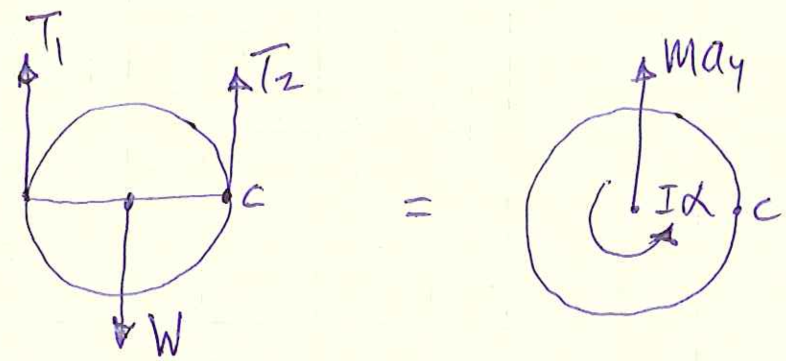
$$\frac{7}{16} r^2 \omega_{B1}^2 \left(\frac{W}{g}\right) + 0 = \frac{7}{16} r^2 \omega_{B2}^2 \left(\frac{W}{g}\right) + Wh$$

$$h = \frac{7}{16}\left(\frac{r^2}{g}\right)\left(\omega_{B1}^2 - \omega_{B2}^2\right) = \frac{7}{16} \cdot \left[\frac{\left(\frac{5}{12} ft\right)^2}{\left(32.2 \frac{ft}{s^2}\right)}\right] \cdot \left[\left(30 \frac{RAD}{s}\right)^2 - \left(5 \frac{RAD}{s}\right)^2\right]$$

$$\boxed{h = 2.064 \text{ ft}}$$

b) FIND TENSION IN THE BELT CONNECTING THE CYLINDERS.

FBD\ CYLINDER A:



$$\Sigma \vec{M}_c = \Sigma (\vec{M}_c)_{EFF} \quad +\circlearrowleft: \quad rW - 2rT_1 = I\alpha - rma_y$$

$$T_1 = \frac{1}{2r}\left(rW - I\alpha + rma_y\right) = \frac{1}{2}\left[W - \frac{I\alpha}{r} + \left(\frac{W}{g}\right)a_y\right]$$

$$I = \frac{1}{2} m r^2 = \frac{1}{2}\left(\frac{W}{g}\right) r^2$$

$$a_y = -r\alpha, \quad \alpha = -\frac{a_y}{r} \quad \text{(WRT POINT C)}$$

$$T_1 = \frac{1}{2}\left\{W - \left[\frac{1}{2}\left(\frac{W}{g}\right)r^2\right]\left(-\frac{a_y}{r}\right) \cdot \frac{1}{r} + \left(\frac{W}{g}\right)a_y\right\}$$

$$T_1 = \frac{W}{2}\left[1 + \frac{1}{2}\left(\frac{a_y}{g}\right) + \left(\frac{a_y}{g}\right)\right] = \frac{W}{2}\left[1 + \frac{3}{2}\left(\frac{a_y}{g}\right)\right]$$

PROB. 17-30 CONT.

UNIFORMLY ACCELERATED RECTILINEAR MOTION:

$$v_{A2}^2 - v_{A1}^2 = 2a_y(x_2 - x_1)$$

$$a_y = \frac{(v_{A2}^2 - v_{A1}^2)}{2(x_2 - x_1)}$$

$$v_{A1} = \frac{1}{2} r\omega_{B1}, \quad v_{A2} = \frac{1}{2} r\omega_{B2}$$

$$a_y = \frac{(\frac{1}{2} r\omega_{B2})^2 - (\frac{1}{2} r\omega_{B1})^2}{2(x_2 - x_1)} = \frac{r^2(\omega_{B2}^2 - \omega_{B1}^2)}{8(x_2 - x_1)}$$

$$a_y = \frac{(\frac{5}{12} ft)^2 [(5 \frac{RAD}{s})^2 - (30 \frac{RAD}{s})^2]}{2(2.064 ft)} = -9.2 \frac{ft}{s^2}$$

$$T_1 = \frac{(14^{LB})}{2} \cdot \left[1 + \frac{3}{2}\left(\frac{-9.2}{32.2}\right)\right] \boxed{= 4^{LB}}$$