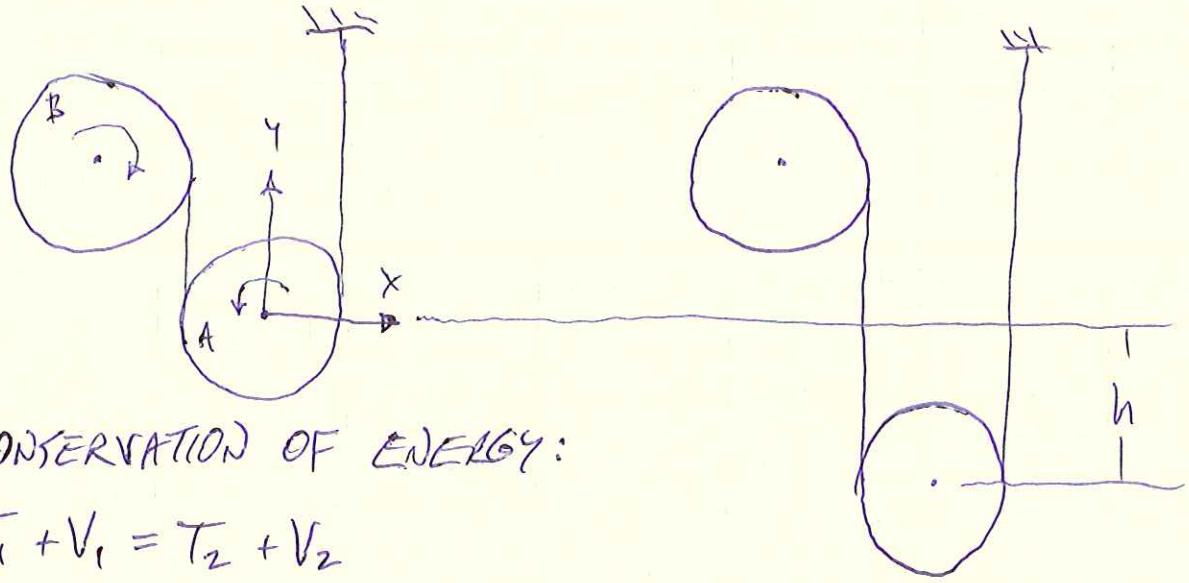
PROB. 17-31

$W_A = W_B = 14^{LB}$, $r = \frac{5}{12}$ ft, $\omega_0 = 0$

a) FIND v_A AFTER $h = 3$ ft

POSITION 1 POSITION 2



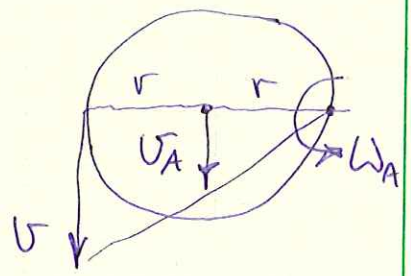
CONSERVATION OF ENERGY:

$T_1 + V_1 = T_2 + V_2$

$T_1 = 0$, $V_1 = 0$

$T_2 = \frac{1}{2} I_B \omega_B^2 + \frac{1}{2} M_A v_A^2 + \frac{1}{2} I_A \omega_A^2$

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



$v_A = r\omega_A$, $\omega_A = \frac{v_A}{r}$

$v = 2r\omega_A = r\omega_B$

$\omega_B = 2\omega_A = \frac{2v_A}{r}$

$T_2 = \frac{1}{2}\left[\frac{1}{2}\left(\frac{W}{g}\right) r^2\right]\left(\frac{2v_A}{r}\right)^2 + \frac{1}{2}\left(\frac{W}{g}\right) v_A^2 + \frac{1}{2}\left[\frac{1}{2}\left(\frac{W}{g}\right) r^2\right]\left(\frac{v_A}{r}\right)^2$

$T_2 = \frac{1}{2}\left(\frac{W}{g}\right) v_A^2 \left(2 + 1 + \frac{1}{2}\right) = \frac{7}{4}\left(\frac{W}{g}\right) v_A^2$

$V_2 = -Wh$

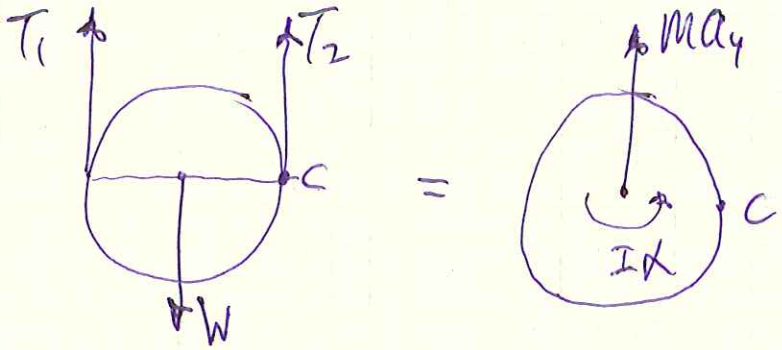
$$0 = \frac{7}{4}\left(\frac{W}{g}\right)v_A^2 - Wh$$

$$v_A = \sqrt{\frac{4}{7}\cdot gh} = \sqrt{\frac{4}{7}\left(32.2\ \frac{ft}{s^2}\right)(3\ ft)}$$

$$\boxed{= 7.43\ \frac{ft}{s}\ \downarrow}$$

b) FIND BELT TENSION BETWEEN CYLINDERS.

FBD| CYLINDER A



$$\Sigma \vec{M}_C = \Sigma(\vec{M}_C)_{EFF} \quad +\circlearrowleft:$$

$$rW - 2rT_1 = I\alpha - rma_y$$

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

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

$$v_{A2}^2 = \cancel{v_{A1}^2}^{\,0} + 2a_y(x_2 - x_1)$$

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

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

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

PROB. 17-31 CONT.

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

$$T_1 = \frac{W}{2}\left\{1 + \frac{3}{2}\,\frac{\left[-\frac{v_{A2}^2}{2h}\right]}{g}\right\} = \frac{W}{2}\left[1 - \frac{3}{4}\left(\frac{v_{A2}^2}{gh}\right)\right]$$

$$T_1 = \frac{(14^{lb})}{2}\left[1 - \frac{3}{4}\cdot\frac{\left(7.43\ \frac{ft}{s}\right)^2}{\left(32.2\ \frac{ft}{s^2}\right)(3^{ft})}\right] \boxed{= 4.0^{lb}}$$