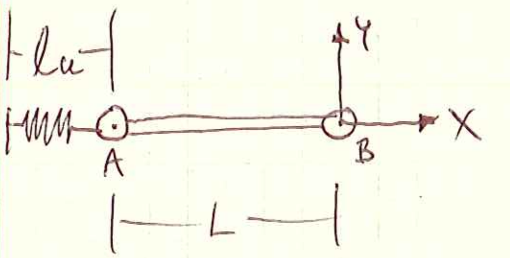
PROB. 17-38

$W = 9^{LB}$, $K = \left(3\,\frac{LB}{IN}\right)\left(\frac{12\ IN}{ft}\right) = 36\,\frac{LB}{ft}$, $L = \frac{25}{12}\,ft$,

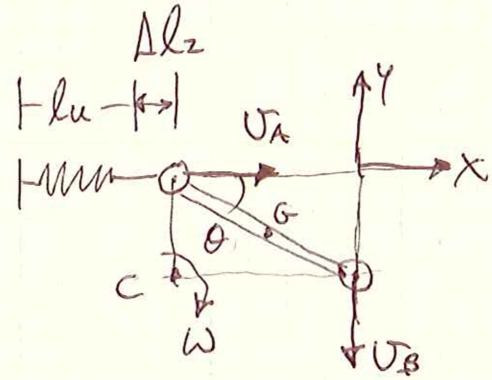
$L_s = l_u$ WHEN $\theta = 0$, $v = 0$ WHEN $\theta = 0$,

FIND ω AND v_B WHEN $\theta = 30°$.

POSITION 1



POSITION 2



CONSERVATION OF ENERGY:

$$T_1 + (V_e)_1 + (V_g)_1 = T_2 + (V_e)_2 + (V_g)_2$$

$$T_1 = 0,\ (V_e)_1 = 0,\ (V_g)_1 = 0$$

$$T_2 = \tfrac{1}{2} m \bar{v}^2 + \tfrac{1}{2} \bar{I} \omega^2$$

$$\bar{v} = r\omega = \tfrac{1}{2} L\omega,\quad \bar{I} = \tfrac{1}{12} m L^2$$

$$T_2 = \tfrac{1}{2} m \left(\tfrac{1}{2} L\omega\right)^2 + \tfrac{1}{2}\left(\tfrac{1}{12} m L^2\right)\omega^2 = \tfrac{1}{6} m L^2 \omega^2$$

$$(V_e)_2 = \tfrac{1}{2} K (\Delta l_2)^2,\quad \Delta l_2 = L - L\cos\theta = L(1-\cos\theta)$$

$$(V_e)_2 = \tfrac{1}{2} K [L(1-\cos\theta)]^2 = \tfrac{1}{2} K L^2 (1-\cos\theta)^2$$

$$(V_g)_2 = -Wh_2 = -W\left(\tfrac{1}{2} L\sin\theta\right)$$

$$0 = \tfrac{1}{6} m L^2 \omega^2 + \tfrac{1}{2} K L^2 (1-\cos\theta)^2 - \tfrac{1}{2} W L \sin\theta$$

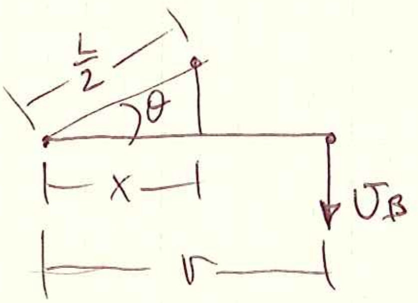
$$\omega = \sqrt{\frac{6}{mL^2}\left[\tfrac{1}{2} W L \sin\theta - \tfrac{1}{2} K L^2 (1-\cos\theta)^2\right]}$$

$$\omega = \sqrt{\frac{3g}{WL}\cdot\left[W\sin\theta - kL(1-\cos\theta)^2\right]}$$

$$\omega = \sqrt{\frac{3\left(32.2\ \frac{ft}{s^2}\right)}{(9\ LB)\left(\frac{25}{12}\ ft\right)}\cdot\left[(9\ LB)\sin 30^\circ - \left(36\ \frac{LB}{ft}\right)\left(\frac{25}{12}\ ft\right)(1-\cos 30^\circ)^2\right]}$$

$$\boxed{\omega = 4.031\ \frac{RAD}{s}}$$

$$v_B = r\omega$$



$$\cos\theta = \frac{x}{L/2}$$

$$x = \frac{1}{2}L\cos\theta$$

$$2x = L\cos\theta = r$$

$$v_B = L\cos\theta\cdot\omega$$

$$v_B = \left(\frac{25}{12}\ ft\right)(\cos 30^\circ)\left(4.031\ \frac{RAD}{s}\right)\ \boxed{= 7.273\ \frac{ft}{s}\downarrow}$$