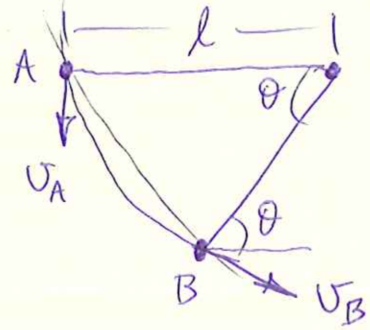
PROB. 13-40

$v_0 = 5\,\frac{m}{s}$, $\ell = 2^m$, FIND θ WHERE $T = 2W$

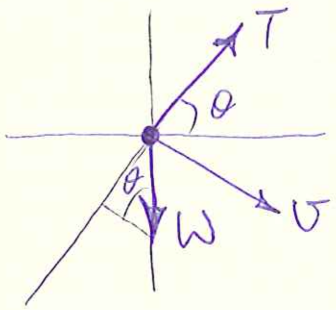


$$T_A + {}_A\mathcal{U}_B = T_B$$

$$T_A = \tfrac{1}{2} m v_A^2, \quad T_B = \tfrac{1}{2} m v_B^2$$

$${}_A\mathcal{U}_B = F \cos\alpha \cdot \Delta x$$

T DOES NO WORK SINCE IT IS NORMAL TO THE PATH.



$${}_A\mathcal{U}_B = W \cdot \ell \sin\theta$$

$$\tfrac{1}{2} m v_A^2 + W \ell \sin\theta = \tfrac{1}{2} m v_B^2$$

$$\sum F_n = m \frac{v^2}{\rho}$$

$$T - W\sin\theta = m\frac{v_B^2}{\ell} \Rightarrow v_B^2 = \frac{\ell}{m}\left(T - W\sin\theta\right)$$

SET $T = 2W$

$$v_B^2 = \frac{\ell}{m}\left(2W - W\sin\theta\right) = \frac{W\ell}{m}\left(2 - \sin\theta\right) = g\ell\left(2 - \sin\theta\right)$$

$$\tfrac{1}{2} m v_A^2 + m g \ell \sin\theta = \tfrac{1}{2} m \cdot g\ell\left(2 - \sin\theta\right)$$

$$\tfrac{1}{2} v_A^2 + g\ell\sin\theta = \tfrac{1}{2} g\ell\left(2 - \sin\theta\right)$$

$$\left(g\ell + \tfrac{1}{2} g\ell\right)\sin\theta = g\ell - \tfrac{1}{2} v_A^2$$

$$\sin\theta = \left(\frac{2}{3g\ell}\right)\left(g\ell - \tfrac{1}{2} v_A^2\right) = \frac{2}{3}\left(1 - \frac{v_A^2}{g\ell}\right)$$

$$\theta = \sin^{-1}\left\{\frac{2}{3}\left[1 - \frac{\left(5\,\frac{m}{s}\right)^2}{2\left(9.81\,\frac{m}{s^2}\right)\left(2^m\right)}\right]\right\} \boxed{= 14.00^\circ}$$