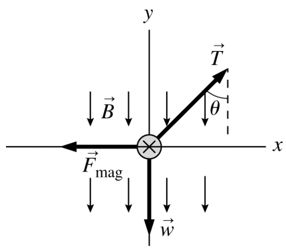
32.73. Model: A magnetic field exerts a magnetic force on a length of current carrying wire.
Visualize:



Please refer to Figure P32.73.

Solve: The above figure shows a side view of the wire, with the current moving into the page. From the right-hand rule, the magnetic field $\vec{B}$ points *down* to give a leftward force on the current. The wire is hanging in static equilibrium, so $\vec{F}_{net} = \vec{F}_{mag} + \vec{W} + \vec{T} = 0$ N. Consider a segment of wire of length *L*. The wire's linear mass density is $\mu = 0.050$ kg/m, so the mass of this segment is $m = \mu L$ and its weight is $W = mg = \mu Lg$. The magnetic force on this length of wire is $F_{mag} = ILB$. In component form, Newton's first law is

$$\left(F_{net}\right)_x = T\sin\theta - F_{mag} = T\sin\theta - ILB = 0 \text{ N} \Rightarrow T\sin\theta = ILB$$

$$\left(F_{net}\right)_y = T\cos\theta - W = T\cos\theta - \mu Lg = 0 \text{ N} \Rightarrow T\cos\theta = \mu Lg$$

Dividing the first equation by the second,

$$\left[\frac{T\sin\theta}{T\cos\theta} = \tan\theta\right] = \left[\frac{ILB}{\mu Lg} = \frac{IB}{\mu g}\right] \Rightarrow B = \frac{\mu g\tan\theta}{I} = \frac{(0.050 \text{ kg / m})(9.8 \text{ m / s}^2)\tan 10°}{10 \text{ A}} = 0.00864 \text{ T}$$

The magnetic field is $\vec{B} = (0.00864 \text{ T, down})$.