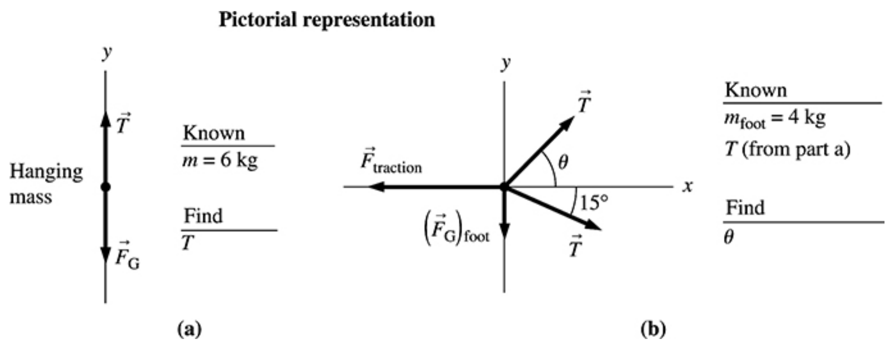
6.35. Model: We can assume the foot is a single particle in equilibrium under the combined effects of gravity, the tensions in the upper and lower sections of the traction rope, and the opposing traction force of the leg itself. We can also treat the hanging mass as a particle in equilibrium. Since the pulleys are frictionless, the tension is the same everywhere in the rope. Because all pulleys are in equilibrium, their net force is zero. So they do not contribute to *T*.

Visualize:



Solve: **(a)** From the free-body diagram for the mass, the tension in the rope is

$$T = F_G = mg = (6\text{ kg})(9.80\text{ m/s}^2) = 58.8\text{ N}$$

(b) Using Newton's first law for the vertical direction on the pulley attached to the foot,

$$(F_{net})_y = \Sigma F_y = T\sin\theta - T\sin 15° - (F_G)_{foot} = 0\text{ N}$$

$$\Rightarrow \sin\theta = \frac{T\sin 15° + (F_G)_{foot}}{T} = \sin 15° + \frac{m_{foot}g}{T} = 0.259 + \frac{(4\text{ kg})(9.80\text{ m/s}^2)}{58.8\text{ N}} = 0.259 + 0.667 = 0.926$$

$$\Rightarrow \theta = \sin^{-1} 0.926 = 67.8°$$

(c) Using Newton's first law for the horizontal direction,

$$(F_{net})_x = \Sigma F_x = T\cos\theta + T\cos 15° - F_{traction} = 0\text{ N}$$

$$\Rightarrow F_{traction} = T\cos\theta + T\cos 15° = T(\cos 67.8° + \cos 15°)$$

$$= (58.8\text{ N})(0.3778 + 0.9659) = (58.8\text{ N})(1.344) = 79.0\text{ N}$$

Assess: Since the tension in the upper segment of the rope must support the foot and counteract the downward pull of the lower segment of the rope, it makes sense that its angle is larger (a more direct upward pull). The magnitude of the traction force, roughly one-tenth of the gravitational force on a human body, seems reasonable.