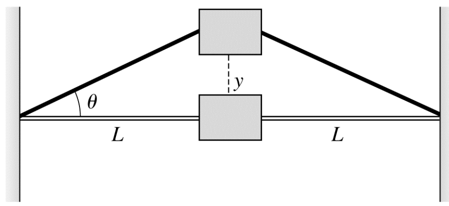
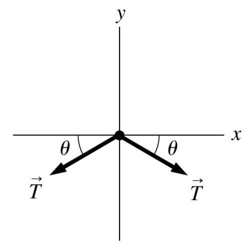
14.65. Model: Assume the small-angle approximation.

Visualize:





Solve: The tension in the two strings pulls downward at angle θ. Thus Newton's second law is

$$\sum F_y = -2T\sin\theta = ma_y$$

From the geometry of the figure we can see that

$$\sin\theta = \frac{y}{\sqrt{L^2 + y^2}}$$

If the oscillation is small, then $y << L$ and we can approximate $\sin\theta \approx y/L$. Since y/L is $\tan\theta$, this approximation is equivalent to the small-angle approximation $\sin\theta \approx \tan\theta$ if $\theta << 1$ rad. With this approximation, Newton's second law becomes

$$-2T\sin\theta \approx -\frac{2T}{L}y = ma_y = m\frac{d^2y}{dt^2} \quad \Rightarrow \quad \frac{d^2y}{dt^2} = -\frac{2T}{mL}y$$

This is the equation of motion for simple harmonic motion (see Eqs. 14.33 and 14.47). The constants $2T/mL$ are equivalent to k/m in the spring equation or g/L in the pendulum equation. Thus the oscillation frequency is

$$f = \frac{1}{2\pi}\sqrt{\frac{2T}{mL}}$$