Suspended Loudspeaker

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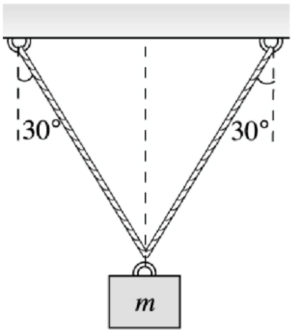
This material is borrowed/adapted from PH 201 Tutorial 5 for Fall 2020 and Mastering Physics.

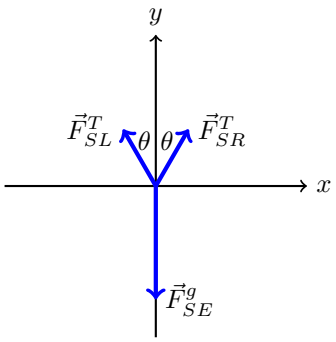
XX-1: Suspended Loudspeaker

A 25 kg loudspeaker is suspended 2.0 m below the ceiling by two cables that are each 30° from vertical.

(a) Draw a sketch illustrating the problem.



(b) Draw a free-body diagram for the loudspeaker.



Here, $\vec{F}^T_{SR}$ is the tension acting on the speaker from the cable on the right, and $\vec{F}^T_{SL}$ is the tension acting on the speaker from the cable on the left. Since there is only one object, I will drop the S subscript in further calculations, and since there is only one force of gravity, I will drop both subscripts from it.

(c) Find the tension in each cable.

First, we consider the x-components. The loudspeaker is not accelerating, so

$$F_x^{net} = ma_x = 0.$$

The sum of the forces in this direction is

$$F_x^{net} = F_R^T \sin\theta - F_L^T \sin\theta,$$

therefore

$$\begin{aligned} F_L^T \cancel{\sin\theta} &= F_R^T \cancel{\sin\theta} \\ F_L^T &= F_R^T. \end{aligned}$$

This can be seen in the symmetry of the problem. Now, in the vertical direction, we have

$$\begin{aligned} F_y^{net} &= ma_y = 0 \\ F_R^T \cos\theta + F_L^T \cos\theta - F^g &= 0 \\ 2F_R^T \cos\theta - mg &= 0 \\ F_R^T &= \frac{mg}{2\cos\theta} \\ &= \frac{(25\text{ kg})(9.8\text{ m/s}^2)}{2\cos(30^\circ)} \\ &\approx 140\text{ N}. \end{aligned}$$

Each cable has 140 N of tension in it.