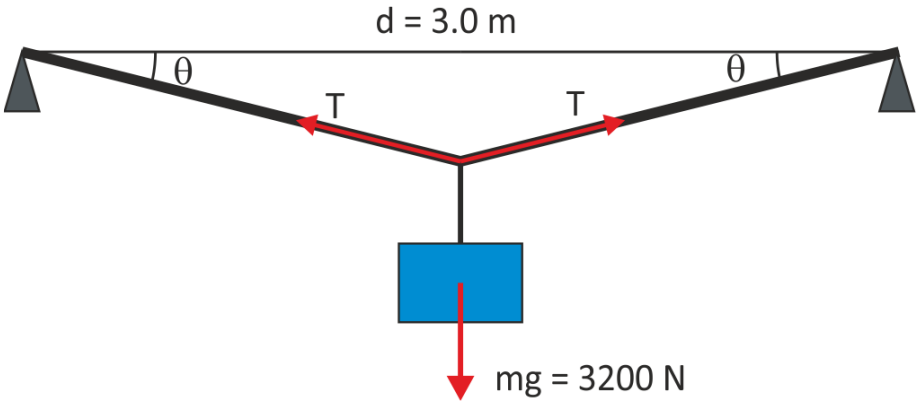
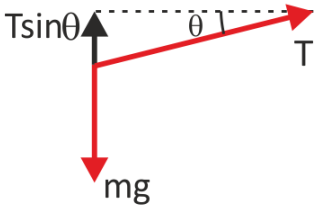
Answer on Question #51647-Physics-Mechanics-Kinematics-Dynamics

A massless rope is stretched horizontally between two supports that are 3.0 m apart. When an object of weight 3200 N is hung at the center of the rope, the rope is observed to sag by 50 cm. Calculate the tension in the rope.

Solution

We have three forces acting on the object being hung at the center of the rope, as you can see in the diagram below. Since the rope is assumed massless, tension is uniform throughout the rope and the rope exerts two forces of equal magnitude on both the left and right side of the object.





To find the horizontal and vertical components of the two tension forces on either side, we must first know the angle θ.

$$\tan\theta = \frac{s}{\frac{d}{2}} = \frac{0.5}{1.5} = \frac{1}{3}.$$

$$\theta = \tan^{-1}\frac{1}{3} = 18.43°.$$

We can split up the tension forces using trigonometry. The horizontal components are always $Tcos(\theta)$ and the vertical components are $Tsin(\theta)$.

For y direction:

$$Tsin(\theta) + Tsin(\theta) = mg.$$

$$T = \frac{mg}{2sin(\theta)} = \frac{3200}{2\sin 18.43°} = 5061\ N.$$

Answer: $5061\ N$.