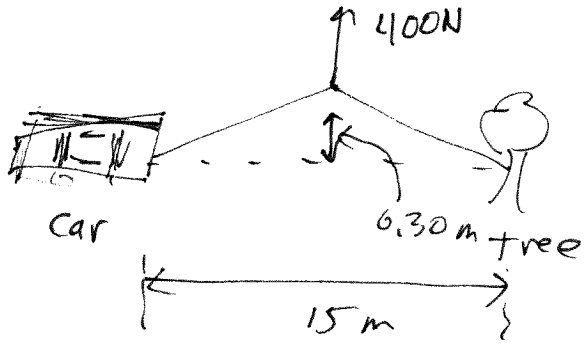
Chapter 12

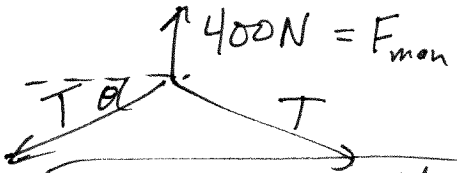
Problem 34

What is the force of the rope on the car?!



Since the tension in the rope must be in line with the rope itself, then we can use trigonometry to find the tension in the rope.

Draw a free-body diagram for the rope where the man is pushing.



T + θ on each side are the same. He pulls on the center of the rope.

Assume the system is not moving, then

$$\Sigma \vec{F} = 0$$

$$-T\cos\theta\,\hat{i} - T\sin\theta\,\hat{j} + F_{man}\,\hat{j} + T\cos\theta\,\hat{i} - T\sin\theta\,\hat{j} = 0$$

x-dir $-T\cos\theta + T\cos\theta = 0 \quad \therefore\ 0 = 0$

y-dir $F_{man} - T\sin\theta - T\sin\theta$

$$F_{man} = 2T\sin\theta \qquad \therefore\ T = \frac{F_{man}}{2\sin\theta}$$

Use trigonometry to find θ.

$$\tan\theta = \frac{y}{x} = \frac{0.30\text{ m}}{7.5\text{ m}} \rightarrow \theta = \tan^{-1}\left(\frac{0.30}{7.5}\right) = 2.29^\circ$$

$$T = \frac{400\text{N}}{2\sin(2.29^\circ)} = \boxed{5005\text{N}}$$