STAEDTLER® No. 937 811E Engineer's Computation Pad

•10 In Fig. 12-28, a man is trying to get his car out of mud on the shoulder of a road. He ties one end of a rope tightly around the front bumper and the other end tightly around a utility pole 18 m away. He then pushes sideways on the rope at its midpoint with a force of 550 N, displacing the center of the rope 0.30 m from its previous position, and the car barely moves. What is the magnitude of the force on the car from the rope? (The rope stretches somewhat.)

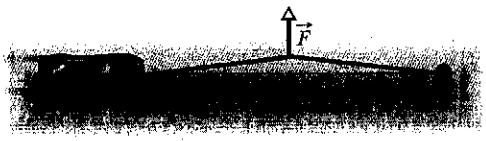
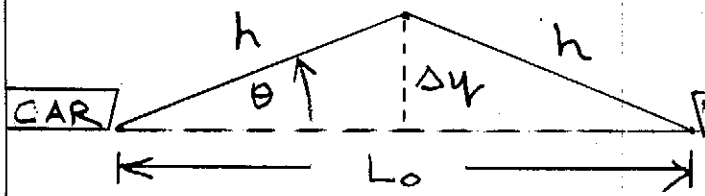



FIG. 12-28 Problem 10.

APPLY THE CONDITION FOR EQUILIBRIUM AT THE POINT WHERE YOU APPLY THE FORCE, $\vec{F}$.

$$\vec{F}_{net} \equiv 0$$

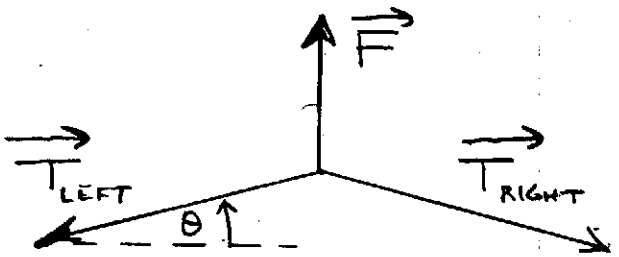
$$\vec{F} + \vec{T}_{RIGHT} + \vec{T}_{LEFT} = 0$$




$$h = \sqrt{\Delta y^2 + (L_o/2)^2}$$

$$\tan\theta = \Delta y / (L_o/2)$$

$$\sin\theta = \frac{\Delta y}{h} = \frac{\Delta y}{\sqrt{\Delta y^2 + \frac{L_o^2}{4}}}$$




THE ROPE WHICH IS IN EQUILIBRIUM HAS CONSTANT TENSION

$$T_{LEFT} = T_{RIGHT} (= T)$$

$$F^{net}_{horizontal} \equiv 0 \Rightarrow T_L \cos\theta = T_R \cos\theta \Rightarrow T_L = T_R = T$$

$$F^{net}_{VERTICAL} \equiv 0 \Rightarrow F - T_L \sin\theta - T_R \sin\theta = 0$$

$$F = 2T\sin\theta$$

$$T = \frac{F}{2\sin\theta}$$

$$T = \frac{F}{2\Delta y}\sqrt{\Delta y^2 + L_o^2/4}$$

$$= \frac{550\,N}{2(0.30\,m)}\sqrt{(0.3)^2 + 18^2/4} = 917\,(9)$$

$$= 8{,}250\,N$$

WOW, you only exert 550N, but the Tension in the rope which pulls the car is 8,300 N!