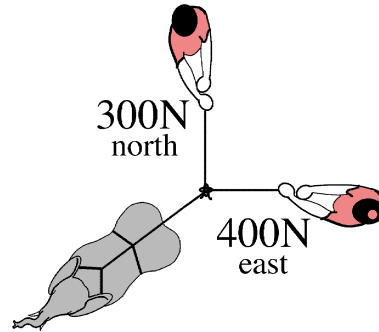
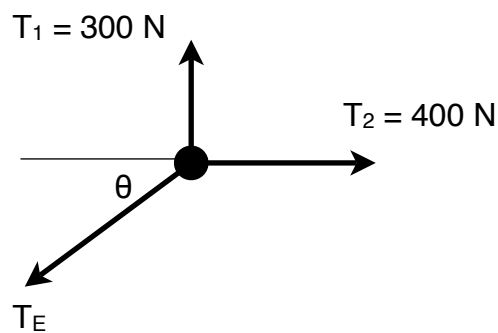


Elephant tug-of-war

Find the tension in (and direction of) the rope attached to the elephant. Everyone is stationary.



Solution: Everyone is stationary, hence the net force is *zero*. Draw the FBD:



Separate into X and Y components: $T_{E,x} = T_E \cos \theta$ and $T_{E,y} = T_E \sin \theta$

(a) X: $\Sigma F_x = 0$
so

$$400 \text{ N} - T_E \cos \theta = 0$$

(b) Y: $\Sigma F_y = 0$
so

$$300 \text{ N} - T_E \sin \theta = 0$$

so

$$\begin{aligned} T_E \cos \theta &= 400 \text{ N} \\ T_E \sin \theta &= 300 \text{ N} \end{aligned}$$

Now, from the definition of $\tan \theta$,
 $\tan \theta = \sin \theta / \cos \theta$

so

$$\tan \theta = T_E \sin \theta / T_E \cos \theta = 300/400 = 0.75$$

so

$$\theta = \arctan(0.75) = 36.9^\circ$$

Hence

$$T_E = 300 \text{ N} / \sin(36.9^\circ) = 300 \text{ N} / 0.6 = 500 \text{ N}$$

so the elephant is pulling with force 500 N at an angle 36.9° S of W