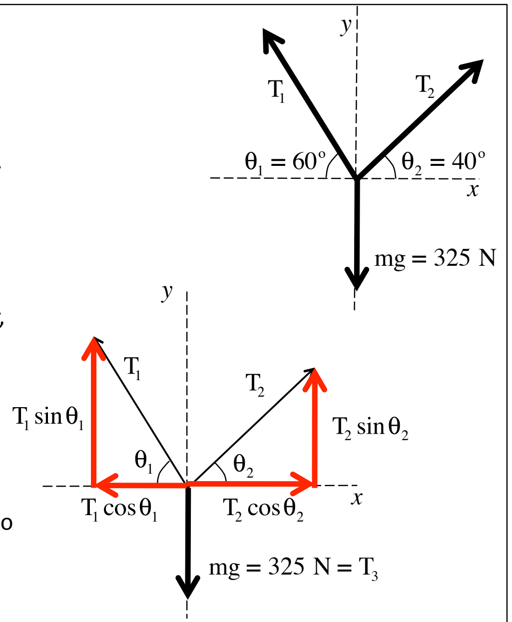
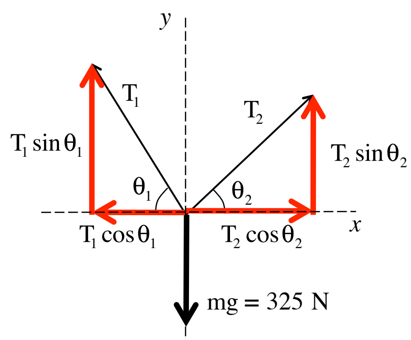
Problem 5.24

Because the system is in equilibrium, the sum of the tension forces on the knot in *any direction* must be zero. And because the concrete sack is not accelerating, the tension in the line attached to the concrete is just its weight, or mg (remember, tension is NOT ALWAYS equal to mg, but it is in this case). With this, we can draw a f.b.d. on the knot, shown to the right, then sum the forces in both the *x-direction* and *y-direction* to generate the equations needed to solve the problem. The second sketch breaks the tensions into components.



Summing forces:

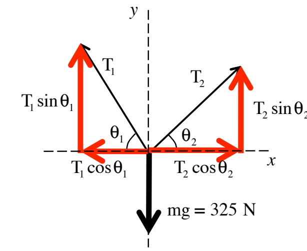


$\sum F_x$:

$$\Rightarrow \quad -T_1\cos\theta_1 + T_2\cos\theta_2 = \cancel{ma_x}^{\,0}$$

$$\Rightarrow \quad T_1 = \frac{T_2\cos\theta_2}{\cos\theta_1} = \frac{T_2\cos 40^\circ}{\cos 60^\circ} = 1.53T_2$$

and



$\sum F_y$:

$$\Rightarrow \quad T_1\sin\theta_1 + T_2\sin\theta_2 - mg = \cancel{ma_y}^{\,0}$$

$$\Rightarrow \quad (1.53T_2)\sin\theta_1 + T_2\sin\theta_2 = mg$$

$$\Rightarrow \quad T_2 = \frac{(mg)}{(1.53)\sin\theta_1 + \sin\theta_2}$$

$$\Rightarrow \quad T_2 = \frac{(325\ \text{N})}{(1.53)\sin 60^\circ + \sin 40^\circ} = 165\ \text{N}$$

$$\Rightarrow \quad T_1 = 1.53T_2 = 1.53(165\ \text{N}) = 253\ \text{N}$$

And from the start we knew that $T_3 = 325$ N.