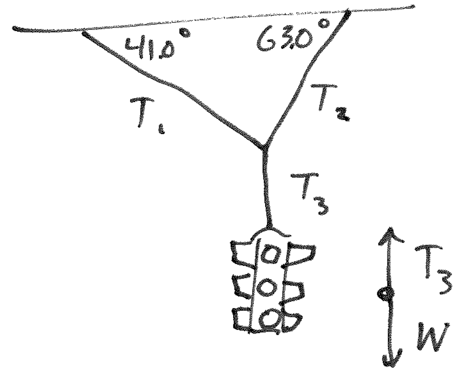
Chapter 6 Problem 26

$$W = 2.00 \times 10^2 N$$

Find the tension in each cable supporting the traffic light.



Tension in the third cable needs to offset the weight of the light.

$$\sum \vec{F} = ma = 0$$

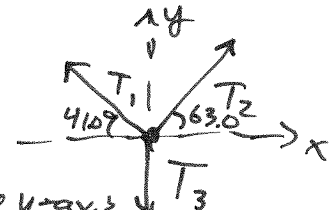
$$\vec{T}_3 + \vec{W} = 0$$

$$T_3 \hat{j} - W\hat{j} = 0 \quad \therefore \quad \boxed{T_3 = W = 2.00 \times 10^2 N}$$

The forces where the cables intersect also need to add to zero

$$\sum \vec{F} = ma = 0$$

$$\vec{T}_1 + \vec{T}_2 + \vec{T}_3 = 0$$



Making horizontal the x-axis & vertical the y-axis

Then

$$\vec{T}_1 = -T_1\cos(41.0)\hat{i} + T_1\sin(41.0)\hat{j}$$

$$\vec{T}_2 = T_2\cos(63.0)\hat{i} + T_2\sin(63.0)\hat{j}$$

$$\vec{T}_3 = -T_3\hat{j}$$

Then $\sum \vec{F} = 0$

$$-T_1\cos(41.0)\hat{i} + T_1\sin(41.0)\hat{j} + T_2\cos(63.0)\hat{i} + T_2\sin(63.0)\hat{j} - T_3\hat{j}$$

x-dir $\quad -T_1\cos(41.0) + T_2\cos(63.0) = 0$ (#1)

y-dir $\quad T_1\sin(41.0) + T_2\sin(63.0) - T_3 = 0$ (#2)

Take (#1) & solve for T_1

$$T_1 = T_2\frac{\cos(63.0)}{\cos(41.0)} \quad (\#3)$$

sub into (#2)

$$T_2\frac{\cos(63.0)}{\cos(41.0)}\sin(41.0) + T_2\sin(63.0) - T_3 = 0$$

$$T_2 \cos(63.0)\tan(41.0) + T_2 \sin(63.0) = T_3$$

$$T_2\left[\cos(63.0)\tan(41.0) + \sin(63.0)\right] = T_3$$

$$T_2 = \frac{T_3}{\cos(63.0)\tan(41.0)+\sin(63.0)} = \frac{2.00\times10^2\,N}{\cos(63.0)\tan(41.0)+\sin(63.0)}$$

$$T_2 = \frac{2.00\times10^2\,N}{1.286} = \boxed{156N}$$

Substitute This result in #3

$$T_1 = T_2\frac{\cos(63.0)}{\cos(41.0)} = (156N)\frac{\cos(63.0)}{\cos(41.0)} = \boxed{93.6N}$$

Notice The angle T_1 acts on The light is smaller or more to The side Than T_2. Therefore, T_2 is bearing more of The weight. T_3 has to bear all of The weight.

$$\boxed{\begin{aligned} T_1 &= 93.6N \\ T_2 &= 156N \\ T_3 &= 200N \end{aligned}}$$

Also notice That
$T_1 + T_2 \neq T_3$
They must be added as vectors.