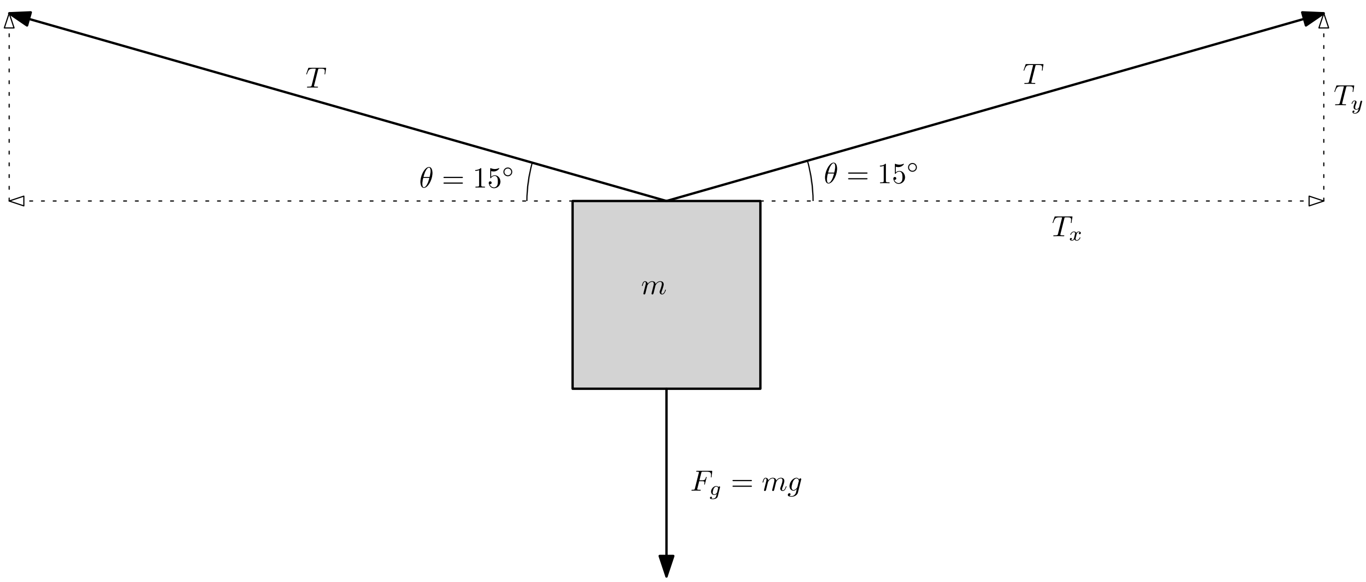
Suppose there is a 12 kg mass hanging at the center of a clothesline. The mass is at rest. The clothesline is depressed by an angle of 15° with respect to the horizontal? What is the tension in the two halves of the clothesline?



We know that the mass is at rest, so $F_{\text{net}} = 0$. That means $F_{\text{net}x} = 0$ and $F_{\text{net}y} = 0$.

$$\sum F_y = T_y + T_y - F_g = 0$$
$$2T_y - mg = 0$$
$$T_y = \frac{mg}{2}$$

We can see that the T_x's are equal and in opposite directions ($\sum F_x = 0$). To find them we just use $\tan\theta$ since we already know T_y.

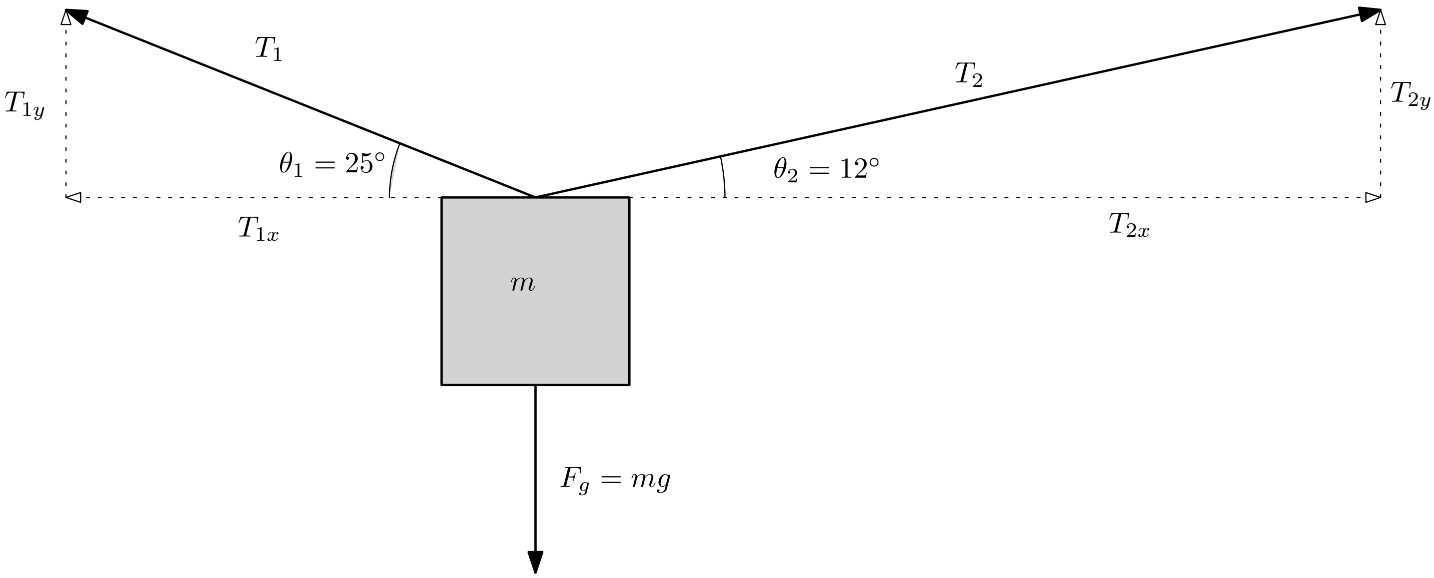
$$\tan\theta = \frac{T_y}{T_x} \Longrightarrow T_x = \frac{T_y}{\tan\theta}$$
$$T_x = \frac{mg}{2\tan\theta}$$

To find the magnitude of T, use the pythagorean theorem:

$$T = \sqrt{T_x^2 + T_y^2}$$

Compute values for F_g and T:

Now suppose the 12 kg mass hanging *off*-center on a clothesline. The mass is at rest. The clothesline is depressed by an angle of 25° on one side and 12° on the other, with respect to the horizontal. What is the tension in the two halves of the clothesline?



Just like before:

$\sum F_x = 0$ and $\sum F_y = 0$

$$\sum F_y = T_{1y} + T_{2y} - F_g = 0$$
$$T_{1y} + T_{2y} = F_g$$

$$\sum F_x = -T_{1x} + T_{2x} = 0$$
$$T_{1x} = T_{2x}$$

What we end up with is a system of equations:

$$T_1 \sin\theta_1 + T_2 \sin\theta_2 = mg$$
$$T_1 \cos\theta_1 = T_2 \cos\theta_2$$

Use substitution:

$$T_1 = T_2 \frac{\cos\theta_2}{\cos\theta_1}$$

$$T_2 \frac{\cos\theta_2}{\cos\theta_1} \sin\theta_1 + T_2 \sin\theta_2 = mg$$

$$T_2(\cos\theta_2 \tan\theta_1 + \sin\theta_2) = mg$$

$$T_2 = \frac{mg}{\cos\theta_2 \tan\theta_1 + \sin\theta_2}$$

Compute the values for T_1 and T_2: