12.330

EE25BTECH11004 - Aditya Appana

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Question

If a weight of $\mathbf{P} = 100N$ is supported by two massless strings connected to the walls as shown in the figure, the value of T_1 is _____ N.
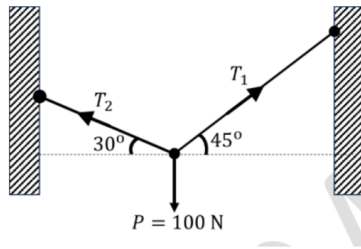

Figure 1: Figure

Solution

$$\mathbf{T_1} + \mathbf{T_2} = -\mathbf{P} \tag{1}$$

$$\mathbf{T_1} = \|T_1\| \begin{pmatrix} \cos 45° \\ \sin 45° \end{pmatrix} \tag{2}$$

$$\mathbf{T_2} = \|T_2\| \begin{pmatrix} \cos 180 - 30° \\ \sin 180 - 30° \end{pmatrix} = \|T_2\| \begin{pmatrix} \cos 150° \\ \sin 150° \end{pmatrix} \tag{3}$$

$$\mathbf{P} = -\|P\| \begin{pmatrix} \cos -90° \\ \sin -90° \end{pmatrix} = -100 \begin{pmatrix} \cos(-90°) \\ \sin(-90°) \end{pmatrix} \tag{4}$$

Therefore:

$$\|T_1\| \begin{pmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{pmatrix} + \|T_2\| \begin{pmatrix} -\frac{\sqrt{3}}{2} \\ \frac{1}{2} \end{pmatrix} = 100 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \tag{5}$$

$$\begin{pmatrix} \frac{1}{\sqrt{2}} & -\frac{\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{2} \end{pmatrix} \begin{pmatrix} \|T_1\| \\ \|T_2\| \end{pmatrix} = \begin{pmatrix} 0 \\ 100 \end{pmatrix} \tag{6}$$

Organising the data into an augmented matrix and obtaining RREF:

$$\left(\begin{array}{cc|c} \frac{1}{\sqrt{2}} & -\frac{\sqrt{3}}{2} & 0 \\ \frac{1}{\sqrt{2}} & \frac{1}{2} & 100 \end{array} \right) \xrightarrow{R_2 \to R_2 - R_1} \left(\begin{array}{cc|c} \frac{1}{\sqrt{2}} & -\frac{\sqrt{3}}{2} & 0 \\ 0 & \frac{1}{2} + \frac{\sqrt{3}}{2} & 100 \end{array} \right) \xrightarrow{R_1 \to \sqrt{2}R_1} \left(\begin{array}{cc|c} 1 & -\sqrt{6} & 0 \\ 0 & \frac{1}{2} + \frac{\sqrt{3}}{2} & 100 \end{array} \right) \tag{7}$$

$$\|T_2\| = \frac{200}{1 + \sqrt{3}} = 73.205N \tag{8}$$

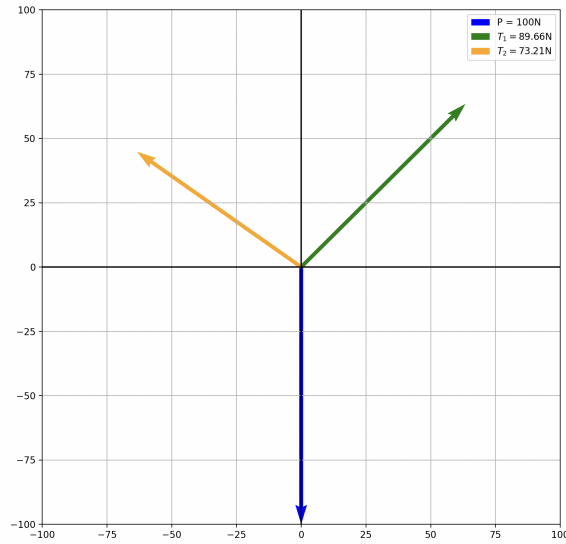$$\|T_1\| = \frac{\sqrt{3}}{\sqrt{2}} \|T_2\| = 89.658N \tag{9}$$

Figure 2: Plot

2