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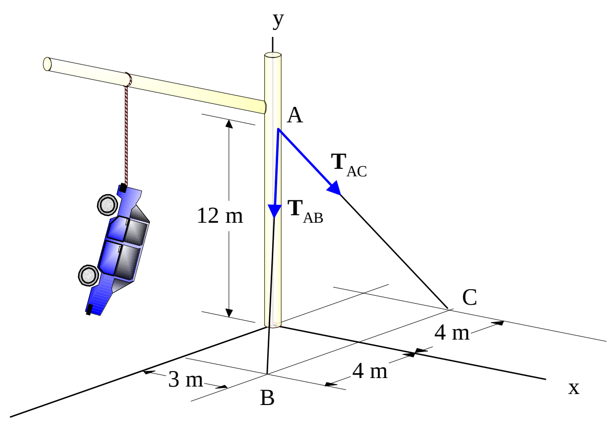
ENG 1440 **Name:** **Group**

Lab #8. Solution

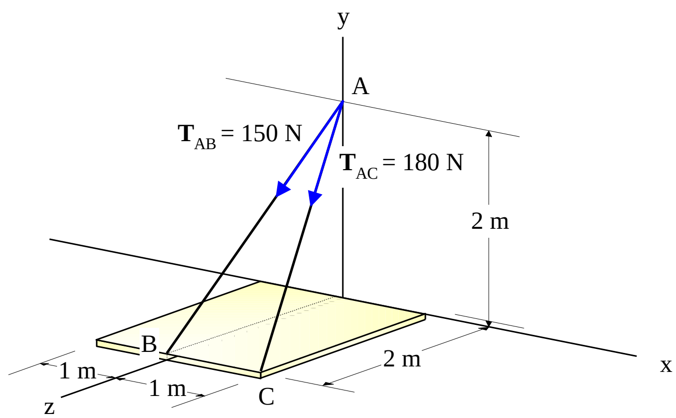
1. Two cables AB and AC secure the post. The cables are pre-stressed so that the forces exerted by the cables on the post are $\mathbf{T}_{AB}$ = 1200 N and $\mathbf{T}_{AC}$ = 1800 N. Determine

(a) The magnitude of the resultant force $\mathbf{R} = \mathbf{T}_{AB} + \mathbf{T}_{AC}$ and,

(b) The angle **R** makes with the coordinate axes.



2. A trap door is held by ropes as shown in the Figure. If the cables exert forces $\mathbf{T}_{AB}$ and $\mathbf{T}_{AC}$ on the wall at A, determine the magnitude of the resultant force **R** acting at A and the angles it makes with the coordinate axes.



1) $\vec{T}_{AB} = T_{AB}\vec{\lambda}_{AB} = 1200\vec{\lambda}_{AB}$

$A(0,12,0)$ $\quad \vec{\lambda}_{AB} = \frac{\vec{AB}}{AB}$ $\quad \vec{AB} = 3\hat{i} - 12\hat{j} + 4\hat{k}$

$B(3,0,4)$

$C(3,0,-4)$ $\quad AB = \sqrt{(3)^2+(-12)^2+4^2} = 13$

$$\vec{\lambda}_{AB} = \frac{3}{13}\hat{i} - \frac{12}{13}\hat{j} + \frac{4}{13}\hat{k}$$

$$\vec{T}_{AB} = 1200\left(\frac{3}{13}\hat{i} - \frac{12}{13}\hat{j} + \frac{4}{13}\hat{k}\right) = 276.92\hat{i} - 1107.69\hat{j} + 369.23\hat{k}$$

$$\vec{T}_{AC} = T_{AC}\vec{\lambda}_{AC} \quad \vec{\lambda}_{AC} = \frac{\vec{AC}}{AC} \quad \vec{AC} = 3\hat{i} - 12\hat{j} - 4\hat{k}$$

$$AC = \sqrt{(3)^2+(-12)^2+(-4)^2} = 13$$

$$\vec{\lambda}_{AC} = \frac{3}{13}\hat{i} - \frac{12}{13}\hat{j} - \frac{4}{13}\hat{k}$$

$$\vec{T}_{AC} = 1800\left(\frac{3}{13}\hat{i} - \frac{12}{13}\hat{j} - \frac{4}{13}\hat{k}\right.$$

$$415.38\hat{i} - 1661.54\hat{j} - 553.85\hat{k}$$

$$\vec{R} = \vec{T}_{AB} + \vec{T}_{AC} = (276.92 + 415.38)\hat{i} + (-1107.69 - 1661.54)\hat{j} + (369.23 - 553.85)k$$

$$\vec{R} = 692.3\hat{i} - 2769.23\hat{j} - 184.62k \quad N$$

$$R = \sqrt{692.3^2 + (-2769.23)^2 + (-184.62)^2} = 2860.42 N$$

$$\cos\theta_x = \frac{R_x}{R} = \frac{692.3}{2860.42} \qquad \theta_x = 76°$$

$$\cos\theta_y = \frac{R_y}{R} = \frac{-2769.23}{2860.42} \qquad \theta_y = 165.5°$$

$$\cos\theta_z = \frac{R_z}{R} = \frac{-184.62}{2860.42} \qquad \theta_z = 93.7°$$

2)

$A(0,2,0)$
$B(0,0,2)$
$C(1,0,2)$

$$\vec{T}_{AB} = T_{AB}\vec{\lambda}_{AB} = 150\vec{\lambda}_{AB}$$

$$\vec{\lambda}_{AB} = \frac{\vec{AB}}{AB} \qquad \vec{AB} = 0\hat{i} - 2\hat{j} + 2\hat{k}$$

$$AB = \sqrt{(-2)^2+(2)^2} = \sqrt{8}$$

$$\vec{\lambda}_{AB} = \frac{-2\hat{j}+2\hat{k}}{\sqrt{8}} = \frac{-\hat{j}+\hat{k}}{\sqrt{2}}$$

$$\vec{T}_{AB} = 150\left(\frac{-\hat{j}+\hat{k}}{\sqrt{2}}\right) = -106.07\hat{j} + 106.07\hat{k}\ N$$

$$\vec{T}_{AC} = T_{AC}\vec{\lambda}_{AC} = 180\,\vec{\lambda}_{AC}$$

$$\vec{\lambda}_{AC} = \frac{\vec{AC}}{AC} \qquad \vec{AC} = 1\hat{i} - 2\hat{j} + 2\hat{k}$$

$$AC = \sqrt{(1)^2+(-2)^2+(2)^2} = 3$$

$$\vec{\lambda}_{AC} = \frac{1}{3}\hat{i} - \frac{2}{3}\hat{j} + \frac{2}{3}\hat{k}$$

$$\vec{T}_{AC} = 180\left(\frac{1}{3}\hat{i} - \frac{2}{3}\hat{j} + \frac{2}{3}\hat{k}\right) = 60\hat{i} - 120\hat{j} + 120\hat{k}\ N$$

$$\vec{R}_A = \vec{T}_{AB} + \vec{T}_{AC} = 60\hat{i} + (-106.07-120)\hat{j} + (106.07+120)\hat{k}$$

$$= 60\hat{i} - 226.07\hat{j} + 226.07\hat{k}\ N$$

$$R_A = \sqrt{(60)^2+(-226.07)^2+(226.07)^2} = 325.29\,N$$

$$\cos\theta_x = \frac{R_x}{R} = \frac{60}{325.29} \qquad \theta_x = 79.37°$$

$$\cos\theta_y = \frac{R_y}{R} = \frac{-226.07}{325.29} \qquad \theta_y = 134.03°$$

$$\cos\theta_z = \frac{R_z}{R} = \frac{226.07}{325.29} \qquad \theta_z = 45.97°$$