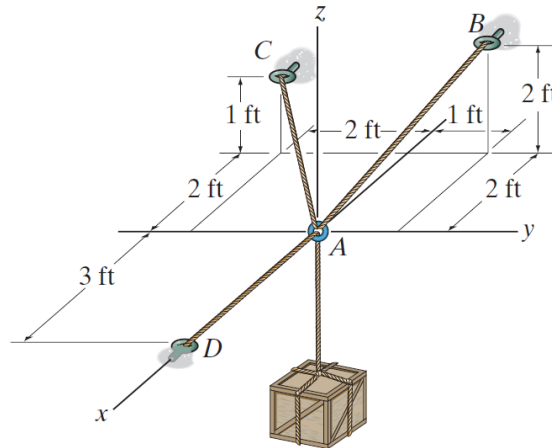


Problem 3-67

Determine the maximum weight of the crate so that the tension developed in any cable does not exceed 450 lb.



Prob. 3-67

Solution

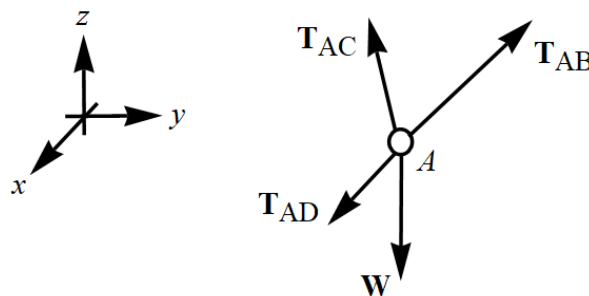
Write position vectors to points A , B , and C .

$$\mathbf{r}_A = \langle 0, 0, 0 \rangle \text{ ft}$$

$$\mathbf{r}_B = \langle -2, 1, 2 \rangle \text{ ft}$$

$$\mathbf{r}_C = \langle -2, -2, 1 \rangle \text{ ft}$$

Draw a free-body diagram for point A .



In order for the system to be in equilibrium, the sum of the forces must be zero.

$$\mathbf{T}_{AB} + \mathbf{T}_{AC} + \mathbf{T}_{AD} + \mathbf{W} = \mathbf{0}$$

$$T_{AB}\hat{\mathbf{u}}_{AB} + T_{AC}\hat{\mathbf{u}}_{AC} + T_{AD}\langle 1, 0, 0 \rangle + W\langle 0, 0, -1 \rangle = \mathbf{0}$$

$$T_{AB}\frac{\mathbf{r}_B - \mathbf{r}_A}{|\mathbf{r}_B - \mathbf{r}_A|} + T_{AC}\frac{\mathbf{r}_C - \mathbf{r}_A}{|\mathbf{r}_C - \mathbf{r}_A|} + T_{AD}\langle 1, 0, 0 \rangle + W\langle 0, 0, -1 \rangle = \mathbf{0}$$

Write out the unit vectors and simplify the left side.

$$T_{AB} \frac{\langle -2-0, 1-0, 2-0 \rangle}{\sqrt{(-2-0)^2 + (1-0)^2 + (2-0)^2}} + T_{AC} \frac{\langle -2-0, -2-0, 1-0 \rangle}{\sqrt{(-2-0)^2 + (-2-0)^2 + (1-0)^2}} + T_{AD} \langle 1, 0, 0 \rangle + W \langle 0, 0, -1 \rangle = \mathbf{0}$$

$$T_{AB} \left\langle -\frac{2}{3}, \frac{1}{3}, \frac{2}{3} \right\rangle + T_{AC} \left\langle -\frac{2}{3}, -\frac{2}{3}, \frac{1}{3} \right\rangle + T_{AD} \langle 1, 0, 0 \rangle + W \langle 0, 0, -1 \rangle = \mathbf{0}$$

$$\left\langle -\frac{2}{3}T_{AB} - \frac{2}{3}T_{AC} + T_{AD}, \frac{1}{3}T_{AB} - \frac{2}{3}T_{AC}, \frac{2}{3}T_{AB} + \frac{1}{3}T_{AC} - W \right\rangle = \langle 0, 0, 0 \rangle$$

Match the components to get a system of equations.

$$\left. \begin{aligned} -\frac{2}{3}T_{AB} - \frac{2}{3}T_{AC} + T_{AD} &= 0 \\ \frac{1}{3}T_{AB} - \frac{2}{3}T_{AC} &= 0 \\ \frac{2}{3}T_{AB} + \frac{1}{3}T_{AC} - W &= 0 \end{aligned} \right\}$$

In the previous problem it was found that the tensions in cables AB and AD are equal, so set $T_{AB} = T_{AD} = 450$ lb and solve the system for T_{AC} and W .

$$T_{AC} = 225 \text{ lb}$$

$$W = 375 \text{ lb}$$