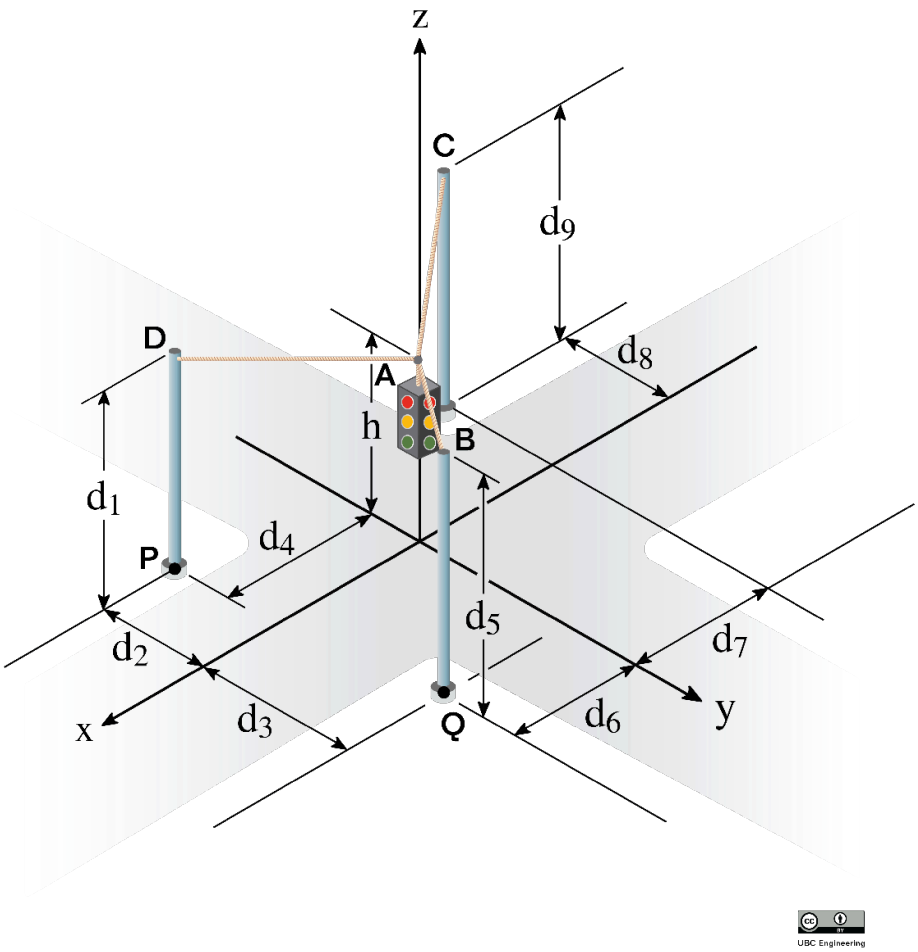
21-S-2.8-RP-05



Three cables are attached to the traffic light hanging at point A. If the resultant force of the three tension forces points along the positive z axis, and cable AD has a tension force with magnitude F_{AD}, determine the magnitudes of the tension in cable AB and cable AC.

Express each cable as a cartesian vector with tail at point A.

$\overrightarrow{AB} = d_6\hat{i} + d_3\hat{j} + (d_5 - h)\hat{k}$

$\overrightarrow{AC} = -d_7\hat{i} - d_8\hat{j} + (d_9 - h)\hat{k}$

$\overrightarrow{AD} = d_4\hat{i} - d_2\hat{j} + (d_1 - h)\hat{k}$

Determine the magnitudes of the tension in cable AB and cable AC.

$AB = \sqrt{{d_6}^2 + {d_3}^2 + (d_5 - h)^2}$

$$AC = \sqrt{{d_7}^2 + {d_8}^2 + (d_9 - h)^2}$$

$$AD = \sqrt{d_4^2 + {d_2}^2 + (d_1 - h)^2}$$

$$\overrightarrow{F_{AB}} = B \cdot (d_6\hat{i} + d_3\hat{j} + (d_5 - h)\hat{k})$$

$$B = \frac{F_{AB}}{AB}$$

$$\overrightarrow{F_{AC}} = C \cdot (-d_7\hat{i} - d_8\hat{j} + (d_9 - h)\hat{k})$$

$$C = \frac{F_{AC}}{AC}$$

$$\overrightarrow{F_{AD}} = D \cdot (d_4\hat{i} - d_2\hat{j} + (d_1 - h)\hat{k})$$

$$D = \frac{F_{AD}}{AD}$$

$$\Sigma F_x = 0 \rightarrow B \cdot d_6 - C \cdot d_7 + D \cdot d_4 = 0$$

$$\rightarrow C = \frac{B \cdot d_6 + D \cdot d_4}{d_7}$$

$$\Sigma F_y = 0 \rightarrow B \cdot d_3 - C \cdot d_8 - D \cdot d_2 = 0$$

$$\rightarrow B \cdot d_3 - \frac{d_8}{d_7} \cdot (B \cdot d_6 + D \cdot d_4) - D \cdot d_2 = 0$$

$$\rightarrow B \cdot \left(d_3 - \frac{d_8 \cdot d_6}{d_7}\right) = D \cdot \left(d_2 + \frac{d_8 \cdot d_4}{d_7}\right)$$

$$\Rightarrow B = D \cdot \frac{d_2 + \frac{d_8 \cdot d_4}{d_7}}{d_3 - \frac{d_8 \cdot d_6}{d_7}}$$

$$\Rightarrow C = \frac{B \cdot d_6 + D \cdot d_4}{d_7}$$

$$F_{AB} = B \cdot AB$$

$$F_{AC} = C \cdot AC$$

What is the magnitude of the resultant force?

$$F_R = F_{Rz} = \Sigma F_z = B \cdot (d_5 - h) + C \cdot (d_9 - h) + D \cdot (d_1 - h)$$