Triple Product

$$V = \vec{S} \cdot (\vec{P} \times \vec{Q})$$

Moment about an axis

$$M_{OL} = \vec{\lambda} \cdot \vec{M}_O = \vec{\lambda} \cdot (\vec{r} \times \vec{F}) = \begin{vmatrix} \lambda_x & \lambda_y & \lambda_z \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

$\vec{\lambda} = i$

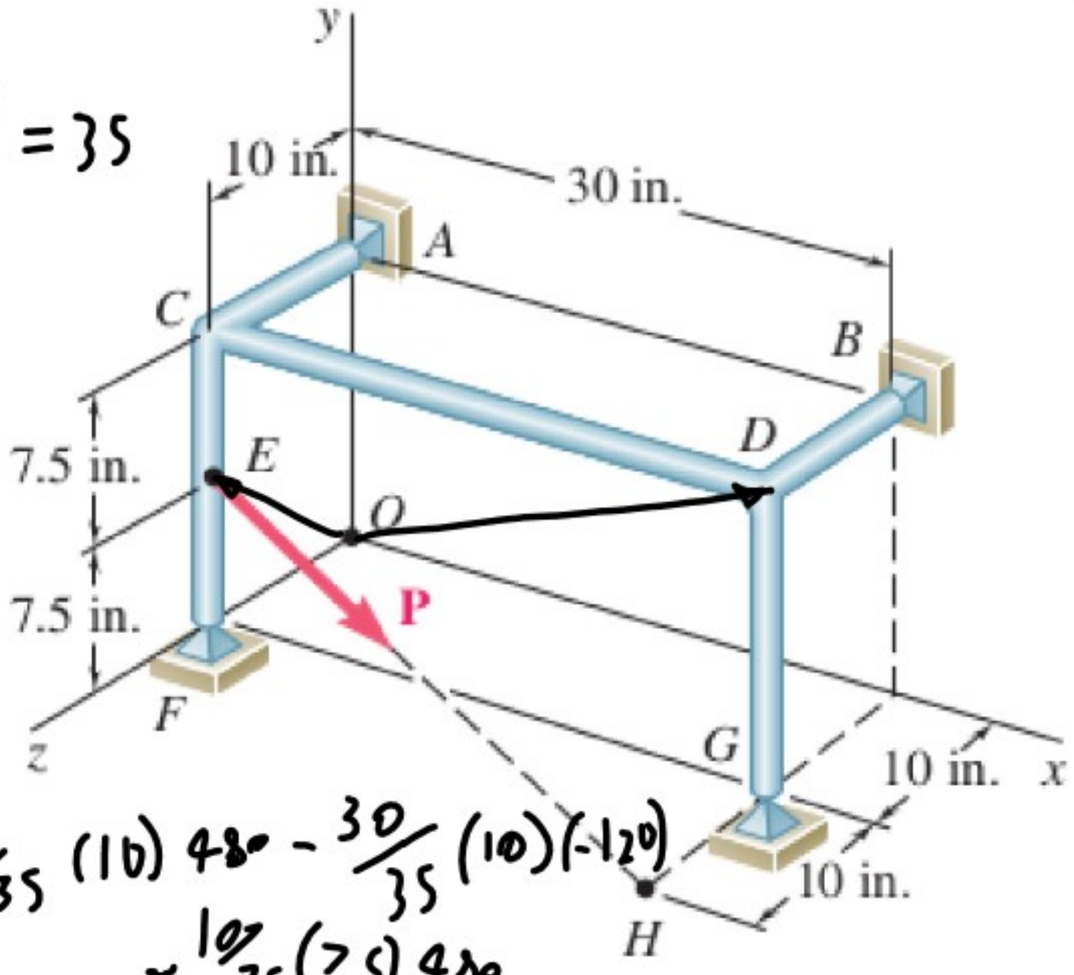
$$M_x = i \cdot (\vec{r} \times \vec{F}) = \begin{vmatrix} i & 0 & 0 \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix} \begin{matrix} i & 0 \\ r_x & r_y \\ F_x & F_y \end{matrix}$$

$$= r_y F_z i - r_z F_y i = r_y F_z - r_z F_y$$

$$M_y = r_z F_x - r_x F_z$$

$$M_z = r_x F_y - r_y F_x$$

A force **P** of magnitude 520 lb acts on the frame shown at point *E*.
Determine the moment of **P** about a line joining points *Q* and *D*.



$\vec{OD} = 30i + 15j + 10k$

$OD = \sqrt{30^2 + 15^2 + 10^2} = 35$

$\vec{\lambda} = \frac{30}{35}i + \frac{15}{35}j + \frac{10}{35}k$

$$M_{OD} = \begin{vmatrix} 30/35 & 15/35 & 10/35 \\ 0 & 7.5 & 10 \\ 480 & -120 & 160 \end{vmatrix}$$

$= 30/35\,(7.5)160 + 15/35\,(10)480 - 30/35\,(10)(-120) - 10/35\,(7.5)480$

$= 3086$ lb-in

$\vec{EH} = 30i - 7.5j + 10k$

$EH = \sqrt{30^2 + 7.5^2 + 10^2}$

$= 32.5$

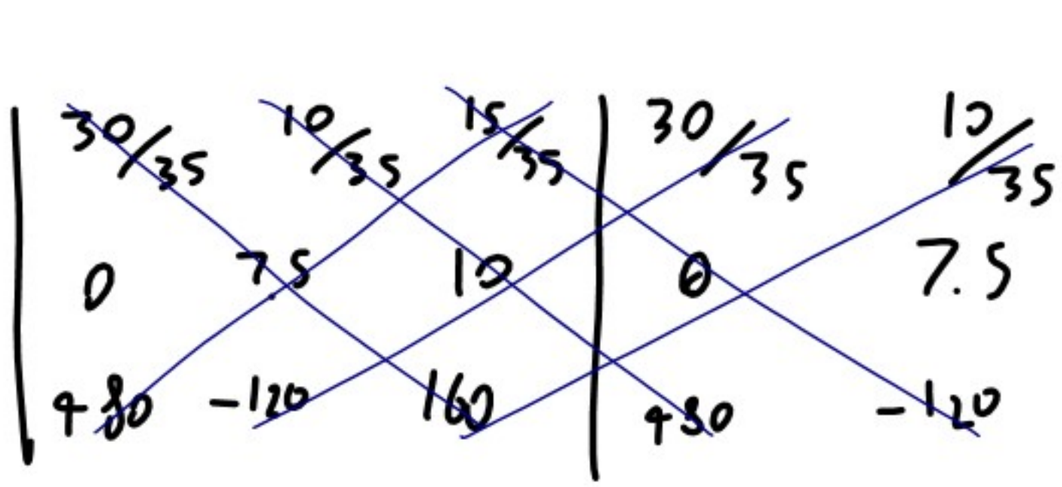
$\vec{\lambda}_P = \vec{EH}/EH$

$= \frac{30}{32.5}i - \frac{7.5}{32.5}j + \frac{10}{32.5}k$

$\vec{P} = 520\vec{\lambda}_P$

$= 480i - 120j + 160k$

$\vec{r} = 0i + 7.5j + 10k$



$$-\frac{10}{35}(0)\,160 = 0$$

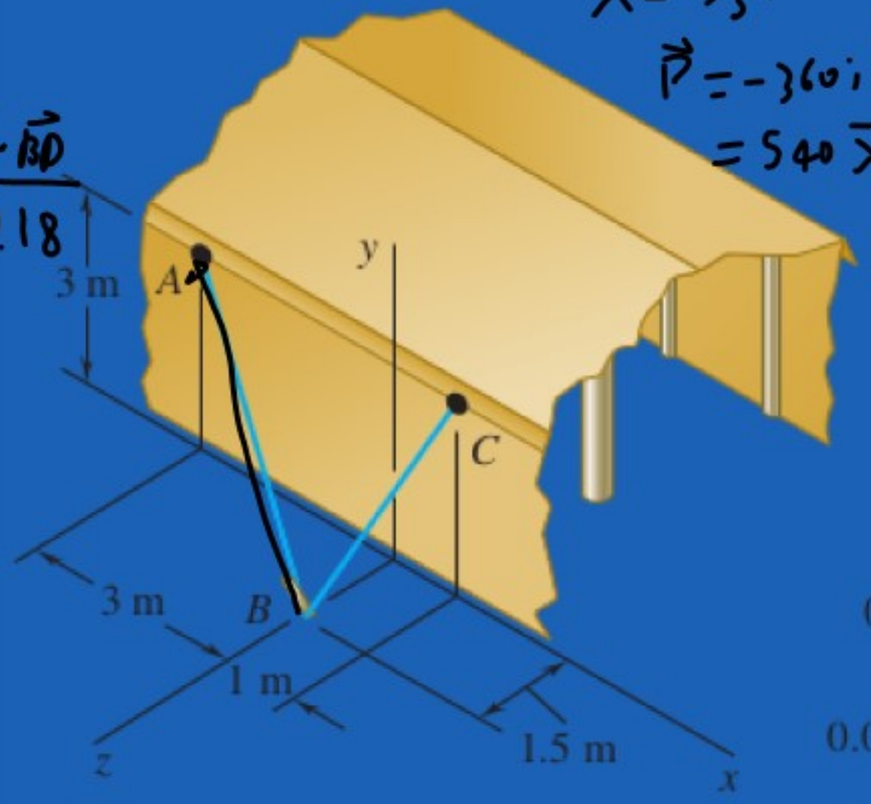
$\vec{P} \cdot \vec{Q} = PQ \cos\theta$

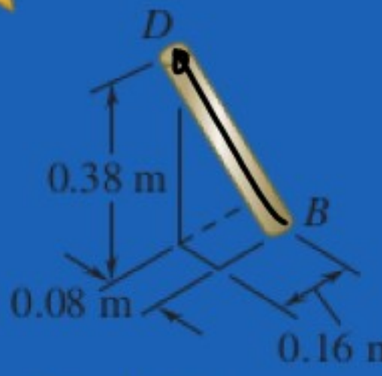
proj P onto Q

$Q \frac{P \cdot Q}{Q \cdot Q}$

$\vec{BD} \frac{\vec{P} \cdot \vec{BD}}{\vec{BD}\,\vec{BD}} = \vec{BD} \frac{\vec{P} \cdot \vec{BD}}{0.18}$

Ropes *AB* and *BC* are two of the ropes used to support a tent. The two ropes are attached to a stake at *B*. If the tension in rope *AB* is 540 N, determine (*a*) the angle between rope *AB* and the stake, (*b*) the projection on the stake of the force exerted by rope *AB* at point *B*.





Detail of the stake at *B*

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

$\vec{P} = -360i + 360j - 180k$

$= 540\vec{\lambda}$

$\vec{BA} = -3i + 3j - 1.5k$

$BA = 4.5$

$\vec{BD} = -0.08i + 0.38j + 0.16k$

$BD = 0.42$

$\vec{BA} \cdot \vec{BD} = 0.24 + 1.14 - 0.29 = 1.14$

$1.14 = 4.5(0.42)\cos\theta$

$\frac{1.14}{4.5(0.42)} = \cos\theta = 0.6$

$\cos^{-1}(0.6) = 53°$