A 100 lb force $F$ is directed along the line from $A$ to $B$.

Find a unit vector in the direction of force $F$.

$$\hat{u} = \frac{\vec{F}}{\|\vec{F}\|} = \frac{4\hat{i} + 8\hat{j} - 8\hat{k}}{\sqrt{4^2 + 8^2 + (-8)^2}}$$

$$\hat{u} = \frac{1}{3}\hat{i} + \frac{2}{3}\hat{j} - \frac{2}{3}\hat{k}$$

Express force $F$ in Cartesian vector form.

$$\vec{F} = F\hat{u} = 100\hat{u}$$

$$\hat{u} = \frac{100}{3}\hat{i} + \frac{200}{3}\hat{j} - \frac{200}{3}\hat{k}$$

$$= -33.3\hat{i} + 66.7\hat{j} - 66.7\hat{k}$$

Find the angles between force $F$ and each of the $x$, $y$, and $z$ axes.

$$\alpha = \cos^{-1} \hat{u}_x = \cos^{-1} \frac{1}{\sqrt{3}} = 70.5^\circ$$

$$\beta = \cos^{-1} \hat{u}_y = 48.2^\circ$$

$$\gamma = \cos^{-1} \hat{u}_z = 13.2^\circ$$

Find the moment of force $F$ about the $x$, $y$, and $z$ axes.

$$\vec{M} = \begin{bmatrix} \hat{x} & \hat{y} & \hat{z} \\ 2 & -2 & 4 \\ \frac{100}{3} & \frac{200}{3} & -\frac{200}{3} \end{bmatrix}$$

$$\vec{r}_{OA} = 2\hat{x} - 2\hat{y} + 4\hat{z}$$

$$\vec{M} = -\frac{400}{3}\hat{x} + \frac{800}{3}\hat{y} + \frac{600}{3}\hat{z}$$

$$= -133\hat{i} + 267\hat{j} + 200\hat{k}$$

$$= 359 \text{ ft-lb}$$
List the zero-force members of the truss shown at the right (if any). Or specify if none.

None

Find the support reactions at the pin A and the rocker E.

\[ \sum F_x = 0 \quad \Rightarrow \quad A_x = 0 \text{ N} \]

\[ \sum M_A = 0 \]

\[ (-20)(1.5) - (10)(4.5) + E_y(6) = 0 \]

\[ E_y = 12.5 \text{ KN} \]

\[ \sum F_y = 0 \]

\[ A_y = 20 - 10 + 12.5 = 0 \]

\[ A_y = 17.5 \text{ KN} \]

Find the force in member GF by any method. State whether it is in tension or compression.

Section

\[ \sum M_C = 0 \]

\[ (-17.5)(3) + 20(1.5) + F_{GF}(2) = 0 \]

\[ F_{GF} = 11.3 \text{ KN (T)} \]
8-98

W_refriger = 180 lb
MN = 0.25
W_min = 150 lb
M_min = 0.6

Can the refrigerator be moved?

If not, does the refrigerator tip or slip?

**Assume Refrigerator Tip**

\[ x = 1.5' \]

\[ \sum F_x = 0 \Rightarrow N = 180 \text{ lb} \]

\[ \sum M_A = 0 \Rightarrow 180(1.5) - P(4) = 0 \]

\[ P = 67.5 \text{ lb} \]

**Assume Refrigerator Slips** (F = UN)

\[ \sum F_y = 0 \Rightarrow N = 180 \]

\[ \sum F_x = 0 \Rightarrow P = UN = 0.25(180) = 45 \text{ lb} \]

Thus the refrigerator slips first when \( P = 45 \text{ lb} \).

\[ \sum F_x = 0 \Rightarrow F = 45 \text{ lb} \]

\[ \sum F_y = 0 \Rightarrow N = 150 \text{ lb} \]

\[ P = UN = 0.6(150) = 90 \text{ lb} \]

Thus, the man will not slip until \( F = 90 \text{ lb} \).

Since \( F = 45 \text{ lb} \), man cannot push the refrigerator.
6-84. Determine the force that the smooth roller C exerts on beam AB. Also, what are the horizontal and vertical components of reaction at pin A? Neglect the weight of the frame and roller.

\[ \Sigma M_A = 0; \quad -60 + D_A(0.5) = 0 \]
\[ D_A = 120 \text{ lb} \]

\[ \Sigma F_x = 0; \quad A_x = 120 \text{ lb} \quad \text{Ans} \]

\[ \Sigma F_y = 0; \quad A_y = 0 \quad \text{Ans} \]

\[ \Sigma M_B = 0; \quad -N_C(4) + 120(0.5) = 0 \]
\[ N_C = 15.0 \text{ lb} \quad \text{Ans} \]

6-85. Determine the horizontal and vertical components of force which the pins exert on member ABC.

\[ \Sigma F_x = 0; \quad A_x = 80 \text{ lb} \quad \text{Ans} \]

\[ \Sigma F_y = 0; \quad A_y = 80 \text{ lb} \quad \text{Ans} \]

\[ \Sigma M_A = 0; \quad 80(15) - B_y(9) = 0 \]
\[ B_y = 133.3 = 133 \text{ lb} \quad \text{Ans} \]

\[ \Sigma M_B = 0; \quad -80(2.5) + 133.3(9) - B_x(3) = 0 \]
\[ B_x = 333 \text{ lb} \quad \text{Ans} \]

\[ \Sigma F_x = 0; \quad 80 + 333 - C_x = 0 \]
\[ C_x = 413 \text{ lb} \quad \text{Ans} \]

\[ \Sigma F_y = 0; \quad -80 + 133.3 - C_y = 0 \]
\[ C_y = 53.3 \text{ lb} \quad \text{Ans} \]
The horizontal beam is supported by springs at its ends. Each spring has a stiffness of $k = 5 \text{ kN/m}$ and is originally unstretched when the beam is in the horizontal position. Determine the angle of tilt of the beam if a load of 800 N is applied at point C as shown.

\[ + \sum F_y = 0 \quad F_A + F_B - 800 = 0 \quad \Rightarrow F_A = \frac{800}{3} \text{ N} \]

\[ + \sum F_x = 0 \quad -800(1) + F_B(3) = 0 \quad \Rightarrow F_B = \frac{800}{3} \text{ N} \]

\[ \Delta B = \frac{F_B}{k} = \frac{800}{3(5 \text{ kN/m})} = \frac{800}{15} = \frac{8}{15} \text{ m} = 0.53 \text{ m} \]

\[ \Delta A = \frac{1600}{3(150)} = \frac{16}{150} \text{ m} = 0.167 \text{ m} \]

\[ \Theta = \tan^{-1} \left( \frac{0.53}{3(150)} \right) = \tan^{-1} \left( \frac{0.167}{3} \right) = \tan^{-1} 0.055 = 1.02^\circ \]