

PROB. 3.77

$P=0$, FIND \vec{M} .

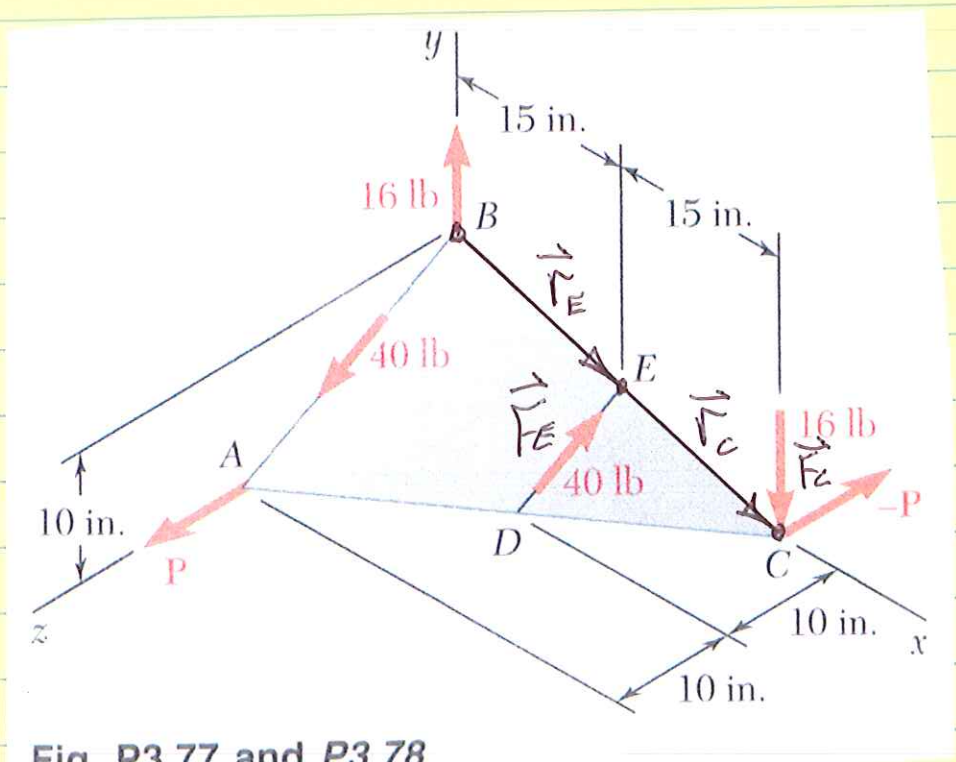


Fig. P3.77 and P3.78

POINT TO EVALUATE \vec{M} IS ARBITRARY.

CHOOSE POINT B TO SIMPLIFY.

$$\vec{M}_B = \vec{r}_E \times \vec{F}_E + \vec{r}_C \times \vec{F}_C$$

LOCATE POINTS: $B(0, 10, 0)^{in}$, $C(30, 0, 0)^{in}$,

$E(15, 5, 0)^{in}$

PROB. 3.77 CONT.

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$$\vec{r}_E: dx = x_E - x_B = 15 - 0 = 15^{\text{IN}}$$

$$dy = y_E - y_B = 5 - 10 = -5^{\text{IN}}, \quad dz = 0^{\text{IN}}$$

$$\vec{r}_E = (15)\hat{i} + (-5)\hat{j}^{\text{IN}}$$

$$\vec{r}_C: dx = x_C - x_B = 30 - 0 = 30^{\text{IN}}$$

$$dy = y_C - y_B = 0 - 10 = -10^{\text{IN}}, \quad dz = 0$$

$$\vec{r}_C = (30)\hat{i} + (-10)\hat{j}^{\text{IN}}$$

$$\vec{F}_C = (-16)\hat{j}^{\text{LB}}$$

$$\vec{F}_E: dx = 0, \quad dy = 5, \quad dz = -10$$

$$d = \sqrt{5^2 + 10^2} = 11.18^{\text{IN}}$$

$$F_y = F \frac{dy}{d} = (40^{\text{LB}}) \left(\frac{5}{11.18} \right) = 17.9^{\text{LB}}$$

$$F_z = F \frac{dz}{d} = (40) \left(\frac{-10}{11.18} \right) = -35.8^{\text{LB}}$$

$$\vec{F}_E = (17.9)\hat{j} + (-35.8)\hat{k}^{\text{LB}}$$

PROB. 3.77 CONT.

(3)

$$\vec{r}_E \times \vec{F}_E = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 15 & -5 & 0 \\ 0 & 17.9 & -35.8 \end{vmatrix}$$

$$= [(-5)(-35.8) - 0] \hat{i} - [(15)(-35.8) - 0] \hat{j}$$

$$+ [(15)(17.9) - 0] \hat{k}$$

$$= (179) \hat{i} + (537) \hat{j} + (268) \hat{k} \text{ N}\cdot\text{m}$$

$$\vec{r}_C \times \vec{F}_C = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 30 & -10 & 0 \\ 0 & -16 & 0 \end{vmatrix}$$

$$= (0) \hat{i} - (0) \hat{j} + [(30)(-16) - 0] \hat{k}$$

$$= (-480) \hat{k} \text{ N}\cdot\text{m}$$

$$\vec{M}_B = (179) \hat{i} + (537) \hat{j} + (268 - 480) \hat{k}$$

$$\vec{M}_B = (179) \hat{i} + (537) \hat{j} + (-212) \hat{k} \text{ N}\cdot\text{m}$$

$$|\vec{M}_B| = 604 \text{ N}\cdot\text{m}$$

PROB. 3.77 CONT.

(4)

$$\theta_x = \cos^{-1}\left(\frac{179}{604}\right) = \underline{72.8^\circ}$$

$$\theta_y = \cos^{-1}\left(\frac{537}{604}\right) = \underline{27.2^\circ}$$

$$\theta_z = \cos^{-1}\left(\frac{-212}{604}\right) = \underline{110.5^\circ}$$