PROB. 3.76

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

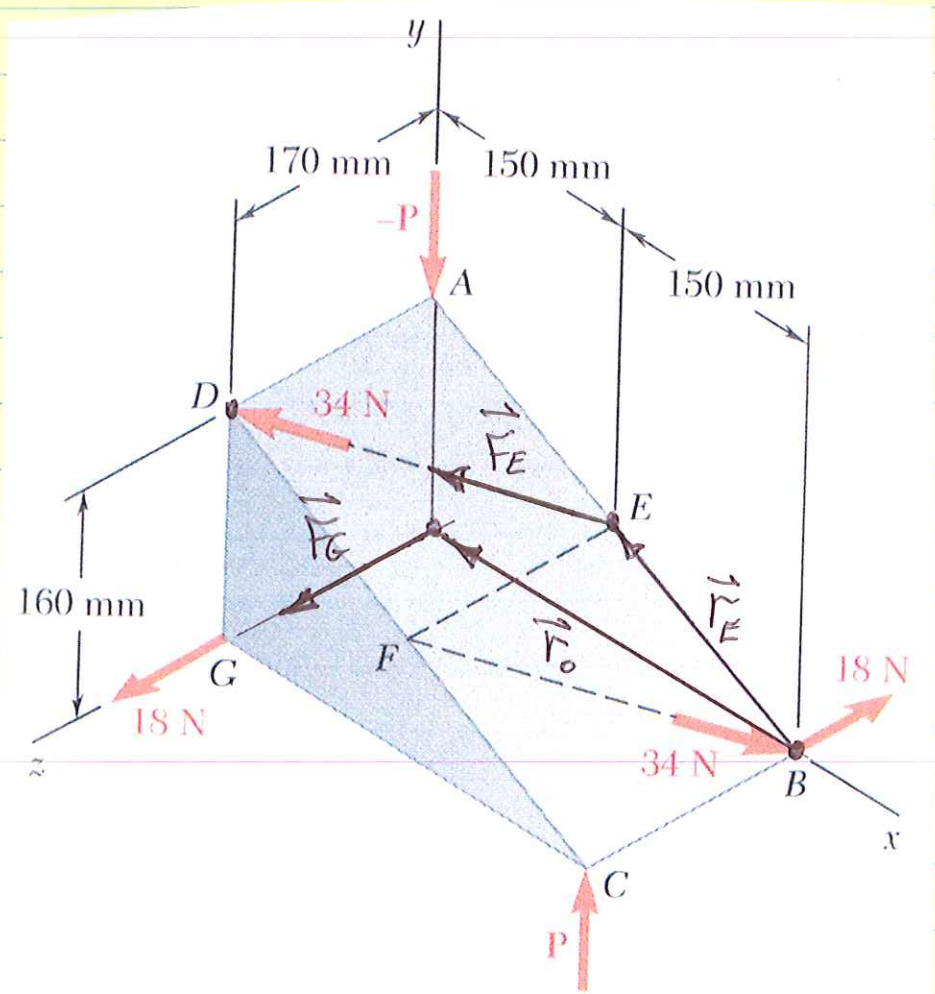

Fig. P3.76 and P3.79

CHOICE OF POINT TO EVALUATE $\vec{M}$ IS ARBITRARY.

CHOOSE B TO SIMPLIFY.

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

PROB. 3.76 CONT.

LOCATE POINTS: $B(300, 0, 0)^{mm}$, $E(150, 80, 0)^{mm}$,

$D(0, 160, 170)^{mm}$

$\vec{r}_B = (-300)\hat{i}^{mm}$

$\vec{r}_E$: $d_X = X_E - X_B = 150 - 300 = -150^{mm}$

$d_Y = Y_E - Y_B = 80 - 0 = 80^{mm}$, $d_Z = 0$

$\vec{r}_E = (-150)\hat{i} + (80)\hat{j}^{mm}$

$\vec{F}_G = (18)\hat{k}^{N}$

$\vec{F}_E$: $d_X = X_D - X_E = 0 - 150 = -150^{mm}$

$d_Y = Y_D - Y_E = 160 - 80 = 80^{mm}$

$d_Z = Z_D - Z_E = 170 - 0 = 170^{mm}$

$d = \sqrt{150^2 + 80^2 + 170^2} = 240.4^{mm}$

$F_X = F\frac{d_X}{d} = (34^{N})\left(\frac{-150}{240.4}\right) = -21.2^{N}$

$F_Y = F\frac{d_Y}{d} = (34)\left(\frac{80}{240.4}\right) = 11.3^{N}$

$$F_z = F\frac{d_z}{d} = (34)\left(\frac{170}{240.4}\right) = 24.0^{N}$$

$$\vec{F}_E = (-21.2)\hat{i} + (11.3)\hat{j} + (24)\hat{k}\ ^{N}$$

$$\vec{r}_O \times \vec{F}_G = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -300 & 0 & 0 \\ 0 & 0 & 18 \end{vmatrix}$$

$$= (0)\hat{i} - [(-300)(18) - 0]\hat{j} + (0)\hat{k}$$

$$= (5400)\hat{j}\ ^{N\cdot mm}$$

$$\vec{r}_E \times \vec{F}_E = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -150 & 80 & 0 \\ -21.2 & 11.3 & 24 \end{vmatrix}$$

$$= [(80)(24) - 0]\hat{i} - [(-150)(24) - 0]\hat{j}$$

$$+ [(-150)(11.3) - (80)(-21.2)]\hat{k}$$

$$= (1920)\hat{i} + (3600)\hat{j} + (0)\hat{k}\ ^{N\cdot mm}$$

$$\vec{M}_B = (1920)\hat{i} + (5400 + 3600)\hat{j}$$

$$\vec{M}_B = (1920)\hat{i} + (9000)\hat{j}\ ^{N\cdot mm}$$

PROB. 3.76 CONT.

$|\vec{M}_B| = 9202^{\text{N·mm}} = 9.20^{\text{N·m}}$

$\theta_x = \cos^{-1}\left(\frac{1920}{9202}\right) = 77.9°$

$\theta_y = \cos^{-1}\left(\frac{9000}{9202}\right) = 12.0°$

$\theta_z = \cos^{-1}(0) = 90°$