

&lt;3.1~3.8 &gt;

3.2  $\mathbf{M}_A = 2.20 \text{ N}\cdot\text{m}\uparrow$ ,

$$\beta = \tan^{-1}\left(\frac{0.122 \text{ m}}{0.086 \text{ m}}\right) = 54.82^\circ$$

$$r_{AB} = \sqrt{(0.086 \text{ m})^2 + (0.122 \text{ m})^2} = 0.14926 \text{ m}$$

$P$ 가  $\perp$   $AB$ ,  $P$ 가  $\perp$   $AB$

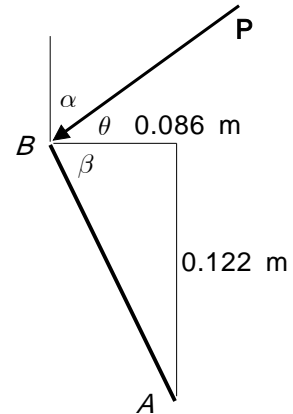
$$\alpha = \beta = 54.82^\circ$$

$$\theta = 90^\circ - \alpha = 90^\circ - 54.82^\circ = 35.18^\circ$$

$$\mathbf{M}_A = \mathbf{r}_{B/A} \times \mathbf{P} \quad M_A = r_{AB} P \sin 90^\circ$$

$$P = \frac{M_A}{r_{AB}} = \frac{2.20 \text{ N}\cdot\text{m}}{0.14926 \text{ m}} = 14.74 \text{ N}$$

$$\mathbf{P}_{\min} = 14.74 \text{ N} \quad \nwarrow 35.2^\circ$$



3.10  $F = 125 \text{ N}$

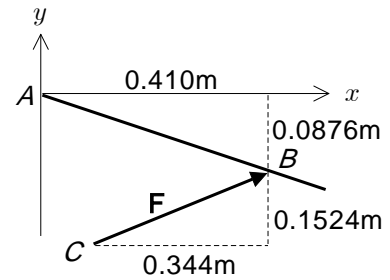
$$d_x = 0.344 \text{ m}, \quad d_y = 0.1524 \text{ m}$$

$$d_{CB} = \sqrt{(0.344 \text{ m})^2 + (0.1524 \text{ m})^2} = 0.3762 \text{ m}$$

$$F_x = (125 \text{ N}) \frac{0.344 \text{ m}}{0.3762 \text{ m}} = 114.30 \text{ N}$$

$$F_y = (125 \text{ N}) \frac{0.1524 \text{ m}}{0.3762 \text{ m}} = 50.64 \text{ N}$$

$$x_{B/A} = 0.410 \text{ m}, \quad y_{B/A} = -0.0876 \text{ m}$$



$$\mathbf{M}_A = \mathbf{r}_{B/A} \times \mathbf{F}$$

$$= (x_{B/A} \mathbf{i} + y_{B/A} \mathbf{j}) \times (F_x \mathbf{i} + F_y \mathbf{j})$$

$$= [x_{B/A} F_y - y_{B/A} F_x] \mathbf{k}$$

$$= [(0.410 \text{ m})(50.64 \text{ N}) - (-0.0876 \text{ m})(114.30 \text{ N})] \mathbf{k}$$

$$= 30.78 \text{ N}\cdot\text{m} \mathbf{k}$$

$$\mathbf{M}_A = 30.8 \text{ N}\cdot\text{m} \uparrow$$

3.23  $F = 35 \text{ N}$

$$F_y = -F \sin 45^\circ = -(35 \text{ N}) \sin 45^\circ = -24.749 \text{ N}$$

$$F_h = F \cos 45^\circ = (35 \text{ N}) \cos 45^\circ = 24.749 \text{ N}$$

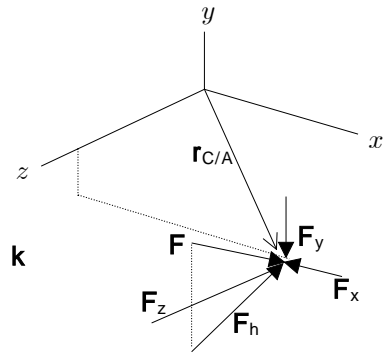
$$F_x = -F_h \sin 12^\circ = -(24.749 \text{ N}) \sin 12^\circ = -5.1456 \text{ N}$$

$$F_z = -F_h \cos 12^\circ = -(24.749 \text{ N}) \cos 12^\circ = -24.208 \text{ N}$$

$$\mathbf{F} = (-5.1456 \text{ N}) \mathbf{i} + (-24.749 \text{ N}) \mathbf{j} + (-24.208 \text{ N}) \mathbf{k}$$

$$\mathbf{r}_{C/A} = (0.210 \text{ m}) \mathbf{i} + (-0.050 \text{ m}) \mathbf{j} + (0.140 \text{ m}) \mathbf{k}$$

$$\begin{aligned} \mathbf{M}_A &= \mathbf{r}_{C/A} \times \mathbf{F} = [(0.210 \text{ m}) \mathbf{i} + (-0.050 \text{ m}) \mathbf{j} + (0.140 \text{ m}) \mathbf{k}] \\ &\quad \times [(-5.1456 \text{ N}) \mathbf{i} + (-24.749 \text{ N}) \mathbf{j} + (-24.208 \text{ N}) \mathbf{k}] \\ &= [(-0.050 \text{ m})(-24.208 \text{ N}) - (0.140 \text{ m})(-24.749 \text{ N})] \mathbf{i} \\ &\quad + [(0.140 \text{ m})(-5.1456 \text{ N}) - (0.210 \text{ m})(-24.208 \text{ N})] \mathbf{j} \\ &\quad + [(0.210 \text{ m})(-24.749 \text{ N}) - (-0.050 \text{ m})(-5.1456 \text{ N})] \mathbf{k} \\ &= 4.675 \mathbf{i} + 4.363 \mathbf{j} - 5.454 \mathbf{k} \text{ (N}\cdot\text{m)} \\ \mathbf{M}_A &= 4.68 \mathbf{i} + 4.36 \mathbf{j} - 5.45 \mathbf{k} \text{ (N}\cdot\text{m)} \end{aligned}$$



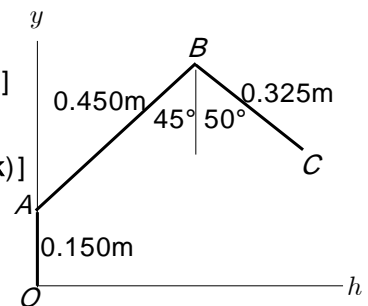
3.26  $AB = 450 \text{ mm}$ ,  $BC = 325 \text{ mm}$

$$\mathbf{r}_{A/O} = 0.150 \mathbf{j} \text{ (m)}$$

$$\begin{aligned} \mathbf{r}_{B/A} &= (0.450 \text{ m}) [\cos 45^\circ \mathbf{j} + \sin 45^\circ (\cos 30^\circ \mathbf{i} + \sin 30^\circ \mathbf{k})] \\ &= 0.2756 \mathbf{i} + 0.3182 \mathbf{j} + 0.1591 \mathbf{k} \text{ (m)} \end{aligned}$$

$$\begin{aligned} \mathbf{r}_{C/B} &= (0.325 \text{ m}) [-\cos 50^\circ \mathbf{j} + \sin 50^\circ (\cos 30^\circ \mathbf{i} + \sin 30^\circ \mathbf{k})] \\ &= 0.2156 \mathbf{i} - 0.2089 \mathbf{j} + 0.1245 \mathbf{k} \text{ (m)} \end{aligned}$$

$$\begin{aligned} \mathbf{r}_{C/O} &= \mathbf{r}_{A/O} + \mathbf{r}_{B/A} + \mathbf{r}_{C/B} \\ &= (0.150 \mathbf{j}) + (0.2756 \mathbf{i} + 0.3182 \mathbf{j} + 0.1591 \mathbf{k}) \\ &\quad + (0.2156 \mathbf{i} - 0.2089 \mathbf{j} + 0.1245 \mathbf{k}) \text{ (m)} \\ &= 0.4912 \mathbf{i} + 0.2593 \mathbf{j} + 0.2836 \mathbf{k} \text{ (m)} \end{aligned}$$



$$F = 8 \text{ N}$$

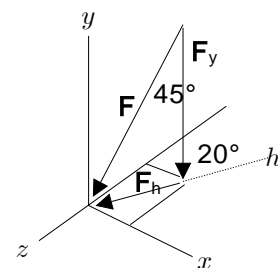
$$F_y = -F \sin 45^\circ = -(8 \text{ N}) \sin 45^\circ = -5.657 \text{ N}$$

$$F_h = F \cos 45^\circ = (8 \text{ N}) \cos 45^\circ = 5.657 \text{ N}$$

$$F_x = -F_h \sin 20^\circ = -(5.657 \text{ N}) \sin 20^\circ = -1.935 \text{ N}$$

$$F_z = F_h \cos 20^\circ = (5.657 \text{ N}) \cos 20^\circ = 5.316 \text{ N}$$

$$\mathbf{F} = -1.935 \mathbf{i} - 5.657 \mathbf{j} + 5.316 \mathbf{k} \text{ (N)}$$



$$\begin{aligned} \mathbf{M}_O &= \mathbf{r}_{C/O} \times \mathbf{F} = [0.4912 \mathbf{i} + 0.2593 \mathbf{j} + 0.2836 \mathbf{k} \text{ (m)}] \\ &\quad \times [-1.935 \mathbf{i} - 5.657 \mathbf{j} + 5.316 \mathbf{k} \text{ (N)}] \\ &= [(0.2593)(5.316) - (0.2836)(-5.657)] \mathbf{i} \\ &\quad + [(0.2836)(-1.935) - (0.4912)(5.316)] \mathbf{j} \\ &\quad + [(0.4912)(-5.657) - (0.2593)(-1.935)] \mathbf{k} \text{ (N}\cdot\text{m)} \\ &= 2.983 \mathbf{i} - 3.160 \mathbf{j} - 2.277 \mathbf{k} \text{ (N}\cdot\text{m)} \\ \mathbf{M}_O &= 2.98 \mathbf{i} - 3.16 \mathbf{j} - 2.28 \mathbf{k} \text{ (N}\cdot\text{m)} \end{aligned}$$

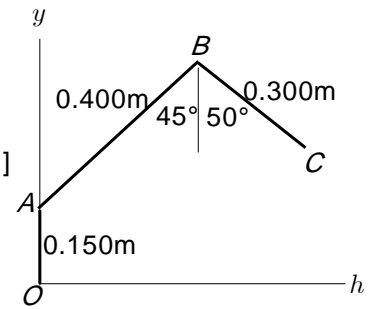
3.26( )  $AB = 400 \text{ mm}$ ,  $BC = 300 \text{ mm}$

$$\mathbf{r}_{A/O} = 0.150 \mathbf{j} \text{ (m)}$$

$$\begin{aligned} \mathbf{r}_{B/A} &= (0.400 \text{ m})[\cos 45^\circ \mathbf{j} + \sin 45^\circ(\cos 30^\circ \mathbf{i} + \sin 30^\circ \mathbf{k})] \\ &= 0.2449 \mathbf{i} + 0.2828 \mathbf{j} + 0.1414 \mathbf{k} \text{ (m)} \end{aligned}$$

$$\begin{aligned} \mathbf{r}_{C/B} &= (0.300 \text{ m})[-\cos 50^\circ \mathbf{j} + \sin 50^\circ(\cos 30^\circ \mathbf{i} + \sin 30^\circ \mathbf{k})] \\ &= 0.1990 \mathbf{i} - 0.1928 \mathbf{j} + 0.1149 \mathbf{k} \text{ (m)} \end{aligned}$$

$$\begin{aligned} \mathbf{r}_{C/O} &= \mathbf{r}_{A/O} + \mathbf{r}_{B/A} + \mathbf{r}_{C/B} \\ &= (0.150 \mathbf{j}) + (0.2449 \mathbf{i} + 0.2828 \mathbf{j} + 0.1414 \mathbf{k}) \\ &\quad + (0.1990 \mathbf{i} - 0.1928 \mathbf{j} + 0.1149 \mathbf{k}) \text{ (m)} \\ &= 0.4439 \mathbf{i} + 0.2400 \mathbf{j} + 0.2563 \mathbf{k} \text{ (m)} \end{aligned}$$



$$F = 8 \text{ N}$$

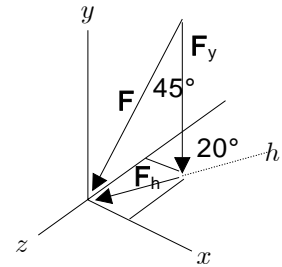
$$F_y = -F \sin 45^\circ = -(8 \text{ N}) \sin 45^\circ = -5.657 \text{ N}$$

$$F_h = F \cos 45^\circ = (8 \text{ N}) \cos 45^\circ = 5.657 \text{ N}$$

$$F_x = -F_h \sin 20^\circ = -(5.657 \text{ N}) \sin 20^\circ = -1.935 \text{ N}$$

$$F_z = F_h \cos 20^\circ = (5.657 \text{ N}) \cos 20^\circ = 5.316 \text{ N}$$

$$\mathbf{F} = -1.935 \mathbf{i} - 5.657 \mathbf{j} + 5.316 \mathbf{k} \text{ (N)}$$



$$\begin{aligned} \mathbf{M}_O &= \mathbf{r}_{C/O} \times \mathbf{F} = [0.4439 \mathbf{i} + 0.2400 \mathbf{j} + 0.2563 \mathbf{k} \text{ (m)}] \\ &\quad \times [-1.935 \mathbf{i} - 5.657 \mathbf{j} + 5.316 \mathbf{k} \text{ (N)}] \end{aligned}$$

$$\begin{aligned} &= [(0.2400)(5.316) - (0.2563)(-5.657)] \mathbf{i} \\ &\quad + [(0.2563)(-1.935) - (0.4439)(5.316)] \mathbf{j} \\ &\quad + [(0.4439)(-5.657) - (0.2400)(-1.935)] \mathbf{k} \text{ (N}\cdot\text{m)} \\ &= 2.726 \mathbf{i} - 2.856 \mathbf{j} - 2.047 \mathbf{k} \text{ (N}\cdot\text{m)} \end{aligned}$$

$$\mathbf{M}_O = 2.73 \mathbf{i} - 2.86 \mathbf{j} - 2.05 \mathbf{k} \text{ (N}\cdot\text{m)}$$