

<3.9~3.11 >

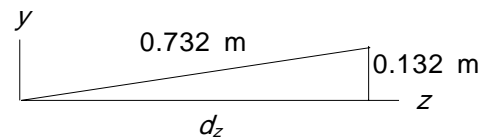
3.43

3

$$\begin{aligned} \text{(a) } \mathbf{P} \times \mathbf{Q} &= [-0.175\mathbf{i} - 0.025\mathbf{j} + 0.050\mathbf{k} \text{ (m)}] \times [0.075\mathbf{i} - 0.050\mathbf{j} + 0.100\mathbf{k} \text{ (m)}] \\ &= [(-0.025)(0.100) - (0.050)(-0.050)]\mathbf{i} + [(0.050)(0.075) - (-0.175)(0.100)]\mathbf{j} \\ &\quad + [(-0.175)(-0.050) - (-0.025)(0.075)]\mathbf{k} \text{ (m}^2\text{)} \\ &= 0\mathbf{i} + 0.02125\mathbf{j} + 0.010625\mathbf{k} \text{ (m}^2\text{)} \\ \mathbf{S} \cdot (\mathbf{P} \times \mathbf{Q}) &= [-0.125\mathbf{i} + 0.150\mathbf{j} - 0.025\mathbf{k} \text{ (m)}] \cdot [0\mathbf{i} + 0.02125\mathbf{j} + 0.010625\mathbf{k} \text{ (m}^2\text{)}] \\ &= (-0.125)(0) + (0.150)(0.02125) + (-0.025)(0.010625) \text{ (m}^3\text{)} \\ &= 0.00292 \text{ (m}^3\text{)} = 2.92 \times 10^{-3} \text{ (m}^3\text{)} \quad ( \quad ) \end{aligned}$$

$$\begin{aligned} \text{(b) } \mathbf{P} \times \mathbf{Q} &= [0.025\mathbf{i} + 0.050\mathbf{j} - 0.025\mathbf{k} \text{ (m)}] \times [-0.200\mathbf{i} - 0.025\mathbf{j} + 0.225\mathbf{k} \text{ (m)}] \\ &= [(0.050)(0.225) - (-0.025)(-0.025)]\mathbf{i} + [(-0.025)(-0.200) - (0.025)(0.225)]\mathbf{j} \\ &\quad + [(0.025)(-0.025) - (0.050)(-0.200)]\mathbf{k} \text{ (m}^2\text{)} \\ &= 0.010625\mathbf{i} - 0.000625\mathbf{j} + 0.009375\mathbf{k} \text{ (m}^2\text{)} \\ \mathbf{S} \cdot (\mathbf{P} \times \mathbf{Q}) &= [0.050\mathbf{i} + 0.075\mathbf{j} + 0.025\mathbf{k} \text{ (m)}] \cdot [0.010625\mathbf{i} - 0.000625\mathbf{j} + 0.009375\mathbf{k} \text{ (m}^2\text{)}] \\ &= (0.050)(0.010625) + (0.075)(-0.000625) + (0.025)(0.009375) \text{ (m}^3\text{)} \\ &= 0.000719 \text{ (m}^3\text{)} = 7.19 \times 10^{-4} \text{ (m}^3\text{)} \end{aligned}$$

$$\begin{aligned} 3.45 \quad d_z &= \sqrt{(0.732 \text{ m})^2 - (0.132 \text{ m})^2} = 0.720 \text{ m} \\ \mathbf{r}_{E/D} &= 0.36\mathbf{i} + 0.72\mathbf{j} - 0.72\mathbf{k} \text{ (m)} \\ d_{DE} &= \sqrt{0.36^2 + 0.72^2 + 0.72^2} \text{ (m)} = 1.08 \text{ m} \\ \mathbf{T}_{DE} &= \frac{T}{d_{DE}} \mathbf{r}_{E/D} = \frac{54 \text{ N}}{1.08} (0.36\mathbf{i} + 0.72\mathbf{j} - 0.72\mathbf{k}) \\ &= 18.0\mathbf{i} + 36.0\mathbf{j} - 36.0\mathbf{k} \text{ (N)} \end{aligned}$$



$$\begin{aligned} \mathbf{M}_A &= \mathbf{r}_{D/A} \times \mathbf{T}_{DE} = [0\mathbf{i} + 0.132\mathbf{j} + 0.72\mathbf{k} \text{ (m)}] \times [18.0\mathbf{i} + 36.0\mathbf{j} - 36.0\mathbf{k} \text{ (N)}] \\ &= [(0.132)(-36.0) - (0.72)(36.0)]\mathbf{i} + [(0.72)(18.0)]\mathbf{j} + [-(0.132)(18.0)]\mathbf{k} \text{ (N}\cdot\text{m)} \\ &= -30.7\mathbf{i} + 12.96\mathbf{j} - 2.38\mathbf{k} \text{ (N}\cdot\text{m)} \\ M_x &= -30.7 \text{ N}\cdot\text{m}, \quad M_y = 12.96 \text{ N}\cdot\text{m}, \quad M_z = -2.38 \text{ N}\cdot\text{m} \end{aligned}$$

$$3.55 \quad \mathbf{r}_{F/I} = (4.6 \text{ m} + 0.8 \text{ m})\mathbf{k} = 5.4 \text{ m } \mathbf{k}$$

$$\begin{aligned} \mathbf{T}_{EF} &= \lambda_{EF} T_{EF} = \frac{66 \text{ N}}{\sqrt{1.2^2 + (-3.6)^2 + 5.4^2}} (1.2\mathbf{i} - 3.6\mathbf{j} + 5.4\mathbf{k}) \\ &= \frac{66 \text{ N}}{6.6} (1.2\mathbf{i} - 3.6\mathbf{j} + 5.4\mathbf{k}) = 12\mathbf{i} - 36\mathbf{j} + 54\mathbf{k} \text{ (N)} \end{aligned}$$

$$\mathbf{r}_{F/I} \times \mathbf{T}_{EF} = (5.4 \text{ m } \mathbf{k}) \times [12\mathbf{i} - 36\mathbf{j} + 54\mathbf{k} \text{ (N)}] = 194.4\mathbf{i} + 64.8\mathbf{j} \text{ (N}\cdot\text{m)}$$

$$\lambda_{DI} = \frac{1}{\sqrt{1.6^2 + (-0.4)^2}} (1.6\mathbf{i} - 0.4\mathbf{j}) = \frac{1}{\sqrt{272}} (16\mathbf{i} - 4\mathbf{j})$$

$$\begin{aligned} M_{DI} &= \lambda_{DI} \cdot (\mathbf{r}_{F/I} \times \mathbf{T}_{EF}) = \frac{1}{\sqrt{272}} (16\mathbf{i} - 4\mathbf{j}) \cdot [194.4\mathbf{i} + 64.8\mathbf{j} \text{ (N}\cdot\text{m)}] \\ &= \frac{1}{\sqrt{272}} [(16)(194.4) + (-4)(64.8)] \text{ (N}\cdot\text{m)} = 172.9 \text{ (N}\cdot\text{m)} \end{aligned}$$