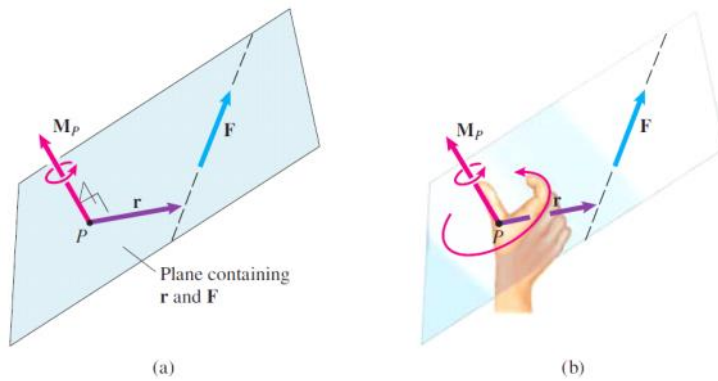
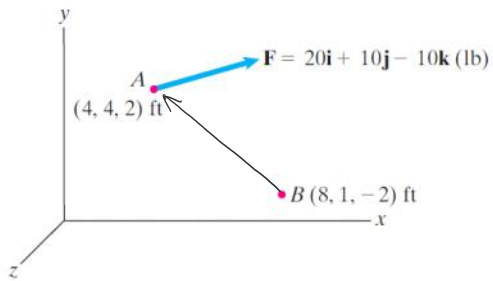


R4 solutions

Thursday, January 25, 2024 8:12 AM



4.56 What is the magnitude of the moment of **F** about point **B**?



$$\vec{r}_{BA} = \vec{OA} - \vec{OB} = (4, 4, 2) - (8, 1, -2) = (-4, 3, 4) \text{ ft}$$

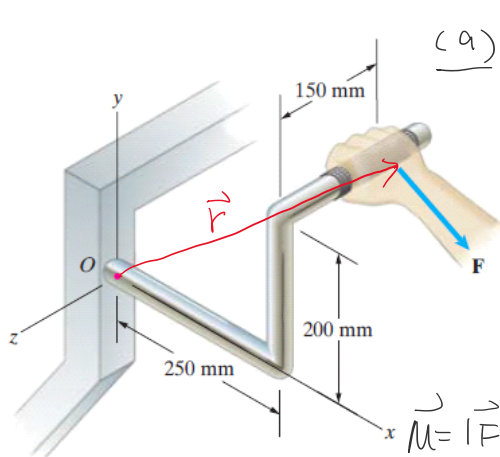
$$\vec{M} = \vec{r}_{BA} \times \vec{F}$$

$$= \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ -4 & 3 & 4 \\ 20 & 10 & -10 \end{vmatrix}$$

$$= -70\vec{i} + 40\vec{j} - 100\vec{k} \text{ ft}\cdot\text{lb}$$

$$|\vec{M}| = \sqrt{70^2 + 40^2 + 100^2} = 128.45 \text{ ft}\cdot\text{lb}$$

4.62 The force \mathbf{F} points in the direction of the unit vector $\mathbf{e} = \frac{2}{3}\mathbf{i} - \frac{2}{3}\mathbf{j} + \frac{1}{3}\mathbf{k}$. The support at O will safely support a moment of 560 N-m magnitude. (a) Based on this criterion, what is the largest safe magnitude of \mathbf{F} ? (b) If the force \mathbf{F} may be exerted in any direction, what is its largest safe magnitude?



Problems 4.61/4.62

(a) $\vec{M} = \vec{r} \times \vec{F}$

$$\vec{r} = (250, 200, -150) \text{ mm} = (0.25, 0.2, -0.15) \text{ m}$$

$$\vec{M} = (0.25, 0.2, -0.15) \times \underbrace{(|\vec{F}|)}_{\text{const.}} \left(\frac{2}{3}, -\frac{2}{3}, \frac{1}{3} \right)$$

$$|\vec{M}| = |\vec{F}| \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0.25 & 0.2 & -0.15 \\ \frac{2}{3} & -\frac{2}{3} & \frac{1}{3} \end{vmatrix} = \left(\frac{1}{30}, -\frac{11}{60}, \frac{3}{10} \right) |\vec{F}|$$

$$|\vec{M}| = |\vec{F}| \sqrt{\left(\frac{1}{30}\right)^2 + \left(\frac{11}{60}\right)^2 + \left(\frac{3}{10}\right)^2} = 0.353 |\vec{F}| \leq 560$$

$$|\vec{F}| \leq 1586.4 \text{ N}$$

(b) $\vec{M} = \vec{r} \times \vec{F} = \vec{r} \times (\vec{F}_{\parallel} + \vec{F}_{\perp})$

$$= \underbrace{\vec{r} \times \vec{F}_{\parallel}}_0 + \vec{r} \times \vec{F}_{\perp} = \vec{r} \times \vec{F}_{\perp}$$

$$|\vec{M}| = |\vec{r}| |\vec{F}_{\perp}| \leq 560$$

$$|\vec{r}| = \sqrt{0.25^2 + 0.2^2 + (0.15)^2} = 0.3535 \text{ m}$$

$$|\vec{F}_{\perp}| = \frac{560}{|\vec{r}|} = 1583.9 \text{ N}$$