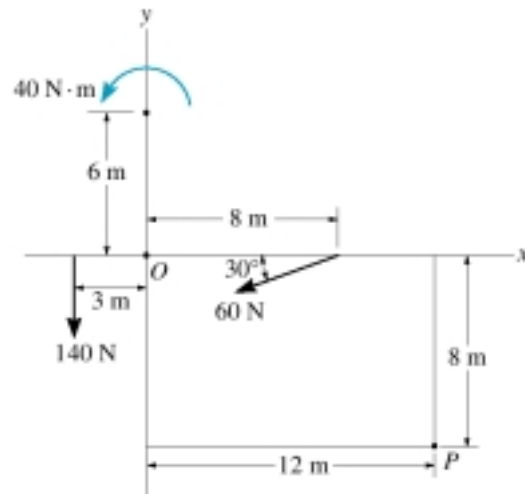


Moment 5:

Problem 1:

Replace the force and couple moment system by an equivalent force and couple moment acting at point P.



Solution:

$$\rightarrow F_{R_x} = \sum F_x$$

$$\Rightarrow F_{R_x} = -60 \cos 30^\circ = -51.96 \text{ N} = 51.96 \text{ N} \leftarrow$$

$$+ \uparrow F_{R_y} = \sum F_y$$

$$\Rightarrow F_{R_y} = -60 \sin 30^\circ - 140 = -170 \text{ N} = 170 \text{ N} \downarrow$$

$$F_R = \sqrt{F_{R_x}^2 + F_{R_y}^2}$$

$$\Rightarrow F_R = \sqrt{(-51.96)^2 + (-170)^2} = 178 \text{ N}$$

$$\theta = \tan^{-1} \left(\frac{F_{R_y}}{F_{R_x}} \right) = \tan^{-1} \left(\frac{-170}{-51.96} \right) = 73^\circ$$

$$\left(+ \right) M_{R_P} = \sum M_P$$

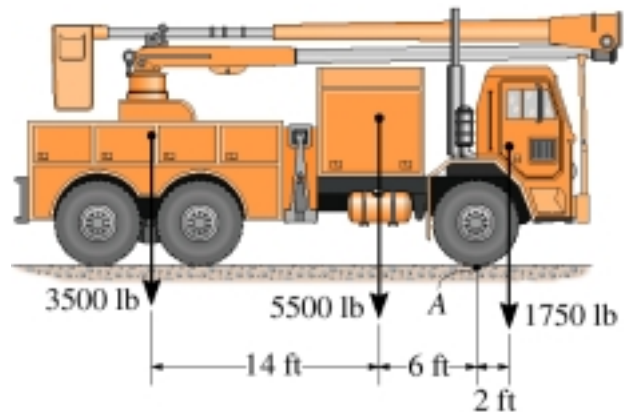
$$\Rightarrow \sum M_{R_P} = 60 \sin 30^\circ (12 - 8) + 60 \cos 30^\circ (8) + 40 + 140(3 + 12)$$

$$\Rightarrow \sum M_{R_P} = 2676 \text{ N}\cdot\text{m}$$

$$\Rightarrow \sum M_{R_P} = 2.68 \text{ kN}\cdot\text{m (counterclockwise)}$$

Problem 2 (equivalent system):

The weights of the various components of the truck are shown. Replace this system of forces by an equivalent resultant force and couple moment acting at point A.



Solution:

$$+\uparrow F_R = \sum F_y$$

$$\Rightarrow F_R = -1750 - 5500 - 3500$$

$$\Rightarrow F_R = -10750 \text{ lb} = 10.75 \text{ kip} \downarrow$$

$$(+\curvearrowright M_{R_A} = \sum M_A$$

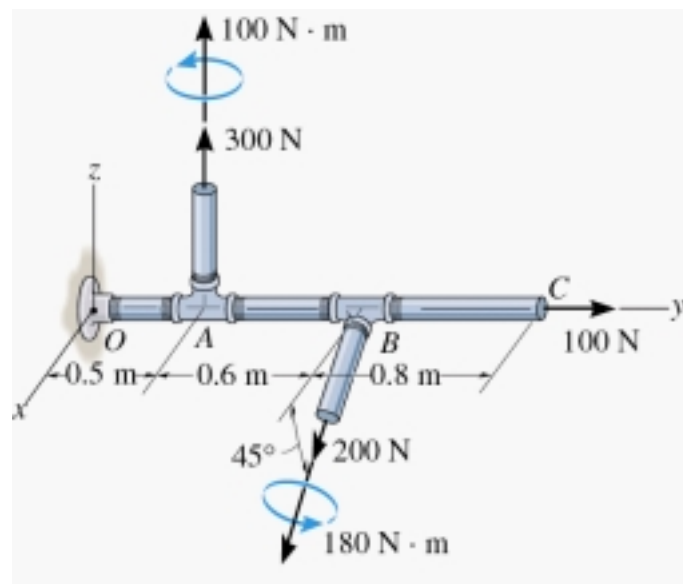
$$\Rightarrow M_{R_A} = 3500(20) + 5500(6) - 1750(2)$$

$$\Rightarrow M_{R_A} = 99500 \text{ lb}\cdot\text{ft}$$

$$\Rightarrow M_{R_A} = 99.5 \text{ kip}\cdot\text{ft} \text{ (counterclockwise)}$$

Problem 3 (equivalent system):

Replace the two wrenches and the force, acting on the pipe assembly, by an equivalent resultant force and couple moment acting at point O.



Solution:

Force and Moment Vectors :

$$\mathbf{F}_1 = \{300\mathbf{k}\}\text{N}; \quad \mathbf{F}_3 = \{100\mathbf{j}\}\text{N}$$

$$\mathbf{F}_2 = 200\{\cos 45^\circ \mathbf{i} - \sin 45^\circ \mathbf{k}\}\text{N}$$

$$\Rightarrow \mathbf{F}_2 = \{141.42\mathbf{i} - 141.42\mathbf{k}\}\text{N}$$

$$\mathbf{M}_1 = \{100\mathbf{k}\}\text{N.m}$$

$$\mathbf{M}_2 = 180\{\cos 45^\circ \mathbf{i} - \sin 45^\circ \mathbf{k}\}\text{N.m}$$

$$\Rightarrow \mathbf{M}_2 = \{127.28\mathbf{i} - 127.28\mathbf{k}\}\text{N.m}$$

$$\mathbf{F}_1 = \{300\mathbf{k}\}\text{N}; \quad \mathbf{F}_3 = \{100\mathbf{j}\}\text{N}$$

$$\mathbf{F}_2 = \{141.42\mathbf{i} - 141.42\mathbf{k}\}\text{N}$$

Equivalent Force at Point O :

$$\mathbf{F}_R = \sum \mathbf{F}$$

$$\Rightarrow \mathbf{F}_R = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3$$

$$\Rightarrow \mathbf{F}_R = 141.42\mathbf{i} + 100\mathbf{j} + (300 - 141.42)\mathbf{k}$$

$$\Rightarrow \mathbf{F}_R = \{141.42\mathbf{i} + 100\mathbf{j} + 159\mathbf{k}\}\text{N}$$

$$\mathbf{F}_1 = \{300\mathbf{k}\}\text{N}; \quad \mathbf{F}_3 = \{100\mathbf{j}\}\text{N}$$

$$\mathbf{F}_2 = \{141.42\mathbf{i} - 141.42\mathbf{k}\}\text{N}$$

$$\mathbf{M}_1 = \{100\mathbf{k}\}\text{N.m}$$

$$\mathbf{M}_2 = \{127.28\mathbf{i} - 127.28\mathbf{k}\}\text{N.m}$$

Equivalent Couple Moment at Point O :

The position vectors are $\mathbf{r}_1 = \{0.5\mathbf{j}\}\text{m}$ and $\mathbf{r}_2 = \{1.1\mathbf{j}\}\text{m}$

$$\mathbf{M}_{R_o} = \sum \mathbf{M}_o$$

$$\Rightarrow \mathbf{M}_{R_o} = \mathbf{r}_1 \times \mathbf{F}_1 + \mathbf{r}_2 \times \mathbf{F}_2 + \mathbf{M}_1 + \mathbf{M}_2$$

$$\Rightarrow \mathbf{M}_{R_o} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 0 & 0.5 & 0 \\ 0 & 0 & 300 \end{vmatrix} + \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 0 & 1.5 & 0 \\ 141.42 & 0 & -141.42 \end{vmatrix} + 100\mathbf{k} + 127.28\mathbf{i} - 127.28\mathbf{k}$$

$$\Rightarrow \mathbf{M}_{R_o} = \{122\mathbf{i} - 183\mathbf{k}\}\text{N.m}$$