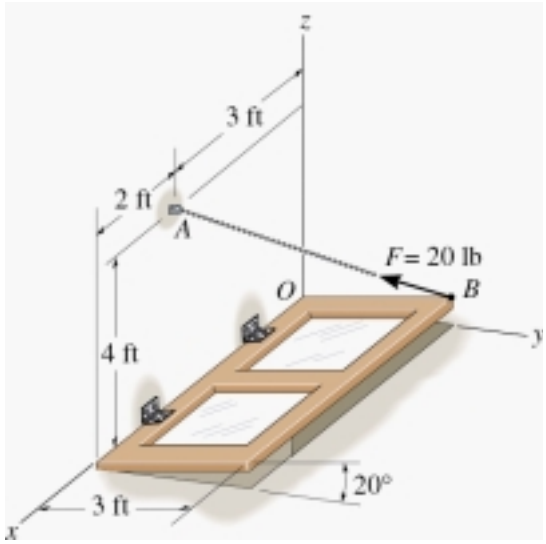
Moment 3

Problem 1:

The chain AB exerts a force of 20 lb on the door at B. Determine the magnitude of the moment of this force along the hinged axis x of the door.



Solution:

$A(3,0,4)$

$B(0, 3\cos 20°, 3\sin 20°)$

$\Rightarrow B(0, 2.82, 1.03)$

$\mathbf{r}_{OA} = \{3\mathbf{i} + 4\mathbf{k}\}\text{ft}$

$\mathbf{r}_{OB} = \{2.82\,\mathbf{j} + 1.03\mathbf{k}\}\text{ft}$

$\mathbf{r}_{BA} = \{(3-0)\mathbf{i} + (0-2.82)\mathbf{j} + (4-1.03)\mathbf{k}\}\text{ft}$

$\Rightarrow \mathbf{r}_{BA} = \{3\mathbf{i} - 2.82\,\mathbf{j} + 2.97\mathbf{k}\}\text{ft}$

$r_{BA} = \sqrt{(3)^2 + (-2.82)^2 + (2.97)^2} = 5.08\text{ ft}$

$$\mathbf{F} = F\frac{\mathbf{r}_{BA}}{r_{BA}} = 20\frac{\{3\mathbf{i} - 2.82\,\mathbf{j} + 2.97\mathbf{k}\}}{5.08}\text{lb}$$

$\Rightarrow \mathbf{F} = \{11.81\mathbf{i} - 11.10\,\mathbf{j} + 11.69\mathbf{k}\}\text{lb}$

Using the information obtained above, we can use two methods:

$\mathbf{r}_{OA} = \{3\mathbf{i} + 4\mathbf{k}\}\text{ft}$

$\mathbf{r}_{OB} = \{2.82\,\mathbf{j} + 1.03\mathbf{k}\}\text{ft}$

$\mathbf{F} = \{11.81\mathbf{i} - 11.10\,\mathbf{j} + 11.69\mathbf{k}\}$

$M_x = \mathbf{i}.(\mathbf{r}_{OA} \times \mathbf{F})$

$$\Rightarrow M_x = \begin{vmatrix} 1 & 0 & 0 \\ 3 & 0 & 4 \\ 11.81 & -11.10 & 11.69 \end{vmatrix}$$

$\Rightarrow M_x = 1[0 + (11.10)(4)] - 0 + 0$

$\Rightarrow M_x = 44.4\text{ lb.ft}$

$\mathbf{r}_{OA} = \{3\mathbf{i} + 4\mathbf{k}\}\text{ft}$

$\mathbf{r}_{OB} = \{2.82\,\mathbf{j} + 1.03\mathbf{k}\}\text{ft}$

$\mathbf{F} = \{11.81\mathbf{i} - 11.10\,\mathbf{j} + 11.69\mathbf{k}\}$

OR

$M_x = \mathbf{i}.(\mathbf{r}_{OB} \times \mathbf{F})$

$$\Rightarrow M_x = \begin{vmatrix} 1 & 0 & 0 \\ 0 & 2.82 & 1.03 \\ 11.81 & -11.10 & 11.69 \end{vmatrix}$$

$\Rightarrow M_x = 1[(2.82)(11.69) + (11.10)(1.03)] - 0 + 0$

$\Rightarrow M_x = 44.4\text{ lb.ft}$