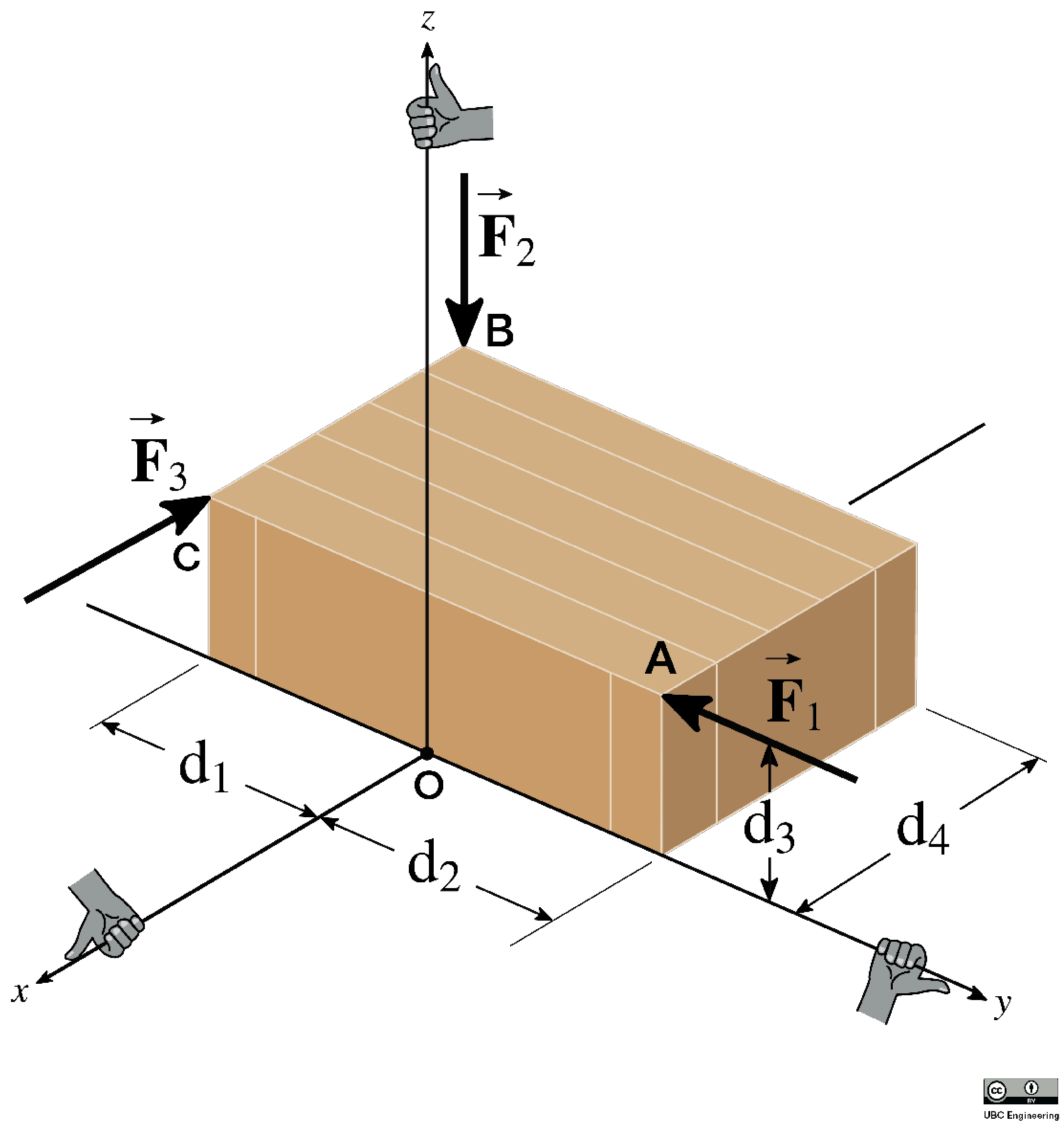

Three force $\vec{F}_1$, $\vec{F}_2$, and $\vec{F}_3$, with magnitudes F_1, F_2, and F_3 respectively, act on a wooden block as shown above. If rather than acting on A, $\vec{F}_1$ was moved d_4 in the direction of the - x axis such that it acted in the same line (parallel to the y axis) as $\vec{F}_2$, replace the three forces with a single equivalent force and identify where it intersects the xy-, yz-, and zx- planes.

$\overrightarrow{F_R} = -F_3\hat{i} - F_1\hat{j} - F_2\hat{k}$

$(M_x)_O = d_3 \cdot F_1 + d_1 \cdot F_2$

$(M_y)_O = -d_4 \cdot F_2 - d_3 \cdot F_3$

$(M_z)_O = d_4 \cdot F_1 - d_1 \cdot F_3$

$\overrightarrow{(M_R)_O} = (M_x)_O\hat{i} + (M_y)_O\hat{j} + (M_z)_O\hat{k}$

For the xy-plane, z = 0:

$\overrightarrow{r_{xy}} = \bar{x}\hat{i} + \bar{y}\hat{j}$

$$\overrightarrow{(M_R)_O} = \overrightarrow{r_{xy}} \times \overrightarrow{F_R} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \bar{x} & \bar{y} & 0 \\ -F_3 & -F_1 & -F_2 \end{vmatrix} = -\bar{y} \cdot F_2\hat{i} + \bar{x} \cdot F_2\hat{j} + (-\bar{x} \cdot F_1 + \bar{y} \cdot F_3)\hat{k}$$

$-\bar{y} \cdot F_2 = (M_x)_O = d_3 \cdot F_1 + d_1 \cdot F_2$

$\Rightarrow \bar{y} = -d_3 \cdot \dfrac{F_1}{F_2} - d_1$

$\bar{x} \cdot F_2 = (M_y)_O = -d_4 \cdot F_2 - d_3 \cdot F_3$

$\Rightarrow \bar{x} = -d_4 - d_3 \cdot \dfrac{F_3}{F_2}$

For the yz-plane, x = 0:

$\overrightarrow{r_{yz}} = \bar{y}\hat{j} + \bar{z}\hat{k}$

$$\overrightarrow{(M_R)_O} = \overrightarrow{r_{yz}} \times \overrightarrow{F_R} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & \bar{y} & \bar{z} \\ -F_3 & -F_1 & -F_2 \end{vmatrix} = (-\bar{y} \cdot F_2 + \bar{z} \cdot F_1)\hat{i} - \bar{z} \cdot F_3\hat{j} + \bar{y} \cdot F_3\hat{k}$$

$-\bar{z} \cdot F_3 = (M_y)_O = -d_4 \cdot F_2 - d_3 \cdot F_3$

$\Rightarrow \bar{z} = d_4 \cdot \dfrac{F_2}{F_3} + d_3$

$\bar{y} \cdot F_3 = (M_z)_O = d_4 \cdot F_1 - d_1 \cdot F_3$

$\Rightarrow \bar{y} = d_4 \cdot \dfrac{F_1}{F_3} - d_1$

For the zx-plane, y = 0:

$\overrightarrow{r_{zx}} = \bar{x}\hat{i} + \bar{z}\hat{k}$

$$\overrightarrow{(M_R)_O} = \overrightarrow{r_{zx}} \times \overrightarrow{F_R} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \bar{x} & 0 & \bar{z} \\ -F_3 & -F_1 & -F_2 \end{vmatrix} = \bar{z} \cdot F_1 \hat{i} + (-\bar{z} \cdot F_3 + \bar{x} \cdot F_2)\hat{j} - \bar{x} \cdot F_1 \hat{k}$$

$$\bar{z} \cdot F_1 = (M_x)_O = d_3 \cdot F_1 + d_1 \cdot F_2$$

$$\Rightarrow \bar{z} = d_3 + d_1 \cdot \frac{F_2}{F_1}$$

$$-\bar{x} \cdot F_1 = (M_z)_O = d_4 \cdot F_1 - d_1 \cdot F_3$$

$$\Rightarrow \bar{x} = -d_4 + d_1 \cdot \frac{F_3}{F_1}$$