Chapter 12 Problem 12 †

Given

$\vec{F}_1 = \{1\hat{\imath} + 2\hat{\jmath}\}\ N$ applied at $\vec{r}_1 = \{2\hat{\imath}\}\ m$
$\vec{F}_2 = \{-2\hat{\imath} - 5\hat{\jmath}\}\ N$ applied at $\vec{r}_2 = \{-1\hat{\imath} + 1\hat{\jmath}\}\ m$
$\vec{F}_3 = \{1\hat{\imath} + 3\hat{\jmath}\}\ N$ applied at $\vec{r}_3 = \{-2\hat{\imath} + 5\hat{\jmath}\}\ m$

Solution

a) Show that the net force is zero.

Adding the three forces together gives

$$\vec{F}_{tot} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = \{1\hat{\imath} + 2\hat{\jmath}\}\ N + \{-2\hat{\imath} - 5\hat{\jmath}\}\ N + \{1\hat{\imath} + 3\hat{\jmath}\}\ N$$

$$\vec{F}_{tot} = \{(1 - 2 + 1)\hat{\imath} + (2 - 5 + 3)\hat{\jmath}\}\ N = 0$$

b) Show the net torque about the origin is zero.

$$\vec{\tau}_{tot} = \vec{\tau}_1 + \vec{\tau}_2 + \vec{\tau}_3 = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2 + \vec{r}_3 \times \vec{F}_3$$

$$\vec{\tau}_{tot} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 2 & 0 & 0 \\ 1 & 2 & 0 \end{vmatrix} + \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ -1 & 1 & 0 \\ -2 & -5 & 0 \end{vmatrix} + \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ -2 & 5 & 0 \\ 1 & 3 & 0 \end{vmatrix}$$

$$\vec{\tau}_{tot} = (4 - 0)\hat{k} + (5 + 2)\hat{k} + (-6 - 5)\hat{k} = 0$$

† Problem from Essential University Physics, Wolfson