Answer on Question 69410, Physics, Other

Question:

A force $F = (\vec{\imath} + \vec{\jmath})\ N$ is applied on a mass of $1\ kg$ located at $(1,2,1)\ m$. Find the torque about the origin.

Solution:

By the definition of the torque we get:

$$\vec{\tau} = \vec{r} \times \vec{F} = \begin{vmatrix} \vec{\imath} & \vec{\jmath} & \vec{k} \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix} = \begin{vmatrix} \vec{\imath} & \vec{\jmath} & \vec{k} \\ 1 & 2 & 1 \\ 1 & 1 & 0 \end{vmatrix} = \vec{\imath} \cdot \begin{vmatrix} 2 & 1 \\ 1 & 0 \end{vmatrix} - \vec{\jmath} \cdot \begin{vmatrix} 1 & 1 \\ 1 & 0 \end{vmatrix} + \vec{k} \cdot \begin{vmatrix} 1 & 2 \\ 1 & 1 \end{vmatrix} =$$

$$(2 \cdot 0 - 1 \cdot 1)\vec{\imath} - (1 \cdot 0 - 1 \cdot 1)\vec{\jmath} + (1 \cdot 1 - 1 \cdot 2)\vec{k} = \left(-\vec{\imath} + \vec{\jmath} - \vec{k}\right) N \cdot m.$$

Also, we can find the magnitude of the torque from the Pythagorean theorem:

$$\tau = \sqrt{\tau_x^2 + \tau_y^2 + \tau_z^2} = \sqrt{(-1\ N \cdot m)^2 + (1\ N \cdot m)^2 + (-1\ N \cdot m)^2} = 1.732\ N \cdot m.$$

Answer:

$$\vec{\tau} = \left(-\vec{\imath} + \vec{\jmath} - \vec{k}\right) N \cdot m.$$

The magnitude of the torque is $\tau = 1.732\ N \cdot m$.