21. If we write $\vec{r} = x\hat{\mathrm{i}} + y\hat{\mathrm{j}} + z\hat{\mathrm{k}}$, then (using Eq. 3-30) we find $\vec{r} \times \vec{F}$ is equal to

$$(yF_z - zF_y)\,\hat{\mathrm{i}} + (zF_x - xF_z)\,\hat{\mathrm{j}} + (xF_y - yF_x)\,\hat{\mathrm{k}} \ .$$

(a) Plugging in, we find

$$\vec{\tau} = ((3.0\,\mathrm{m})(6.0\,\mathrm{N}) - (4.0\,\mathrm{m})(-8.0\,\mathrm{N}))\ \hat{\mathrm{k}} = 50\,\hat{\mathrm{k}}\ \mathrm{N{\cdot}m} \ .$$

(b) We use Eq. 3-27, $|\vec{r} \times \vec{F}| = rF\sin\phi$, where ϕ is the angle between $\vec{r}$ and $\vec{F}$. Now $r = \sqrt{x^2 + y^2} = 5.0\,\mathrm{m}$ and $F = \sqrt{F_x^2 + F_y^2} = 10\,\mathrm{N}$. Thus $rF = (5.0\,\mathrm{m})(10\,\mathrm{N}) = 50\,\mathrm{N}\cdot\mathrm{m}$, the same as the magnitude of the vector product calculated in part (a). This implies $\sin\phi = 1$ and $\phi = 90°$.