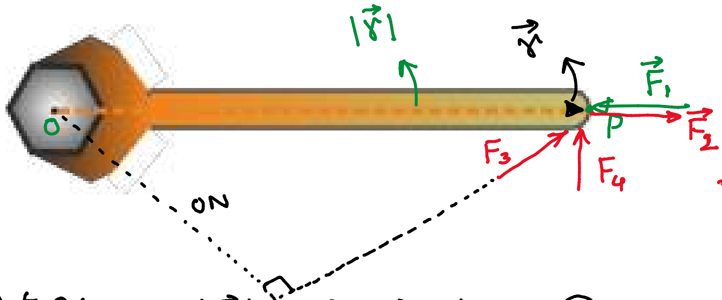


* for $\vec{F_1}$ θ is $180°$
$\Rightarrow |\vec{\tau}| = 0$

* for F_2, $\theta = 0°$
$\Rightarrow |\vec{\tau}| = 0$
$\Rightarrow$ no rotating effect.

* For F_4 $\theta = 90°$
$|\vec{\tau}| = |\vec{\tau}|_{max}$

Note 2:

$$|\vec{\tau}| = |\vec{r}|\,|\vec{F}| \sin\theta \quad \text{—} (4)$$

$$|\vec{\tau}| = (|\vec{r}| \sin\theta) \cdot |\vec{F}|$$

$$|\vec{\tau}| = |\vec{F}| \cdot (ON) \quad \text{—} (5)$$

ON = ⊥ar distance of line of action of force from point of rotation
$= r_\perp$

ON = 'lever arm'

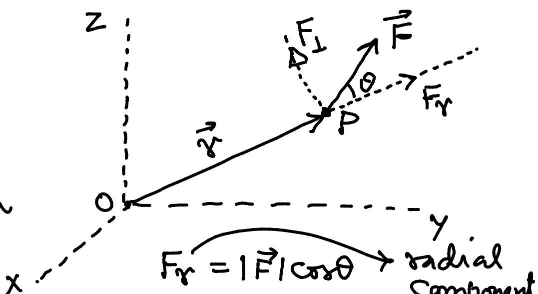
* if the line of action of a force passes through the point of rotation, Torque generated by the force is zero.

Note 3:

$$|\vec{\tau}| = |\vec{r}| \cdot (|\vec{F}| \sin\theta)$$

$$|\vec{\tau}| = |\vec{r}| \cdot F_\perp \quad \text{—} (6)$$

$F_\perp$ = component of force in the direction ⊥ar to the position vector of point of application of force
= Transverse component of force



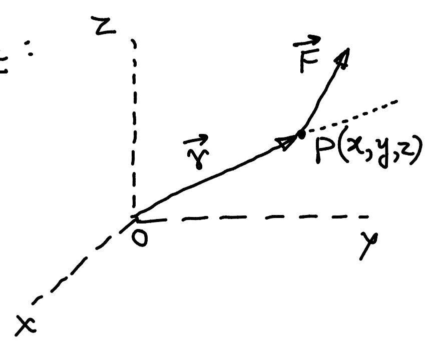
$F_r = |\vec{F}| \cos\theta$ → radial component
$F_\perp = |\vec{F}| \sin\theta$

→ Only the transverse component of force is capable of producing torque.

Rectangular components of Torque:

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k} \quad \text{—} (1)$$

$$\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k} \quad \text{—} (2)$$



$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\vec{\tau} = \begin{vmatrix} (+)\hat{i} & (-)\hat{j} & (+)\hat{k} \\ x & y & z \\ F_x & F_y & F_z \end{vmatrix} = \hat{i}(yF_z - zF_y) - \hat{j}(xF_z - zF_x) + \hat{k}(xF_y - yF_x)$$