TORQUE (MOMENT OF FORCE)

Torque represents the capability of a force to produce change in the rotational motion of the body.

Torque about a point :

Torque of force $\vec{F}$ about a point $\qquad \vec{\tau} = \vec{r} \times \vec{F}$

Where $\qquad$ $\vec{F}$ = force applied

P = point of application of force

Q = Point about which we want to calculate the torque.

$\vec{r}$ = position vector of the point of application of force w.r.t. the point about which we want to determine the torque.

$$|\vec{\tau}| = r\,F\sin\theta \qquad = r_{\perp}F \qquad = rF_{\perp}$$

Where θ = angle between the direction of force and the position vector of P wrt. Q.
$r_{\perp} = r\sin\theta$ = perpendicular distance of line of action of force from point Q ,it is also called force arm.
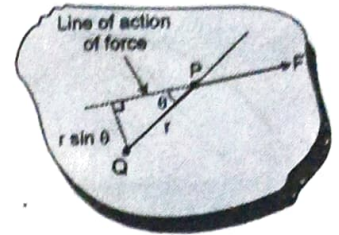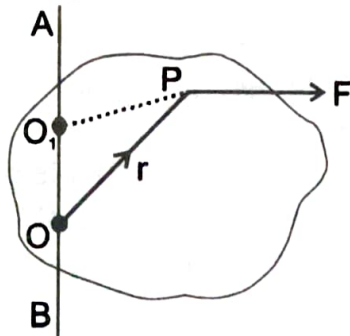
$\qquad F_{\perp} = F\sin\theta$ = component of $\vec{F}$ perpendicular to $\vec{r}$

$\qquad$ SI unit of torque is Nm

☞ Torque is a vector quantity and its direction is determined using right hand thumb rule and its always perpendicular to the plane of rotation of the body.

Torque about an axis :

The torque of a force $\vec{F}$ about an axis AB is defined as the component of torque of $\vec{F}$ about any point O on the axis AB, along the axis AB.

In the given figure torque of $\vec{F}$ about O is $\vec{\tau_0} = \vec{r} \times \vec{F}$

The torque of $\vec{F}$ about AB, τ_{AB} is component of $\vec{\tau_0}$ along line AB.