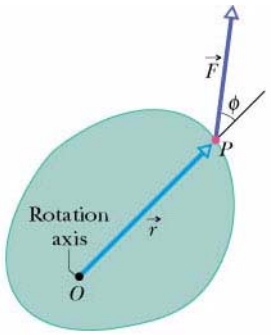
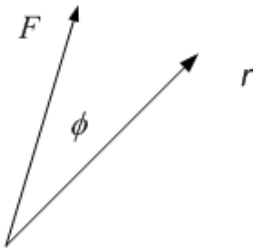


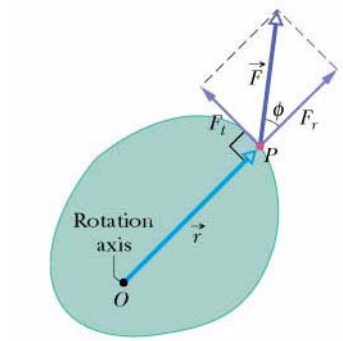
(a)



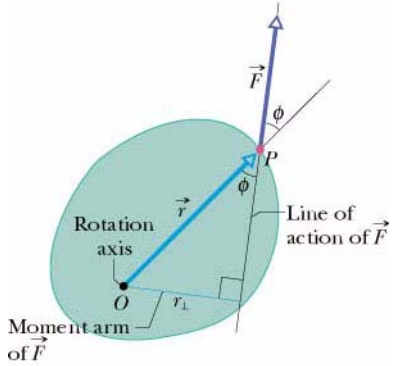
$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\tau = rF \sin \phi$$

By the right-hand rule, the torque is out of the page, corresponding to a CCW rotation.



(b)



(c)

Here rotation is related to the perpendicular component of the force, acting on the distance r from the axis of rotation:

$$\tau = F_t r = \left(F \sin\phi\right) r$$

In the second figure, drop a perpendicular from the axis of rotation to the line along which the force acts. The perpendicular is called the "**moment arm**." The rotation now is related to the entire force, acting on the moment arm:

$$\tau = F r_\perp = F\left(r \sin\phi\right)$$