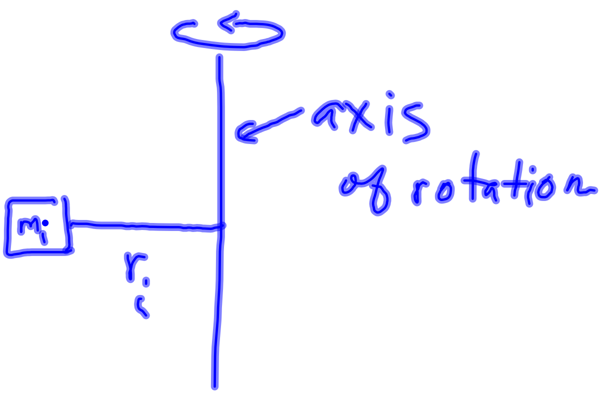
Rotational Motion

Linear	Rotation
x	θ
$v = \frac{\Delta x}{\Delta t}$	$\omega = \frac{\Delta \theta}{\Delta t}$
$a = \frac{\Delta v}{\Delta t}$	$\alpha = \frac{\Delta \omega}{\Delta t}$
m (mass)	I (moment of inertia)
$p = mv$	$L = I\omega$
$\frac{1}{2}mv^2$	$\frac{1}{2}I\omega^2$
$F = \frac{\Delta p}{\Delta t}$	$\tau = \frac{\Delta L}{\Delta t}$ (torque)

Moment of Inertia

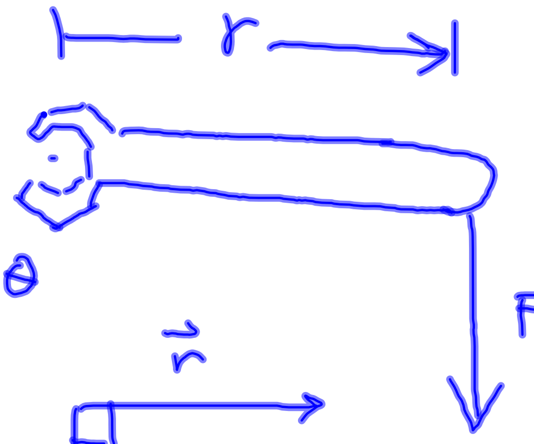
$$I = \sum_{i=1}^{N} r_i^2 m_i$$



$$= r_1^2 m_1 + r_2^2 m_2 + r_3^2 m_3 + \dots$$

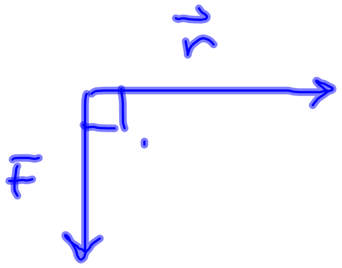
Torque

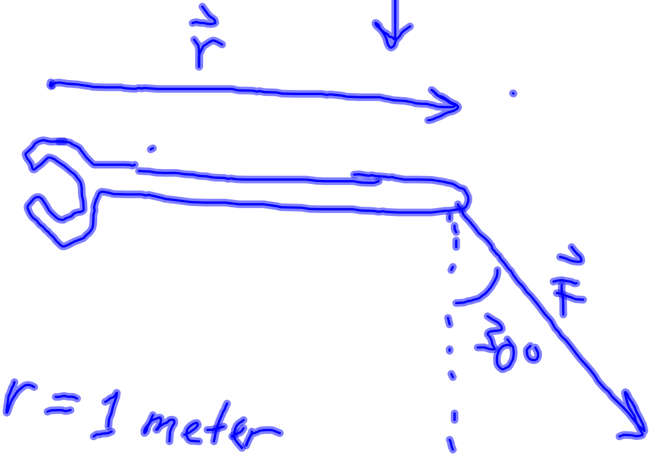
$\vec{\tau} = \vec{r} \times \vec{F}$

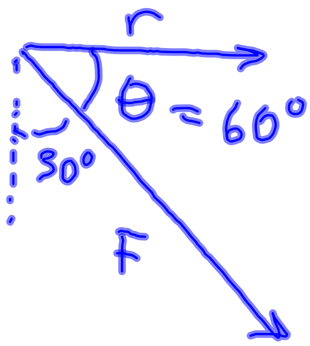


$|\vec{\tau}| = \tau = rF\sin\theta$

$\tau = rF$







$r = 1$ meter

$F = 100$ N

Q. what is τ?

A. $\tau = rF\sin\theta$

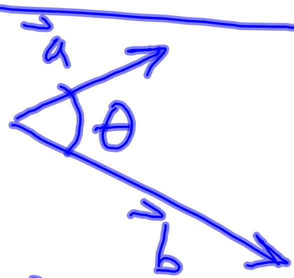
$= (1\,m)(100\,N)\sin 60°$

$= 100\,N\cdot m \frac{\sqrt{3}}{2}$

$= 86.6\,N\cdot m$

Cross Product (Math we need)

$\vec{c} = \vec{a} \times \vec{b}$



magnitude $c = ab\sin\theta$

direction: use right hand rule

$\vec{c}$ is into the page $\otimes$

$\vec{c} = \vec{b} \times \vec{a}$ (same $\vec{a}$ & $\vec{b}$ as above)

$c = ab\sin\theta$

direction of c is out of page $\odot$

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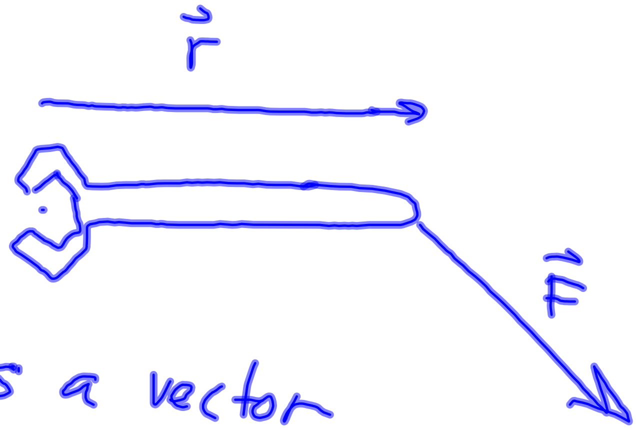
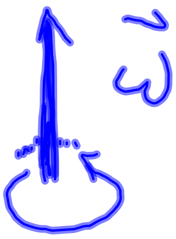
Torque as a Vector

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

τ is into of page



Angular Velocity as a vector



Angular Momentum as a Vector

$\vec{L} = I\vec{\omega}$

Another Analog

Linear	Rotational
$W = Fx$ (W ← work)	$W = \tau\theta$ (W ← work)