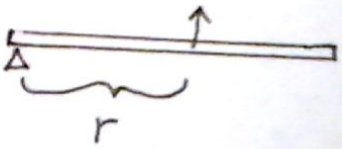
Torque causes objects to rotate. Torque = $F \cdot r \cdot \sin\theta$

Units for τ are Nm like work Nm = Joule.

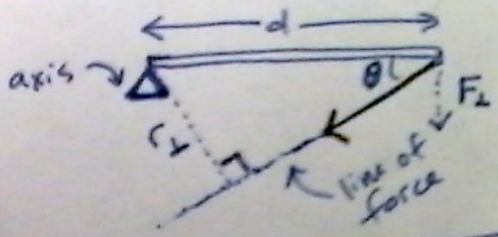


$\tau = 2 \cdot 1 = 2$ Nm $\tau = 4 \cdot \frac{1}{2} = 2$ Nm $\tau = 8 \cdot \frac{1}{4} = 2$ Nm $\tau = 20 \cdot \frac{1}{10} = 2$ Nm

The farther from the pivot point, the more force required to keep the system in equilibrium.

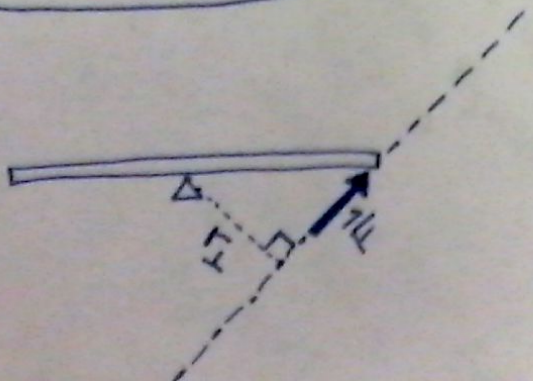
Torque = $F \cdot r \cdot \sin\theta = F_\perp \cdot r = \boxed{F \cdot r_\perp}$ ← most frequently used on the AP Exam.

$r_\perp$ is the lever arm or distance between the line of force and the axis.



$r_\perp = d \sin\theta$

$\tau = F \cdot \underbrace{d \sin\theta}_{r_\perp} = \underbrace{F \sin\theta}_{F_\perp} \cdot d$ $d = r$



Steps to use $r_\perp$

1. Extend a line through the force
2. Draw a perpendicular line from the pivot point to the force line.
3. $\vec{\tau} = F \cdot r_\perp = \vec{\tau} = T \cdot$ radius

Steps to Solving Torque Problems (Equilibrium)

1. Draw a free body diagram
2. If it is not obvious where the pivot point is, put it in a spot that will get rid of an unknown force.
3. Use $F_{net} = 0$ and $\tau_{net} = 0$
4. Solve for a force using torque first then solve for the other force with forces.

Torque & Inertia Notes

$$\vec{\tau} = \vec{r} \times \vec{F} = rF\sin\theta = Fr\sin\theta$$

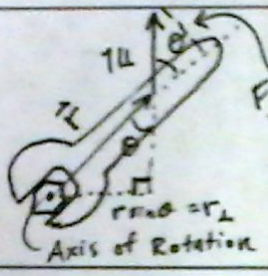
θ of 90° provides maximum torque

Units for torque is N·m

α = angular accel.

ccw: $\tau > 0 \Rightarrow \alpha > 0$

cw: $\tau < 0 \Rightarrow \alpha < 0$



$$\tau = r\underbrace{F\sin\theta} = r \cdot F_\perp$$

$$\tau = F\underbrace{r\sin\theta} = F \cdot r_\perp$$

$r_\perp$ = distance from force line to axis

$F_\perp$ = perpendicular component of force

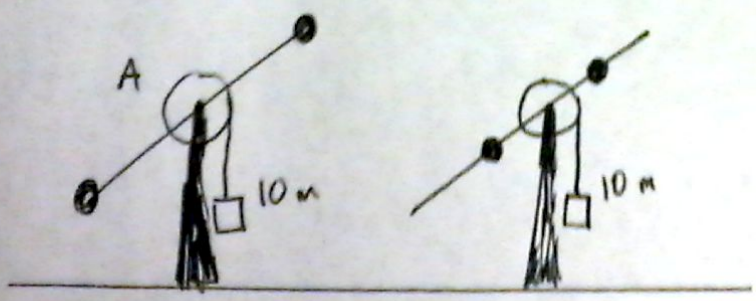
$$\alpha = \frac{a}{r} = \frac{F}{mr}\cdot\left(\frac{r}{r}\right)$$

$$= \frac{F \cdot r}{mr^2} = \boxed{\frac{\tau}{I} = \alpha}$$

Torque causes angular acceleration:

$$\vec{a} = \frac{\Sigma \vec{F}}{m} \quad \text{similarly} \quad \vec{\alpha} = \frac{\vec{\tau}}{I}$$

$$\boxed{\Sigma \vec{\tau} = I\vec{\alpha}}$$



Which 10 m object hits the ground first?