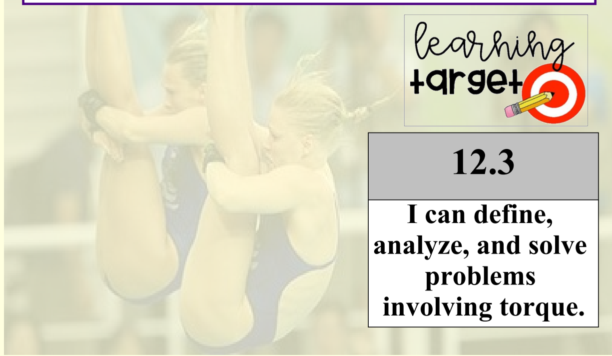
PRACTICE	LABS	TESTS
Unit 12 Problems (1-23)	Balancing Lab (Due Tues. 3/19)	Unit 12 Test Tuesday (3/26/19)

Moment Of Inertia and Newton's 2nd Law for Rotation



12.3

I can define, analyze, and solve problems involving torque.

Describing Rotational Motion

Key Concepts

- Angular position and its changes are measured in radians. One complete revolution is 2π rad.
- Angular velocity is given by the following equation.

$$\omega = \frac{\Delta\theta}{\Delta t}$$

- Angular acceleration is given by the following equation.

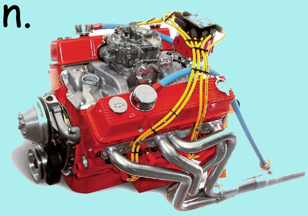
$$\alpha = \frac{\Delta\omega}{\Delta t}$$

- For a rotating, rigid object, the angular displacement, velocity, and acceleration can be related to the linear displacement, velocity, and acceleration for any point on the object.

$$d = r\theta \qquad v = r\omega \qquad a = r\alpha$$

Torque

Torque (τ) is a measure of how effectively a force causes rotation.



Sign of Torque

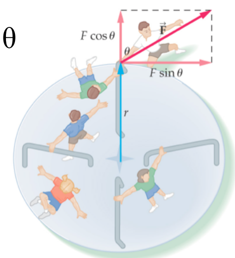
$\tau > 0$ if the torque causes a counterclockwise angular acceleration

$\tau < 0$ if the torque causes a clockwise angular acceleration

Definition of Torque (nontangential force)

$$\tau = r\,F\,\sin\theta$$

torque = radius x force x sin θ

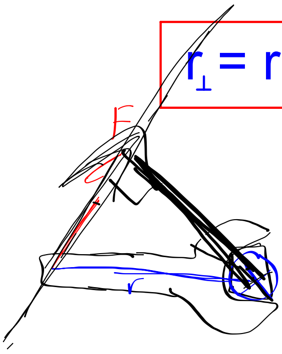


TORQUE

Torque can be defined in terms of a moment arm

The perpendicular distance from the axis of rotation to the line of the force is defined as the **lever arm** or **moment arm**.

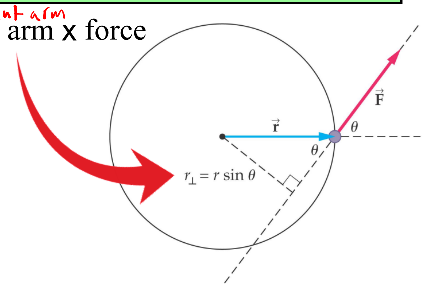
$$r_{\perp} = r \sin \theta$$



TORQUE

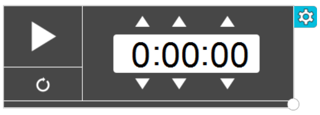
$$\tau = (r \sin \theta)\, F = r_{\perp} F$$

torque = lever arm (moment arm) x force



UNIT 12 IN CLASS PROBLEMS

17. In the next 60 seconds, write down Isaac Newton's three famous laws of motion.



Newton's Second Law for Rotational Motion

Linear	Rotational
F	τ
m	I
a	α

$$\tau = I\alpha$$

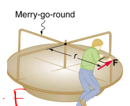
Newton's Second Law for Rotational Motion

Newton's second law for rotational motion states that the angular acceleration is proportional to the net torque and inversely proportional to the moment of inertia.

$$\vec{\alpha} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$$

EXAMPLE: MERRY-GO-ROUND

Consider a father pushing a playground merry-go-round. He exerts a force of 250 N at the edge of the 50.0-kg merry-go-round, which has a 1.50 m radius. Calculate the angular acceleration produced (a) when no one is on the merry-go-round and (b) when an 18.0-kg child sits 1.25 m away from the center. Consider the merry-go-round itself to be a uniform disk with negligible resistive friction.



$\alpha = \frac{\tau_{net}}{I}$

a) $\alpha = \frac{(r \sin\theta) \cdot F}{\frac{1}{2} m r^2} = \frac{r \cdot F}{\frac{1}{2} m r^2} = \frac{375\ N \cdot m}{56.25\ kg \cdot m^2}$

$\alpha = 6.7\ \frac{rad}{s^2}$

$= \frac{kg \cdot \frac{m}{s^2} \cdot m}{kg \cdot m^2}$

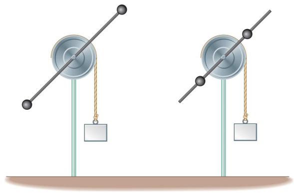
(b) $\alpha = \frac{r \cdot F}{\frac{1}{2} m r_{mgr}^2 + m r_c^2}$

$\alpha = 4.4\ \frac{rad}{s^2}$

UNIT 12 IN CLASS PROBLEMS

18. A fisherman is dozing when a fish takes the line and pulls tangentially on the spool of the fishing reel with a tension of **T** = 8.2 N. The disk-shaped spool is at rest initially and rotates without friction. The radius of the spool is r = 6.6 cm, and its mass if m = 1.8 kg. What is the angular acceleration of the spool?

19. The rotating systems shown in the figure differ only in that the two adjustable masses are position either far from the axis of rotation (left) or near the axis of rotation (right).The hanging blocks are released simultaneously from rest at the same height. Which block will land first? Explain.



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UNIT 12 IN CLASS PROBLEMS

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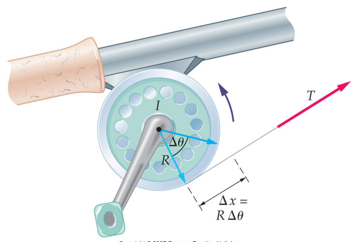

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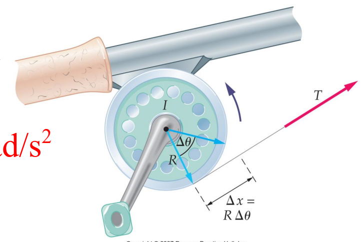
UNIT 12 IN CLASS PROBLEMS

16. A fisherman is dozing when a fish takes the line and pulls tangentially on the spool of the fishing reel with a tension of **T** = 8.2 N. The disk-shaped spool is at rest initially and rotates without friction. The radius of the spool is r = 6.6 cm, and its mass if m = 1.8 kg. What is the angular acceleration of the spool?

$\tau = 0.54$ N.m

$I = 3.9 \times 10^{-3}$ kg.m^2

$$\alpha = \frac{\tau}{I} = 140 \text{ rad/s}^2$$



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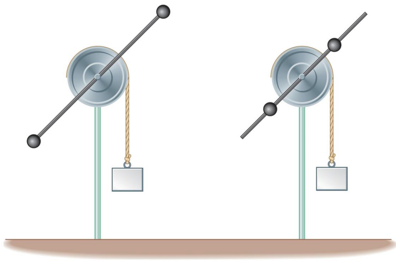
UNIT 12 IN CLASS PROBLEMS

19. The rotating systems shown in the figure differ only in that the two adjustable masses are position either far from the axis of rotation (left) or near the axis of rotation (right).The hanging blocks are released simultaneously from rest at the same height. Which block will land first? Explain.



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UNIT 12 IN CLASS PROBLEMS

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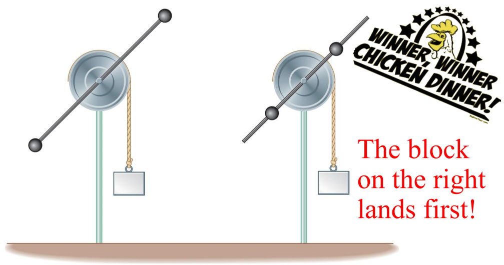

The block on the right lands first!

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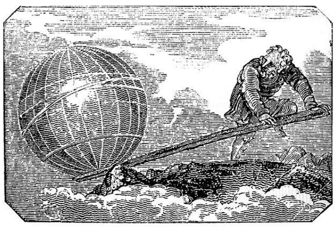

Archimedes is said to have remarked about the lever: "Give me a place to stand on, and I will move the Earth."

UNIT 12 PROBLEMS

(18-23)