PRACTICE	LABS	TESTS
Unit 12 Problems (1-18)	Balancing Lab (Due Thurs. 3/28)	Unit 12 Test Thursday (4/4/19)

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

learning target

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.

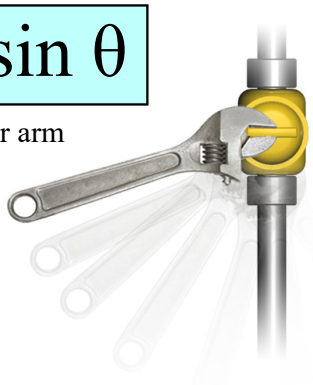
$$d = r\theta \qquad v = r\omega \qquad a = r\alpha$$

V	ω	$V^2 = V_0^2 + 2a(x_f - x_0)$
a	α	$\omega^2 = \omega_0^2 + 2\alpha(\theta_f - \theta_0)$
x	θ	
t	t	

Definition of Torque (tangential force)

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

torque = force x lever arm



UNIT 12 IN CLASS PROBLEMS

13. 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
$F_{net} = ma$	$\tau_{net} = I\alpha$
$a = \frac{F}{m}$	

Newton's Second Law for Rotational Motion

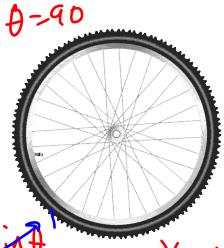
Newton's second law for rotational motion states that the angular acceleration is proportional to the net torque and inversely proportional to the moment of inertia.

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

$\tau_{net} = I\alpha$

EXAMPLE: MERRY-GO-ROUND

A bicycle wheel with a radius of 38 cm is given an angular acceleration of 2.67 rad/s^2 by applying a force of 0.35 N on the edge of the wheel. What is the wheel's moment of inertia?



$r = 0.38\ m$
$\alpha = 2.67\ rad/s^2$
$F = 0.35\ N$
$\theta = 90$

$\tau_{net} = I\alpha$

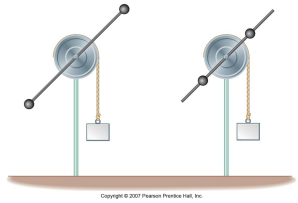
$I = \frac{\tau_{net}}{\alpha} = \frac{Fr\sin\theta}{2.67\ rad/s^2} = \frac{(0.35\ N)(0.38\ m)}{2.67\ rad/s^2}$

$I = 0.050\ kg \cdot m^2$

UNIT 12 IN CLASS PROBLEMS

14. 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?

15. 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.



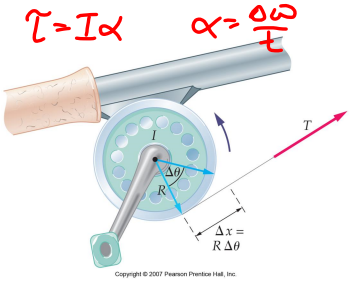
UNIT 12 IN CLASS PROBLEMS

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?

$I = \frac{1}{2}mr^2$

$\tau = Fr\sin\theta$

$\tau = I\alpha \quad \alpha = \frac{\Delta\omega}{t}$



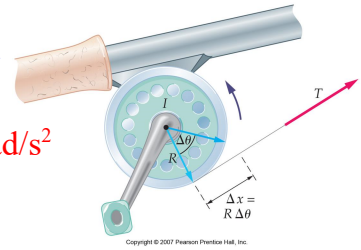
UNIT 12 IN CLASS PROBLEMS

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?

$\tau = 0.54\ N.m$

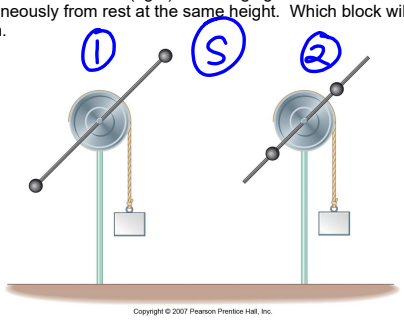
$I = 3.9 \times 10^{-3}\ kg.m^2$

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



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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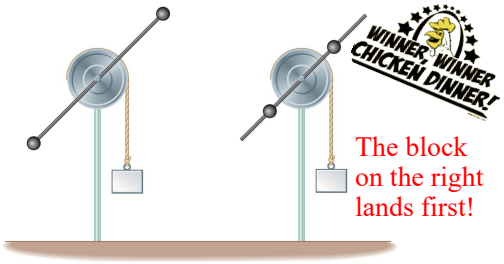
UNIT 12 IN CLASS PROBLEMS

17. 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.



The block on the right lands first!

UNIT 12 PROBLEMS

(19-22)