PRACTICE	LABS	TESTS
Unit 12 Problems (1-15)	Balancing Lab (Due Thus. 3/28)	Unit 12 Test Thursday (4/4/19)

DAILY ANNOUNCEMENTS

TORQUE

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

UNIT 12 REVIEW

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.

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

Rotational Kinetic Energy and Angular Momentum

Rotational Kinetic Energy

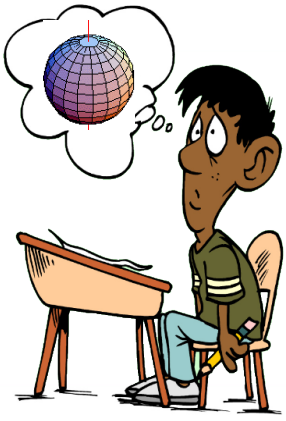
$$K = \frac{1}{2} I\omega^2$$

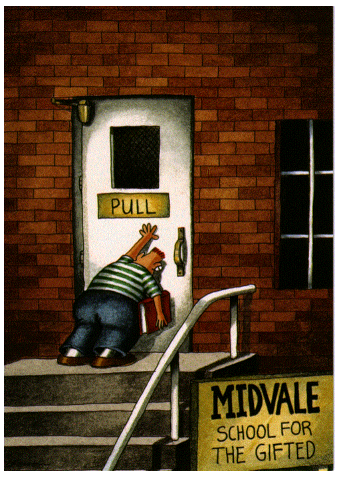
Angular Momentum

$$L = I\omega$$

Question

How do you get an object to rotate?





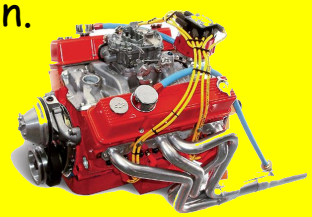
Physics Opens Doors!

Torque

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

Tau

τ



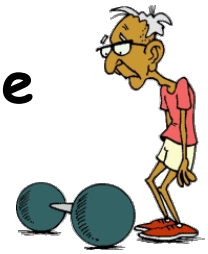
TORQUE

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**.

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

The Torque Experience

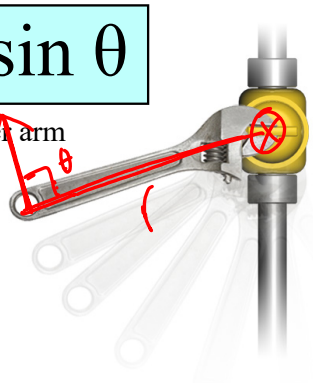


Definition of Torque (tangential force)

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

torque = force x lever arm

$\sin 90 = 1$



Torque

Vector of Scalar?

Units? N·m

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

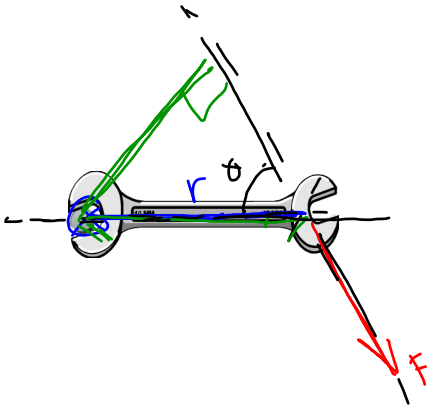
Relationship?

Direct Prop.

TORQUE

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

torque = force x lever arm



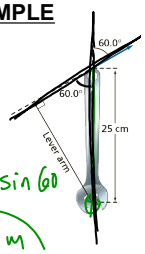
Sign of Torque

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

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

UNIT 12 EXAMPLE

A bolt on a car engine needs to be tightened with a torque of 35 N·m. You use a 25-cm-long wrench and pull on the end of the wrench at an angle of 60.0° from the perpendicular. How long is the lever arm, and how much force do you have to exert?



$r \sin\theta = (0.25\text{m}) \sin 60$

$r \sin\theta = 0.22\text{m}$

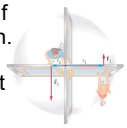
$\tau = F r \sin\theta$

$\frac{\tau}{r\sin\theta} = F = \frac{35\ \text{N·M}}{0.22\text{m}}$

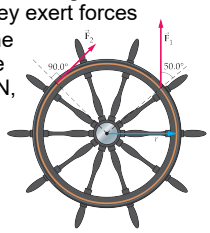
$F = 160\text{N}$

UNIT 12 IN CLASS PROBLEMS

15. To open a revolving door a tangential force **F** if applied at a distance *r* from the axis of rotation. If the minimum torque required to open the door is 3.1 N m, what magnitude of force must be applied if *r* is **(a)** 0.94 m or **(b)** 0.35 m?



16. Captains Sparrow and Barbosa are in a disagreement about which way to turn the ship. They exert forces shown below on the ship's wheel. The wheel has a radius of 0.74 m, and the two forces have magnitudes F_1 = 72 N, and F_2 = 58 N. **(a)** Find the torque caused by F_1. **(b)** Find the torque caused by F_2. **(c)** In which direction does the wheel turn as a result of these two forces?



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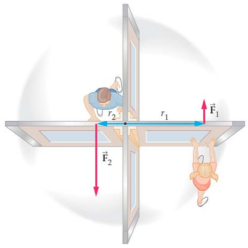

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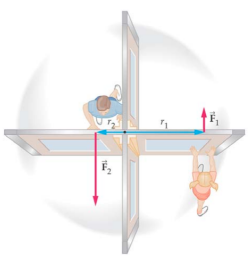
(a) $F_1 = \frac{\tau}{r_1} = 3.3\ \text{N}$

(b) $F_2 = \frac{\tau}{r_2} = 8.9\ \text{N}$



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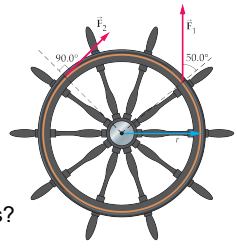
(a) Find the torque caused by F_1.

(b) Find the torque caused by F_2.

(c) In which direction does the wheel turn as a result of these two forces?



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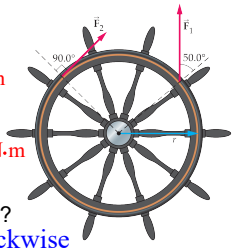


(a) Find the torque caused by F_1.

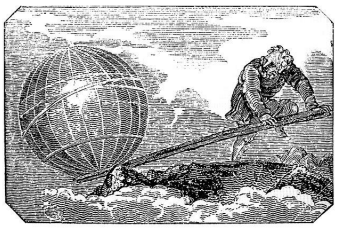
$\tau_1 = (72\ \text{N})(0.74 \sin 50.0^\circ) = 41 \cdot \text{N m}$

(b) Find the torque caused by F_2.

$\tau_2 = -(58\ \text{N})(0.74 \sin 90.0^\circ) = -43\ \text{N} \cdot \text{m}$

(c) In which direction does the wheel turn as a result of these two forces?

$\tau_{total} = \tau_1 + \tau_2 = -2\ \text{N} \cdot \text{m}$ Clockwise



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

(16-18)