April 16, Week 13

Today: Chapter 10, Torque

Homework #9 - Due Today at 11:59pm
Mastering Physics: 7 questions from chapter 9.
Written Question: 10.80

On problem 81 part (d) is wrong! Enter 0.816

Homework #10 - Due April 26 at 11:59pm
Mastering Physics: 7 questions from chapter 10.
Written Question: 10.86

Review

Torque, $\vec{\tau}$ - Measures the effectiveness of a force at causing rotation.

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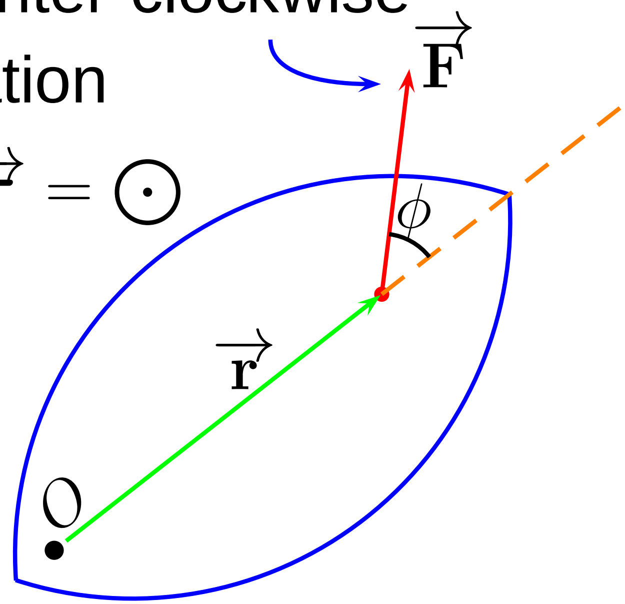
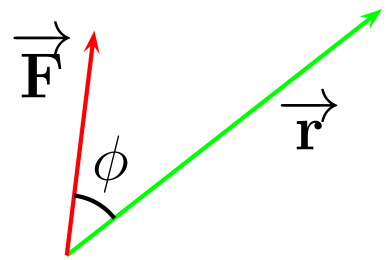
counter-clockwise rotation

$\vec{\tau} = \odot$



$$\tau = rF\sin\phi$$



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

Perpendicular Distance

The calculation of torque can be simplified in some case by the use of the perpendicular distance.

Perpendicular Distance, d - The distance from the axis of rotation to the force's line of action that is perpendicular to the line of action.

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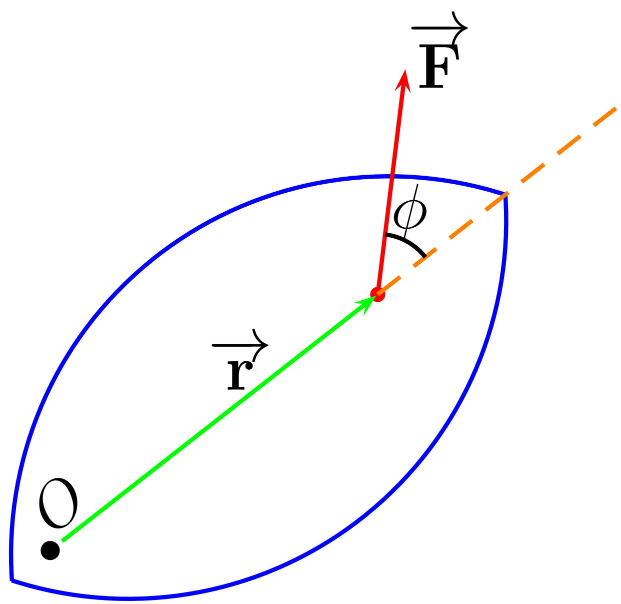

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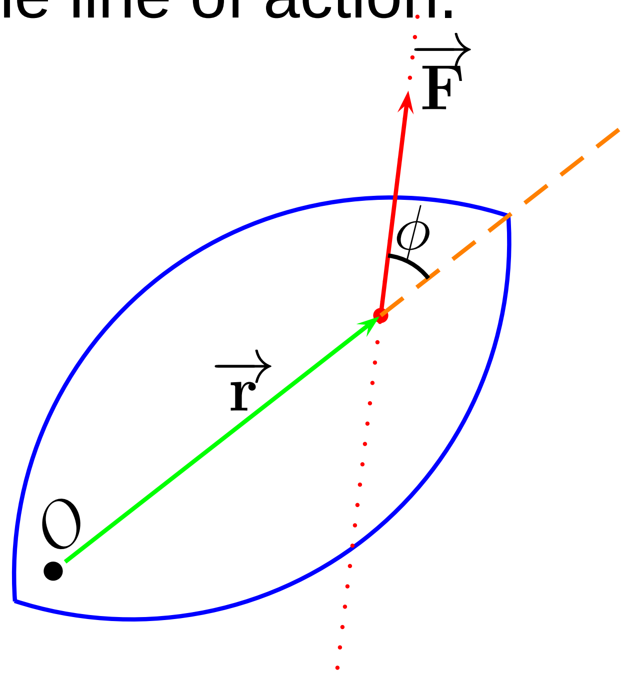

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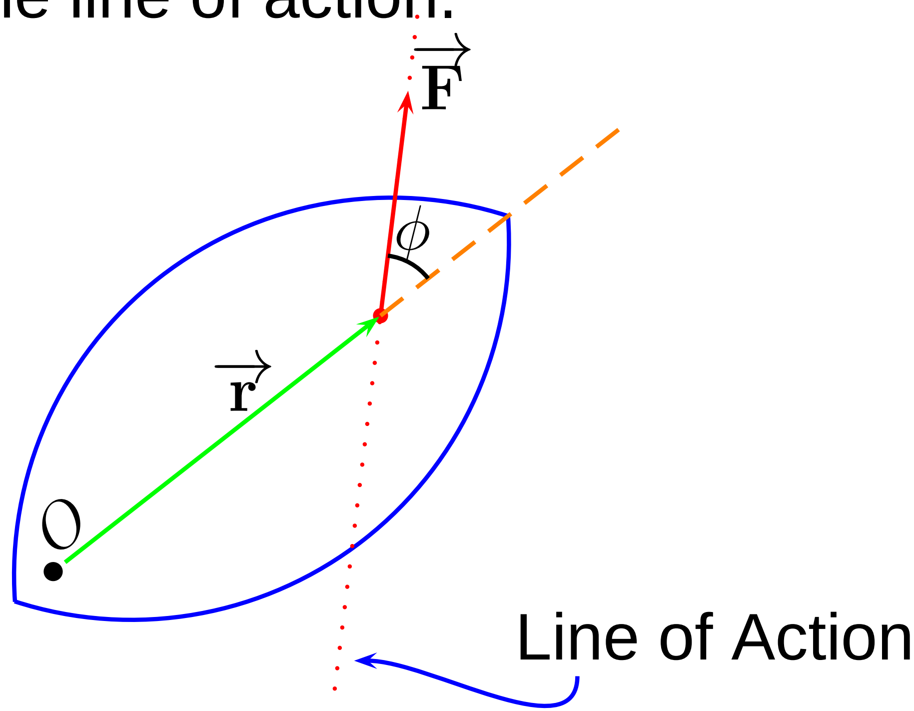

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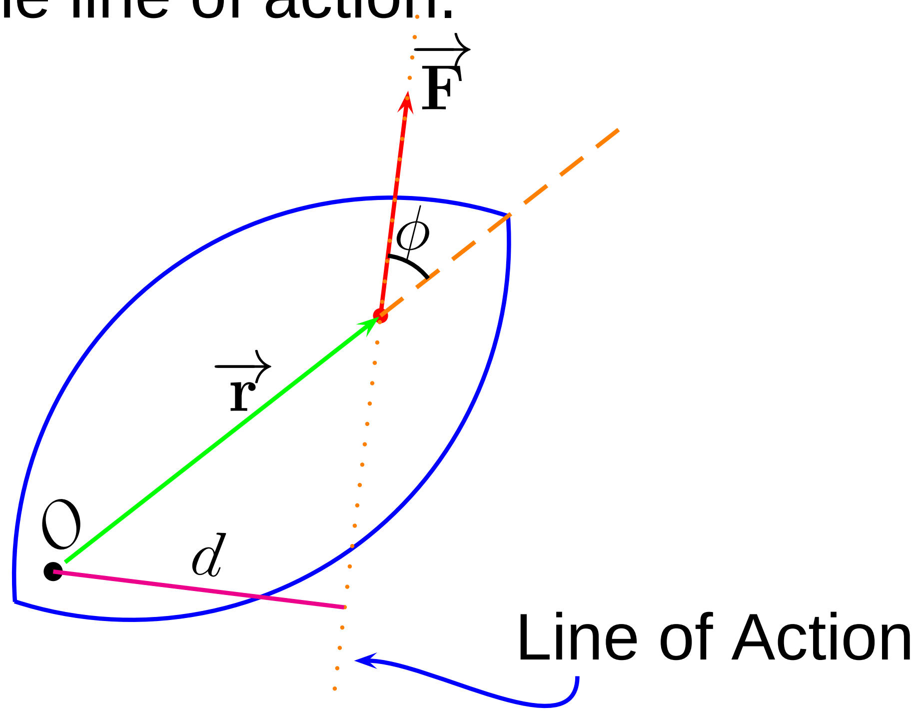

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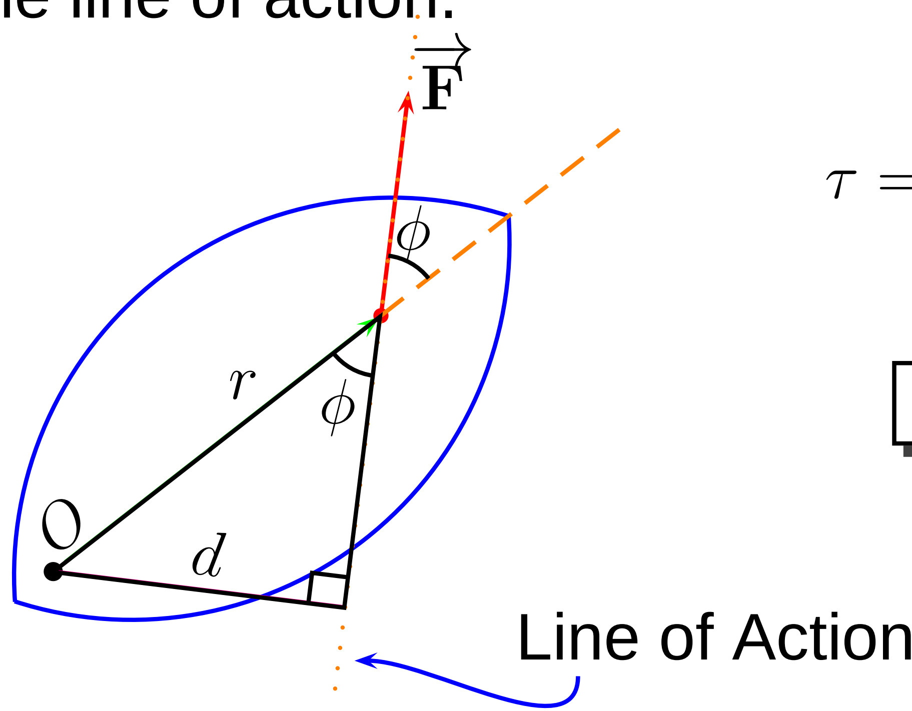

$$\tau = rF\sin\phi = (r\sin\phi)\,F$$

$$\boxed{\tau = dF}$$

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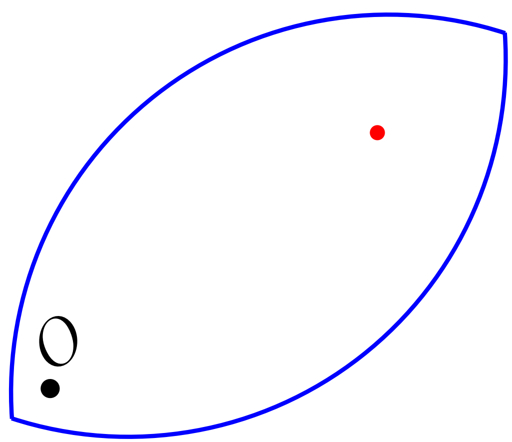

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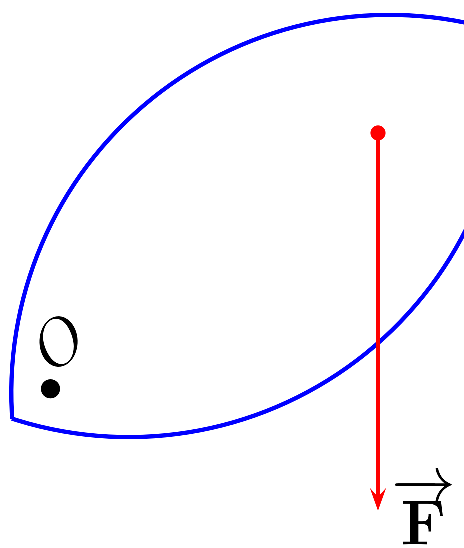

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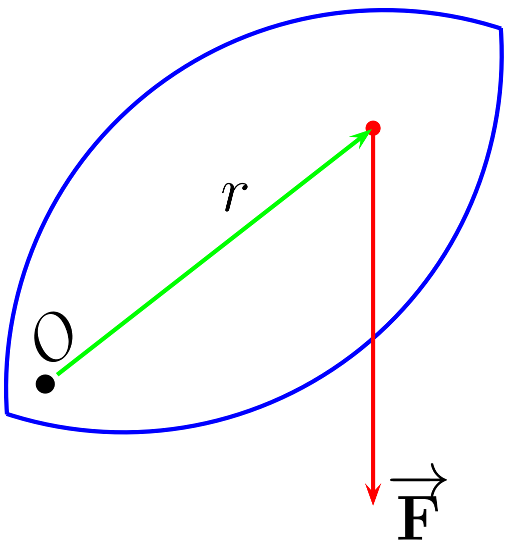

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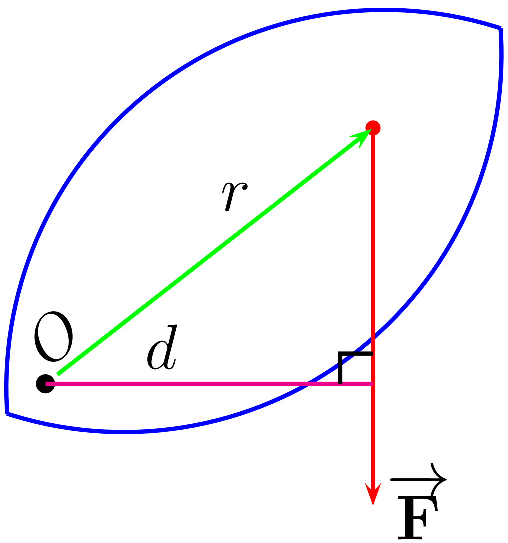

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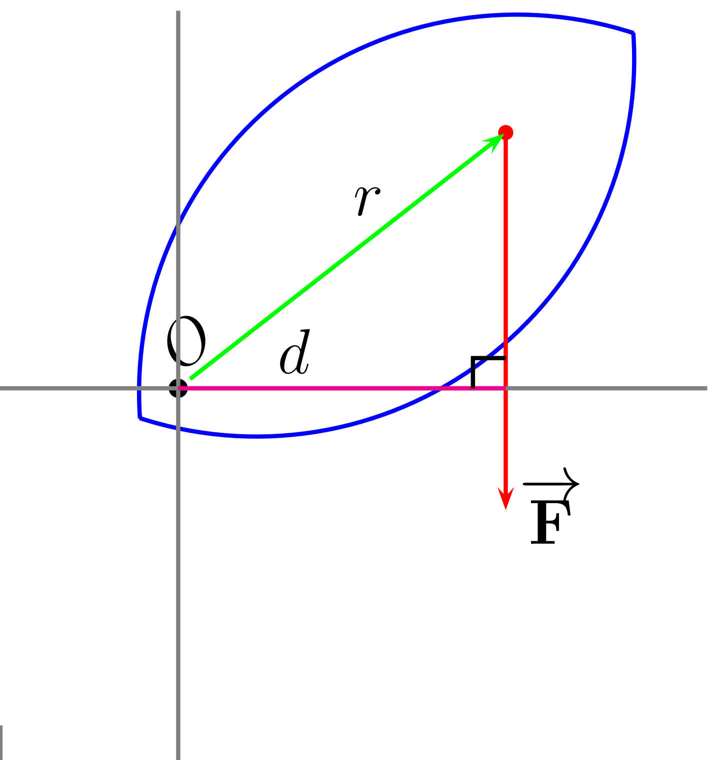

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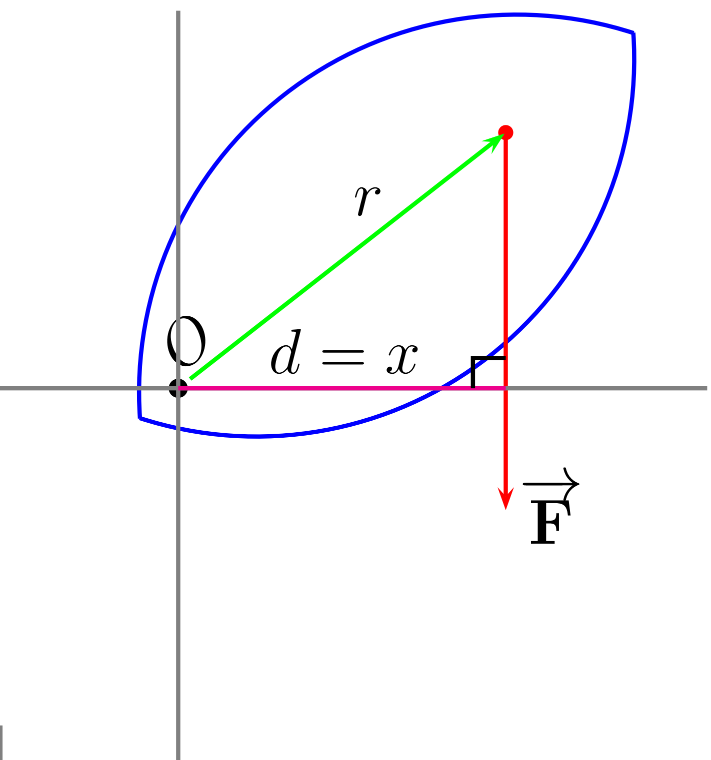

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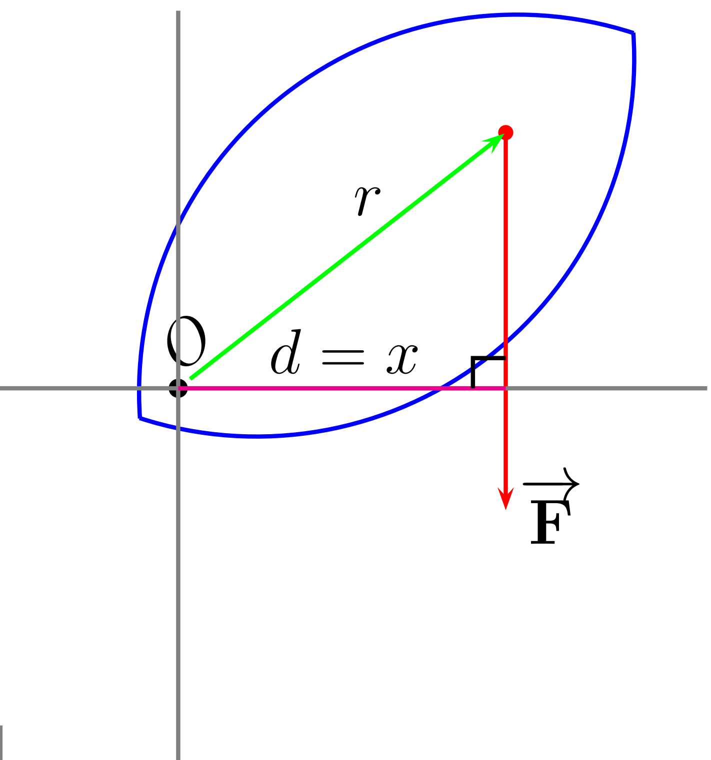

For vertical forces:

$$\boxed{\tau = xF}$$

First Law for Rotation

Newton's First for Rotation - An object at rest, stays at rest. An object in uniform rotation stays in uniform rotation if the net torque acting on it is zero.

Uniform rotation $\Rightarrow$ zero angular acceleration.

Second Law for Rotation

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$$\sum \overrightarrow{\boldsymbol{\tau}} = I\overrightarrow{\boldsymbol{\alpha}}$$

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Only true for spinning motion when you set the origin of your coordinates at the axis of rotation.

Clicker Quiz

What net torque in Newton-meters is required to make a lemon-shaped object with moment of inertia $I = 2\,kg \cdot m^2$ rotate with angular acceleration $30\,rev/s^2$?

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(d) $\sum \tau = 0\, N \cdot m$

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(a) $\sum \tau = 60\,N \cdot m$

(b) $\sum \tau > 60\,N \cdot m$ $\qquad \sum \tau = 120\pi\,N \cdot m$

(c) $\sum \tau < 60\,N \cdot m$

(d) $\sum \tau = 0\,N \cdot m$

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Example: A 5-kg mass is placed on a 36.9° incline and connected, by a massless rope, to a 25-kg flywheel whose radius is $0.2\,m$ and moment of inertia (for rotation about its center) is $0.5\,kg \cdot m^2$. If the coefficient of kinetic friction between the 5-kg mass and the incline is 0.25, what is the tension in the rope and the acceleration of the mass?