April 13, Week 12

Today: Chapter 10, Torque

Homework #9 - Due April 16 at 11:59pm
Mastering Physics: 7 questions from chapter 9.
Written Question: 10.80

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

Test Scores:

C	Clicker Score	Since last Friday with 5 lowest scores dropped.
HW	Homework Average	Mastering Physics and written problems.
CA	Current Average	Out of 80 points!

Review

The kinetic energy of a spinning object is given by:

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

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The kinetic energy of a rolling without slipping object is given by:

$$K = \frac{1}{2} M v_{cm}^2 \left(1 + \frac{I}{MR^2} \right)$$

Torque

Torque, τ - Measures the effectiveness of a force at causing rotation.

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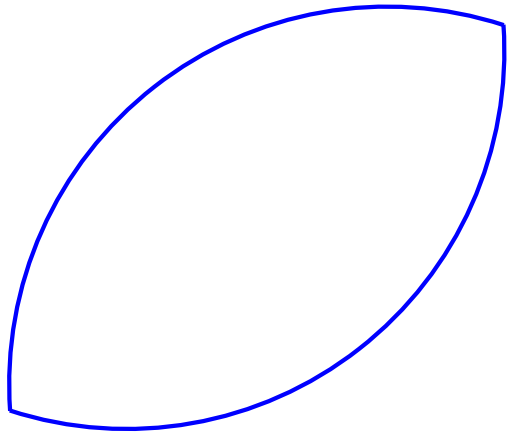

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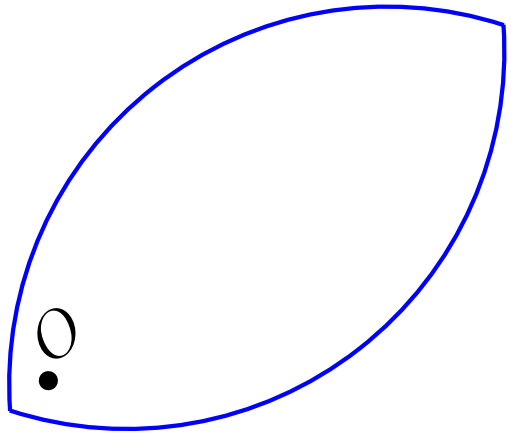

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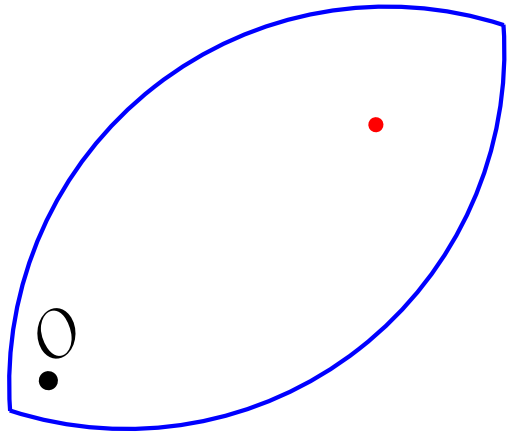

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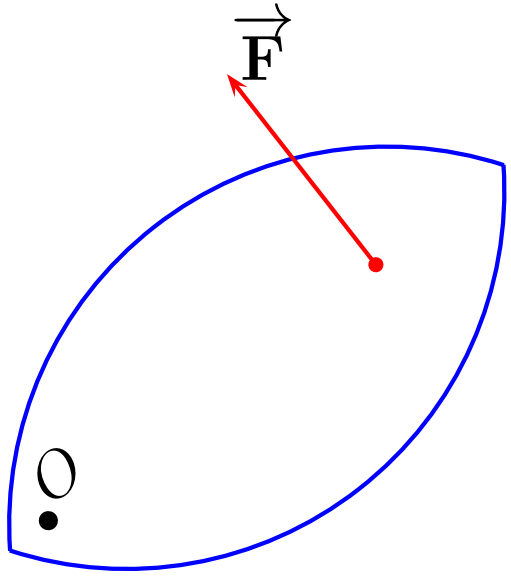

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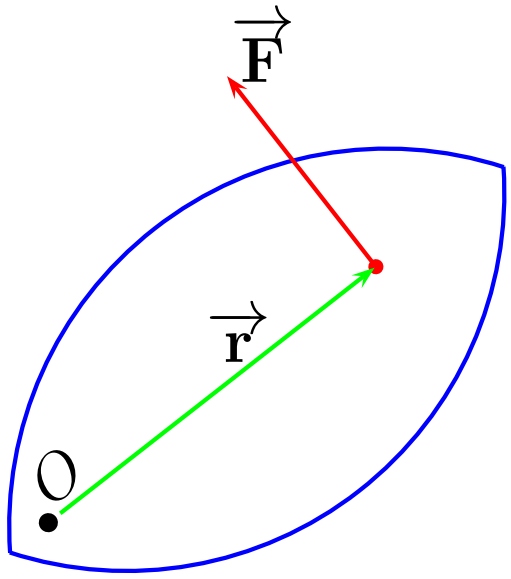

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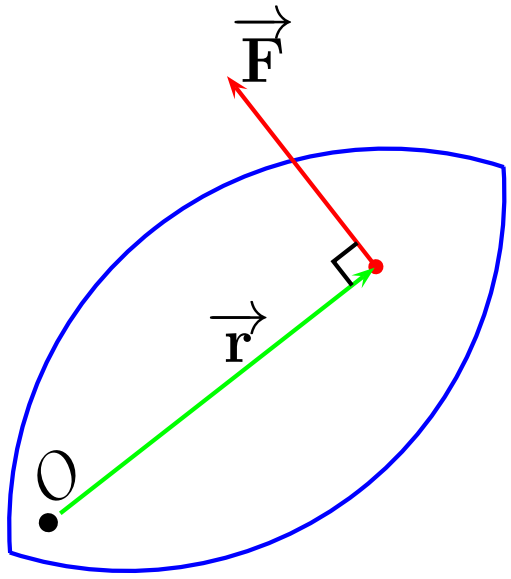

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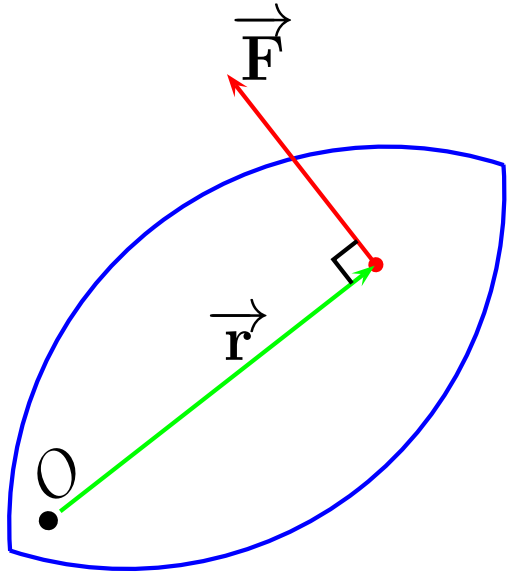

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When $\overrightarrow{\mathbf{r}}$ and $\overrightarrow{\mathbf{F}}$ are perpendicular:

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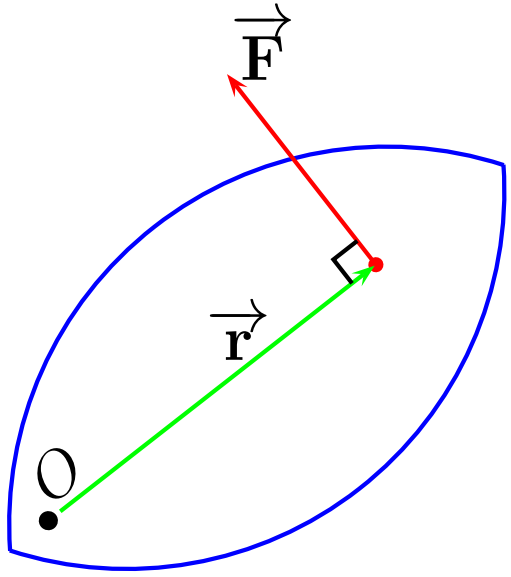

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$\tau = rF$ Unit: $N \cdot m$

Torque II

The direction of the force also determines the torque. When $\overrightarrow{\mathbf{F}}$ is not perpendicular to the lever arm ($\overrightarrow{\mathbf{r}}$), only the component of $\overrightarrow{\mathbf{F}}$ which is perpendicular to $\overrightarrow{\mathbf{r}}$ causes torque.

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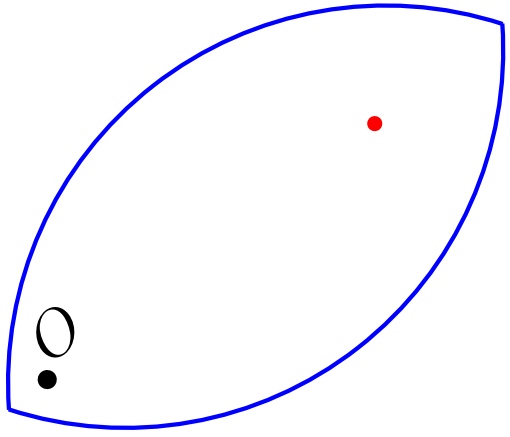

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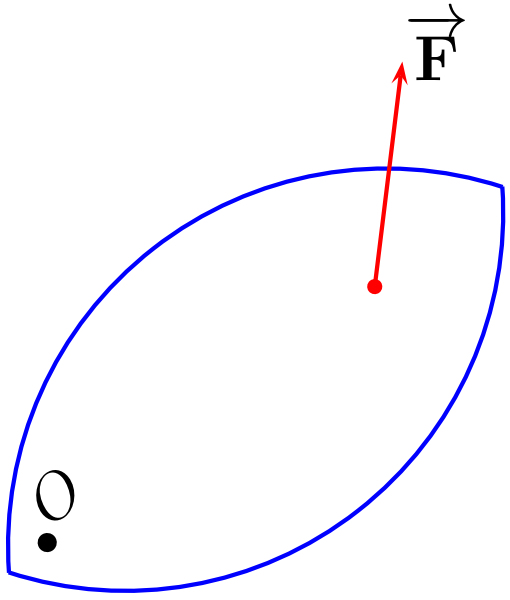

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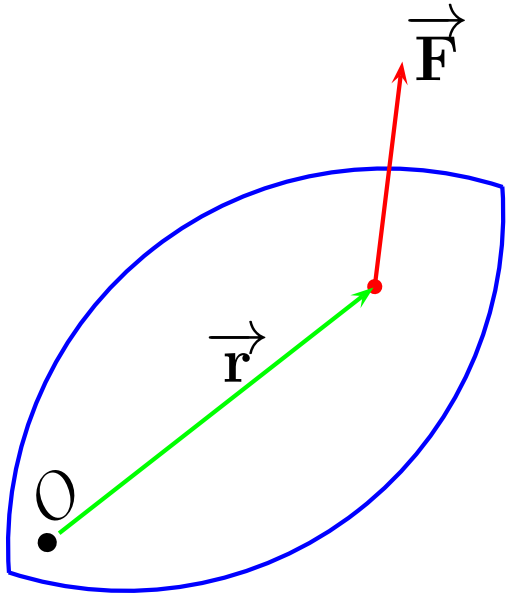

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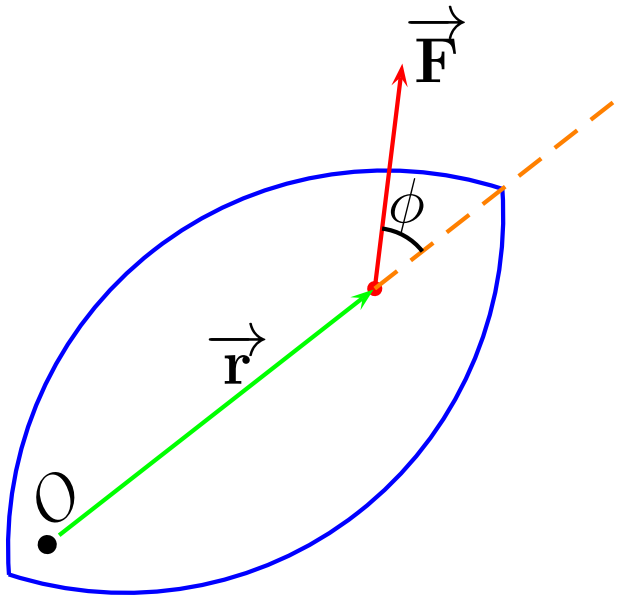

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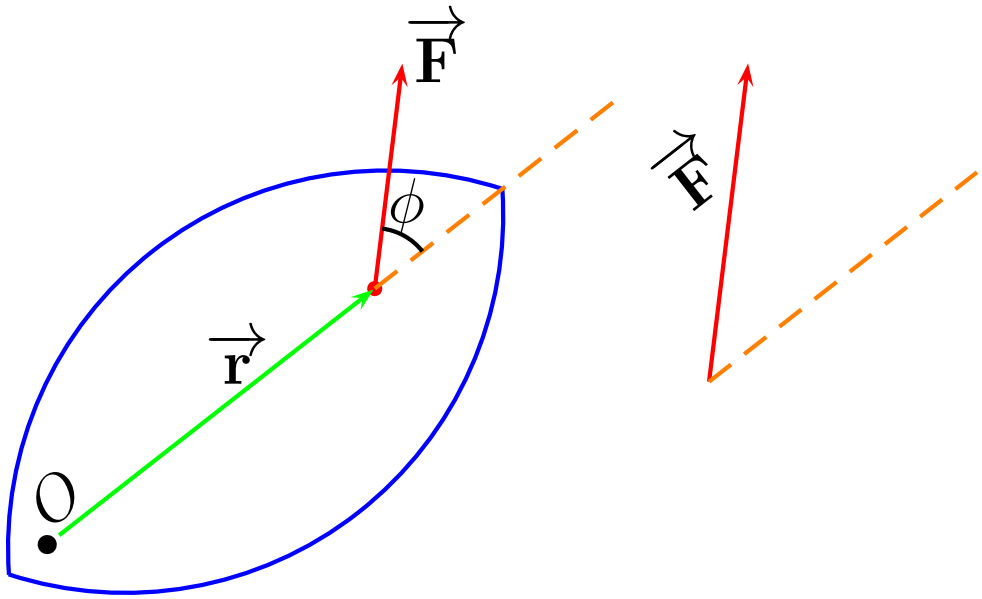

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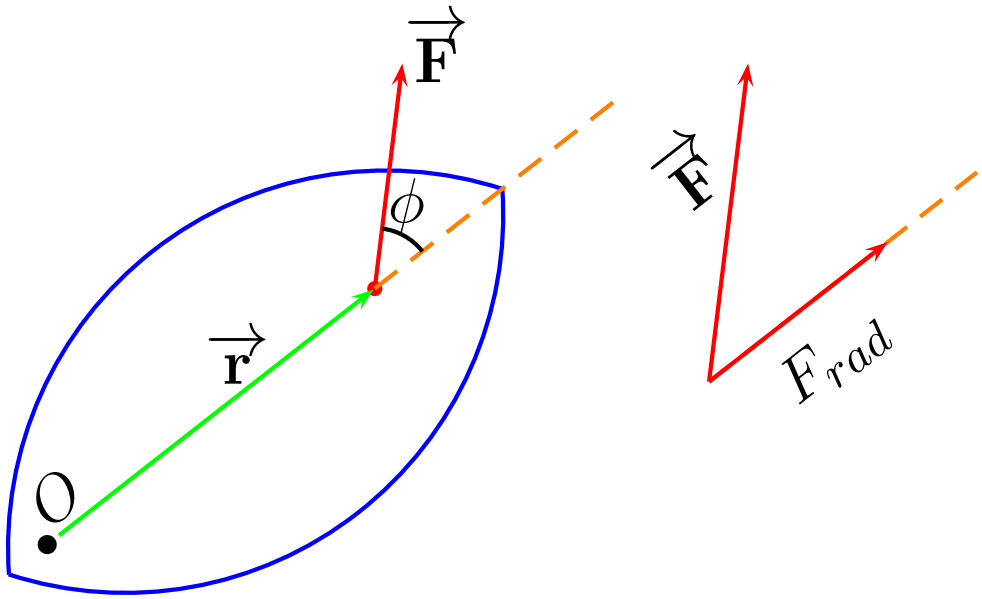

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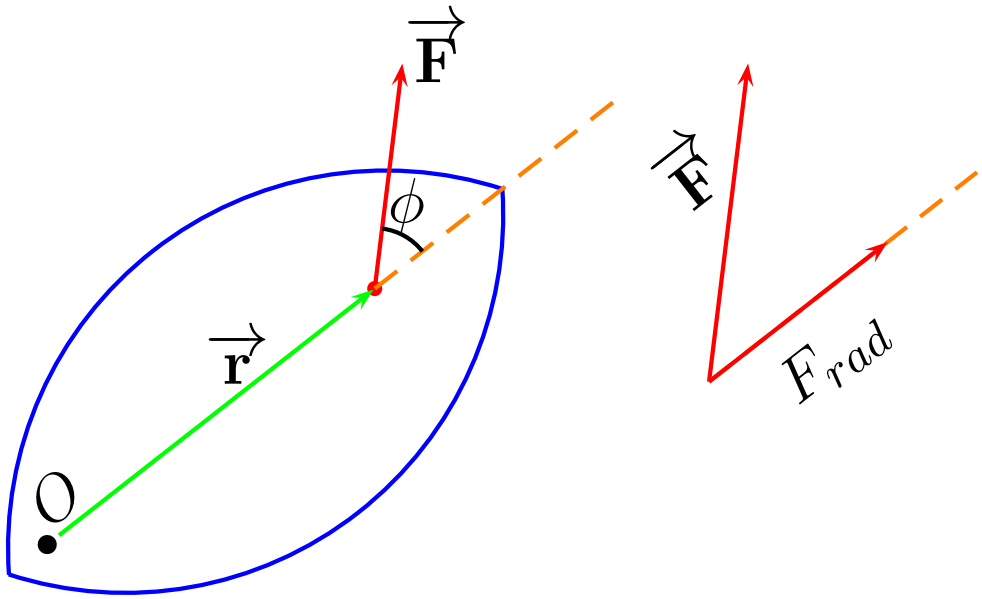

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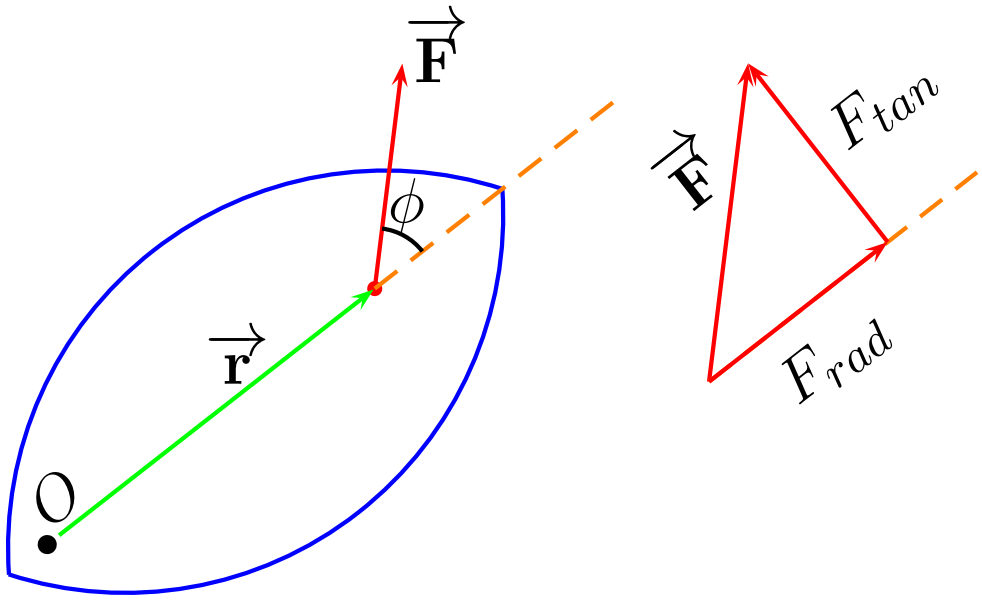

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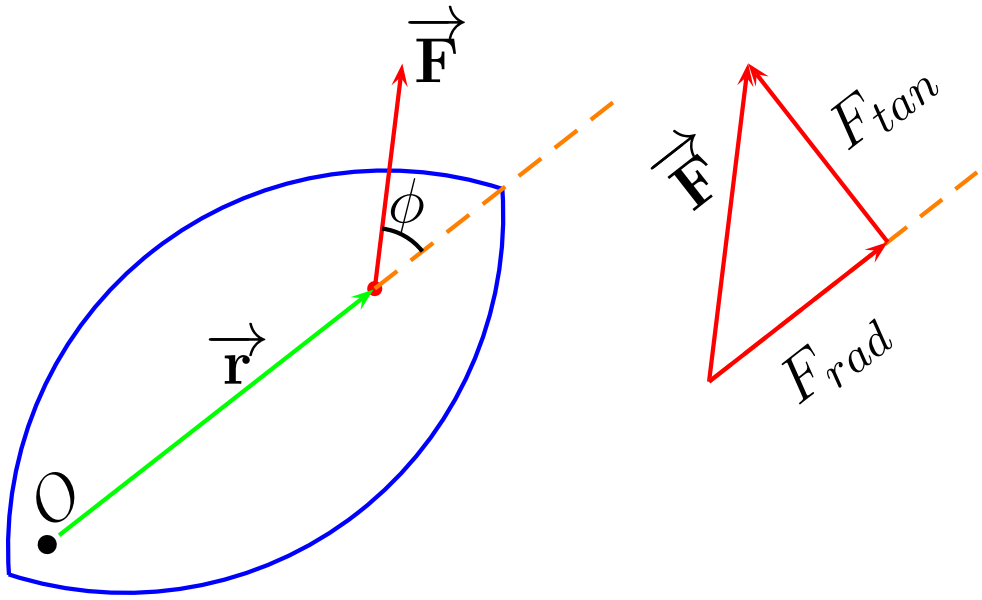

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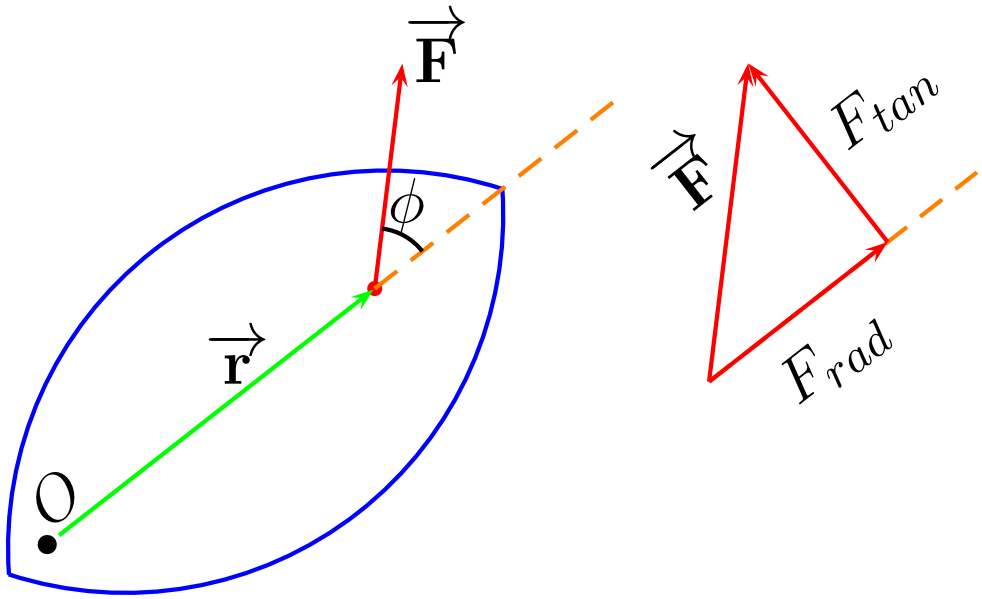

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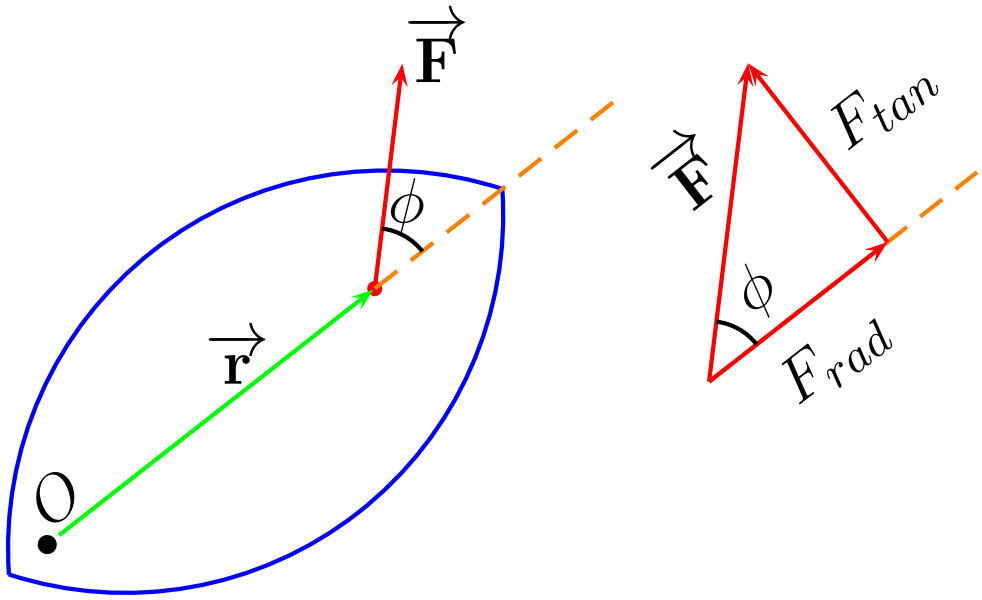

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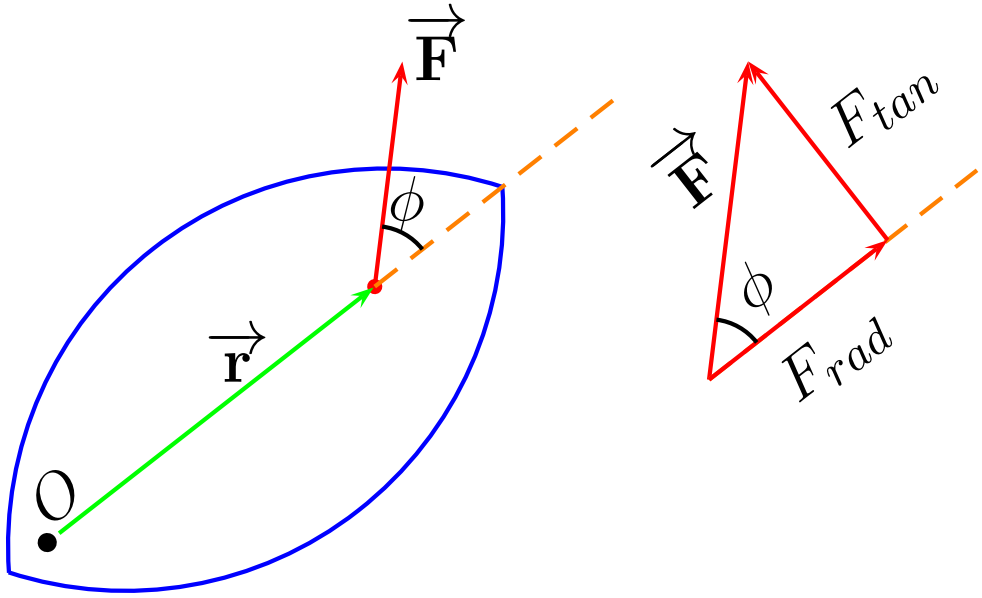

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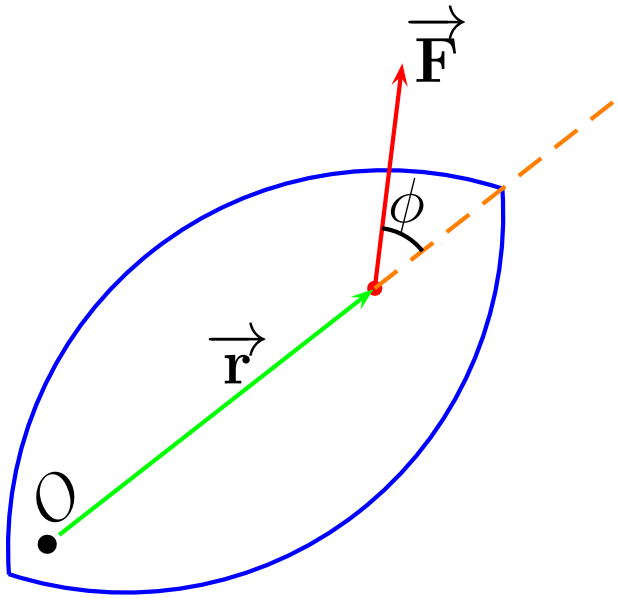
$$\tau = rF_{tan} = rF\sin\phi$$

Torque III

The direction of the torque is given by a cross product.



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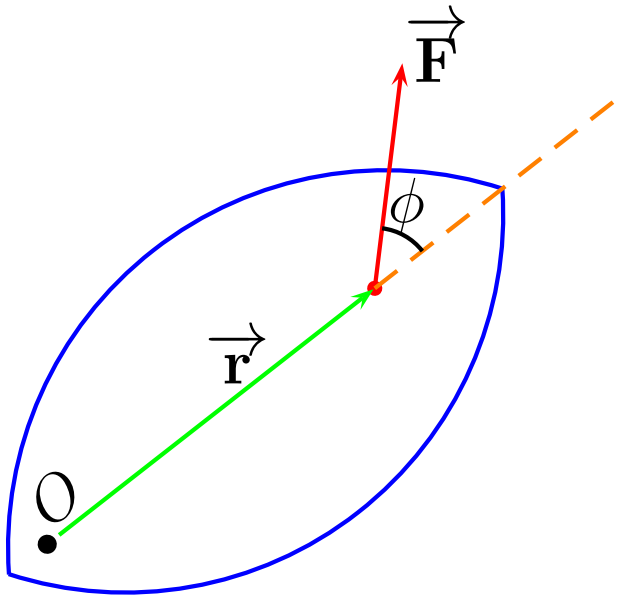

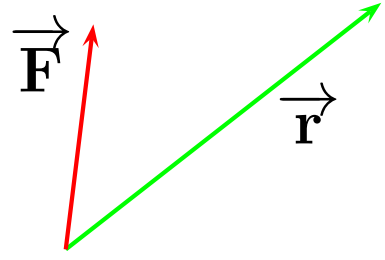

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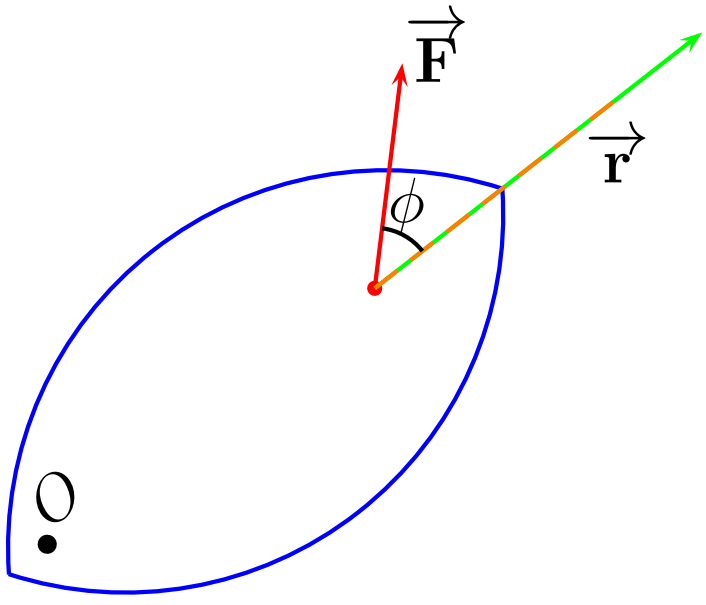

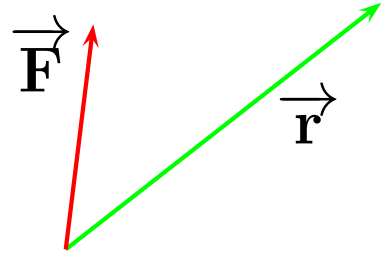

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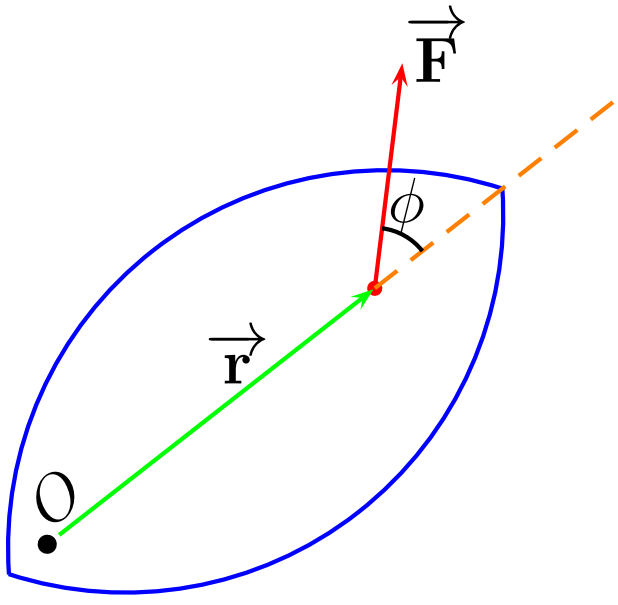

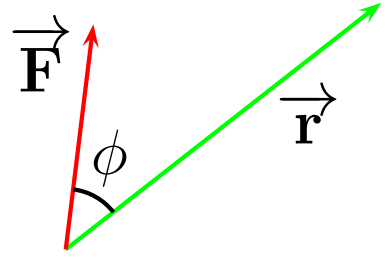

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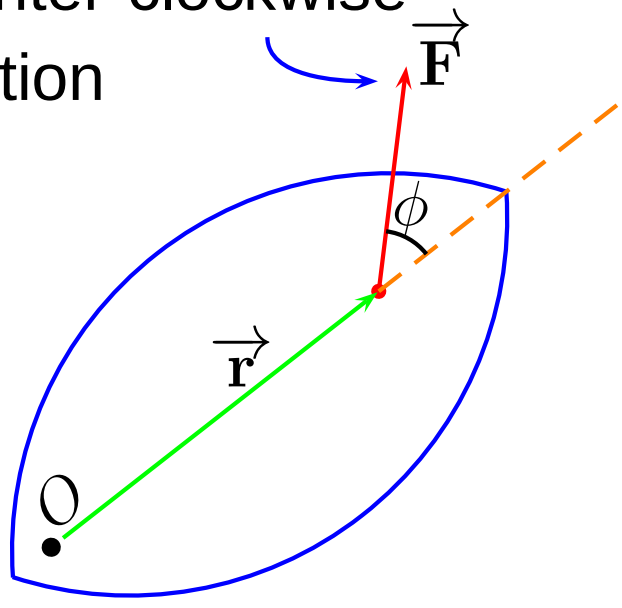
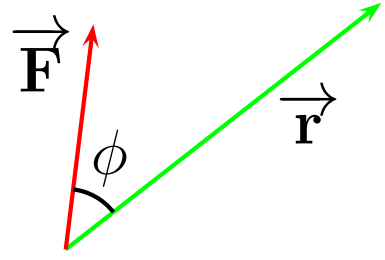
counter-clockwise rotation





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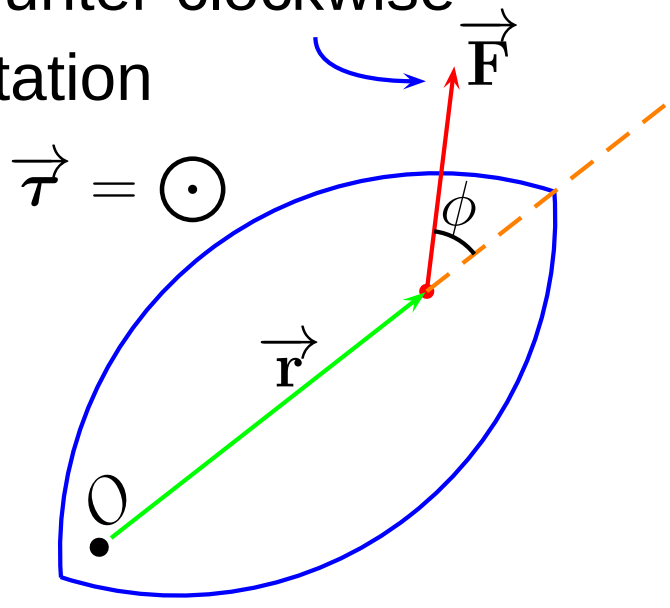

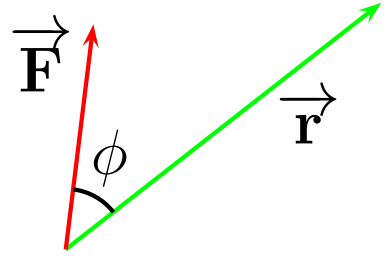

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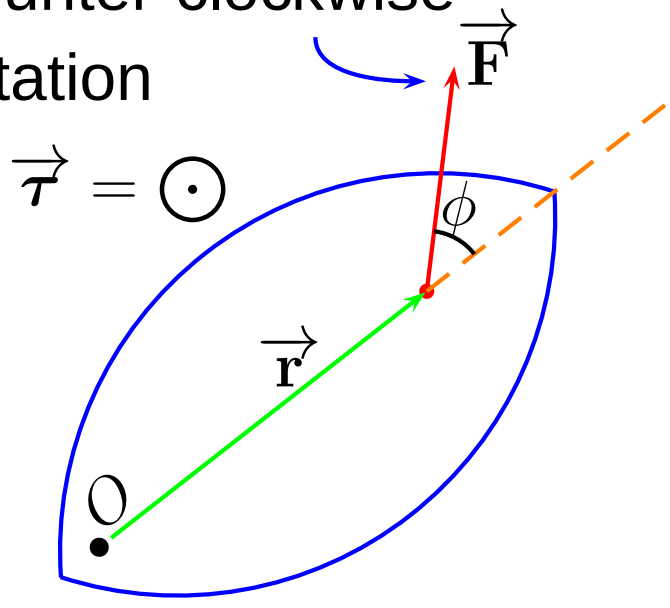

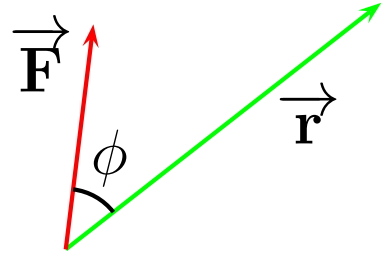

$$\vec{\tau} = \vec{\mathbf{r}} \times \vec{\mathbf{F}}$$

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

Clicker Quiz

Which of the following forces would cause a torque that is into the page ($\otimes$) about an axis passing through O?

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Which of the following forces would cause a torque that is into the page ($\otimes$) about an axis passing through O?

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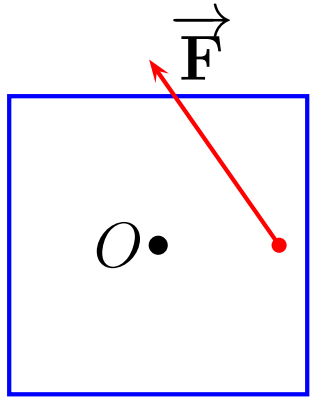

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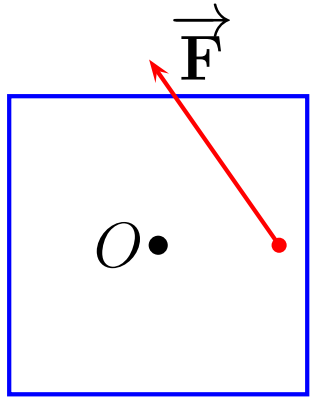

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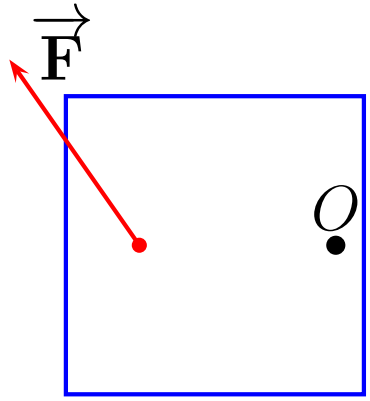

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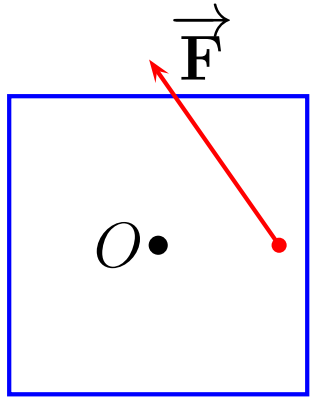

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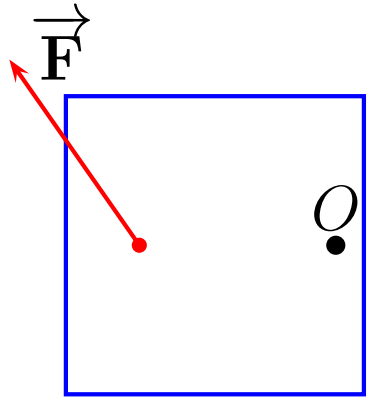

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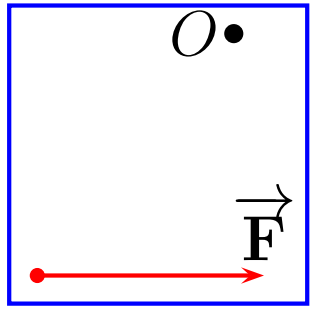

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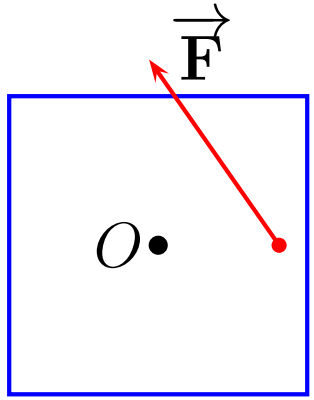

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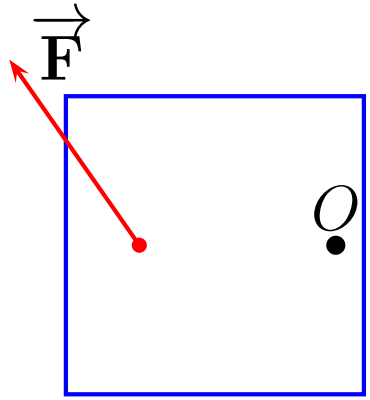

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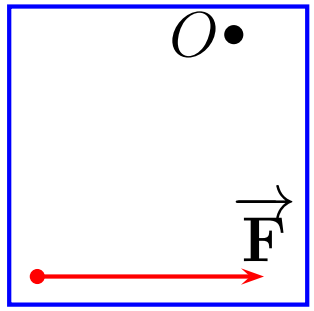

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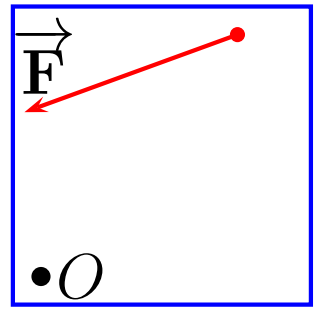

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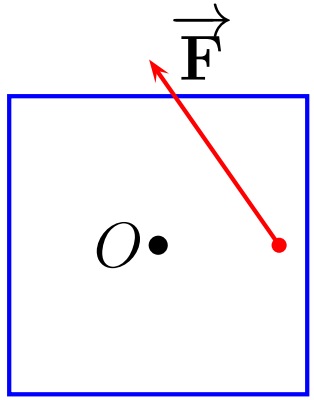
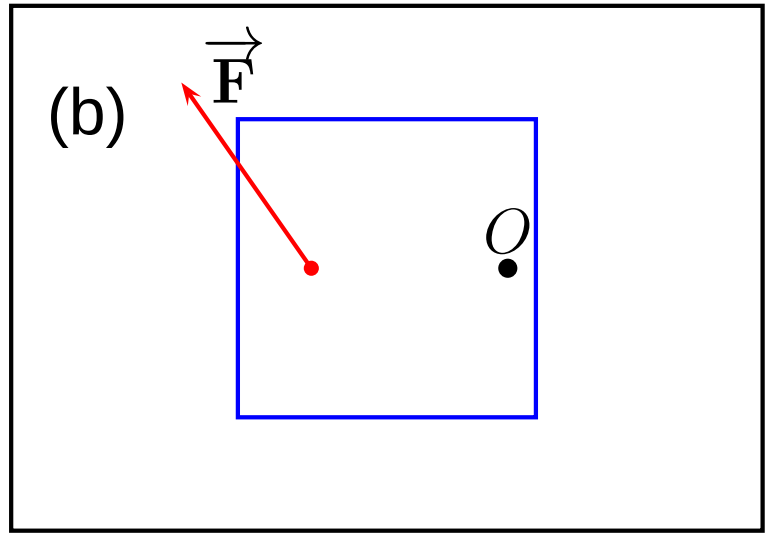
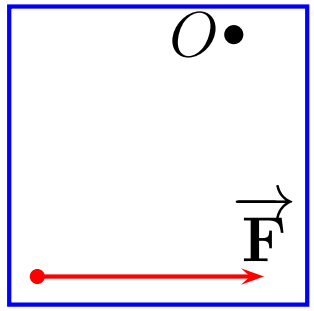


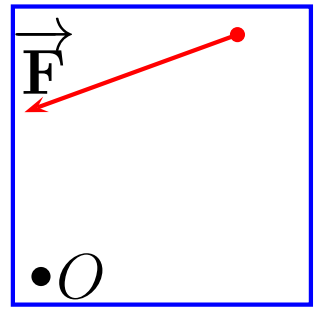
(b)



(c)



(d)



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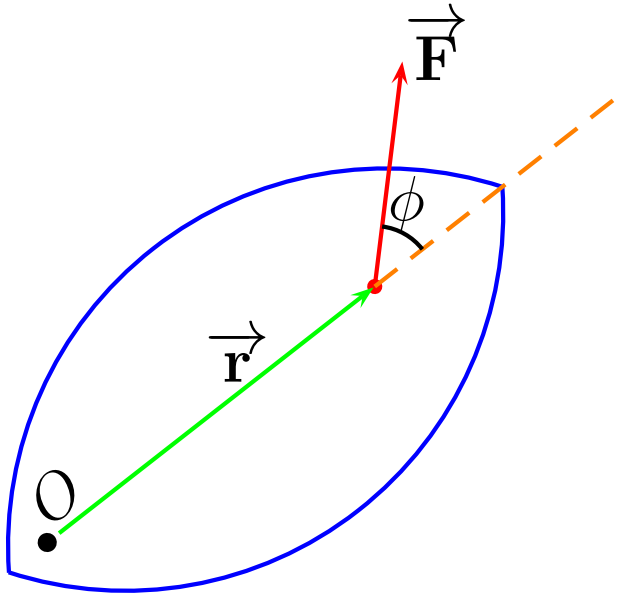

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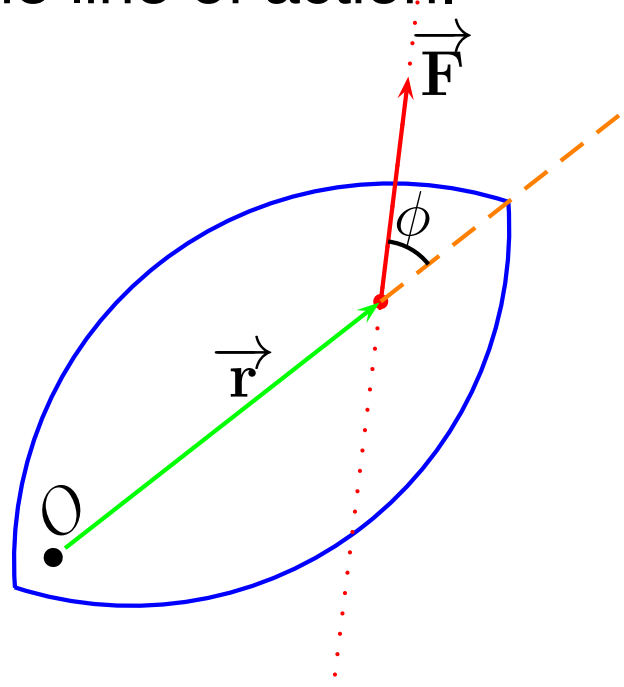

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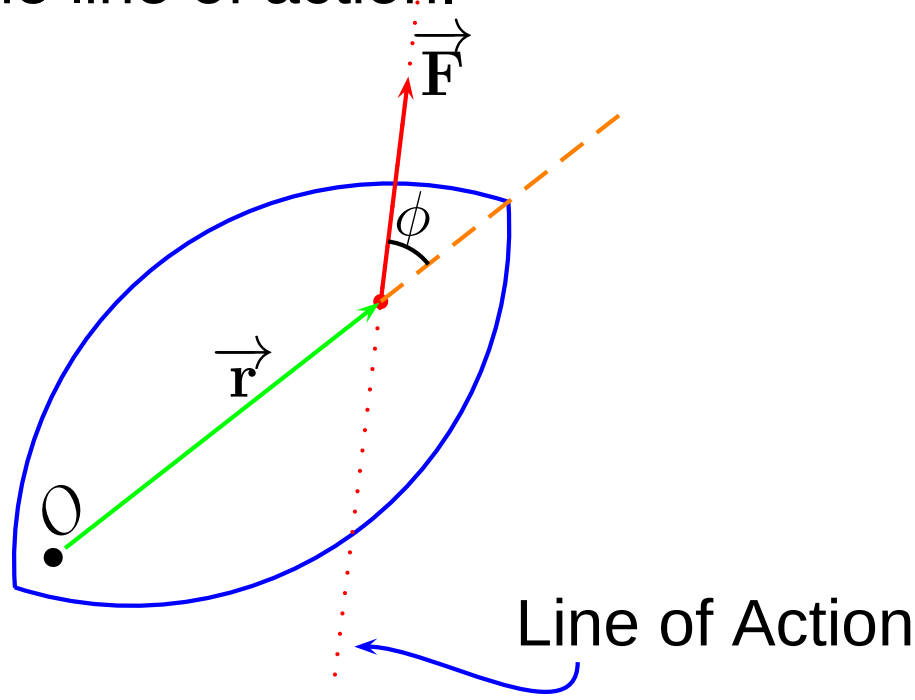

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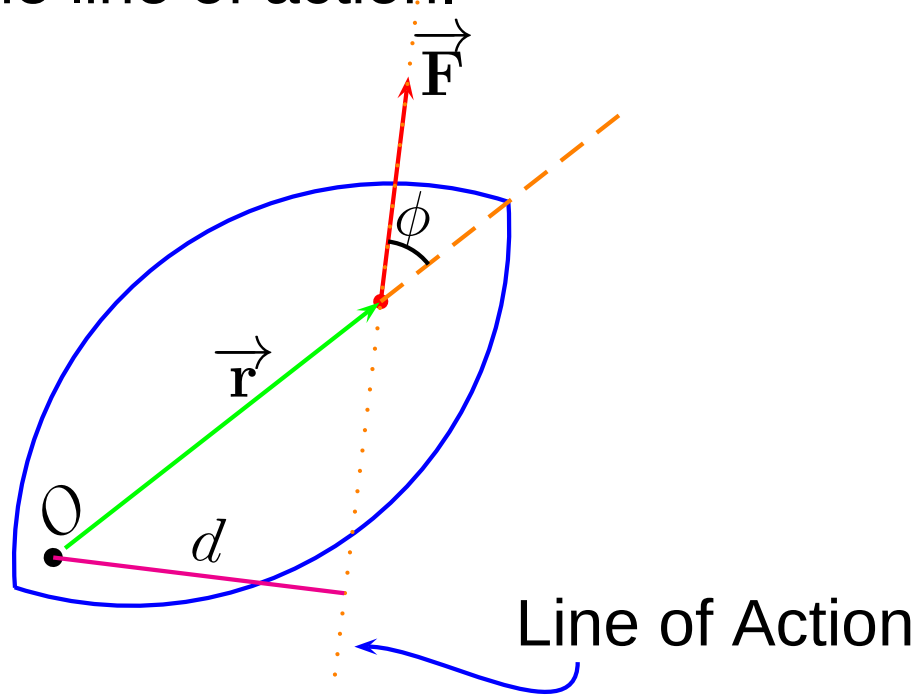

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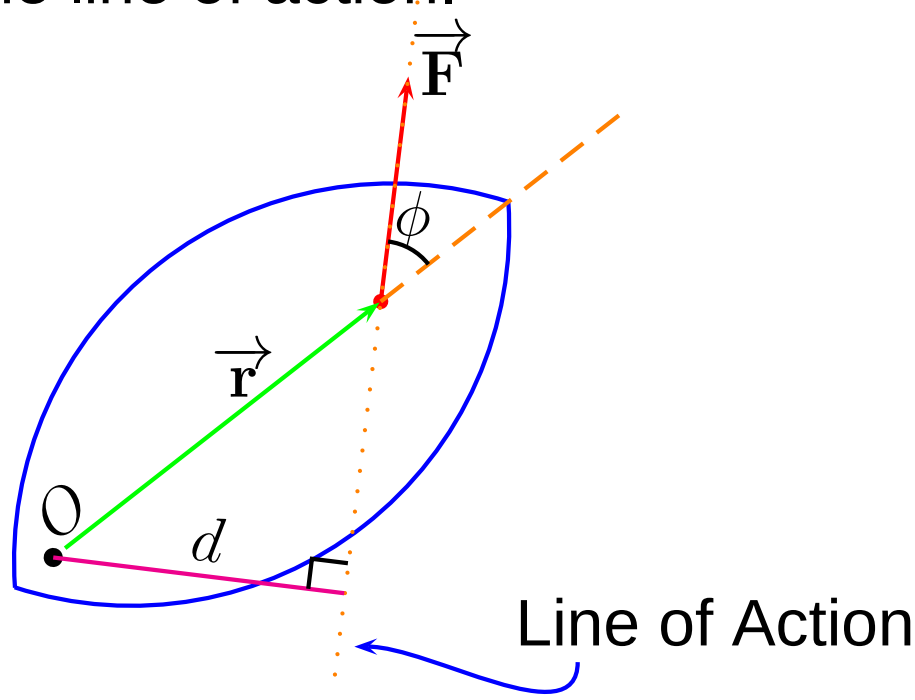

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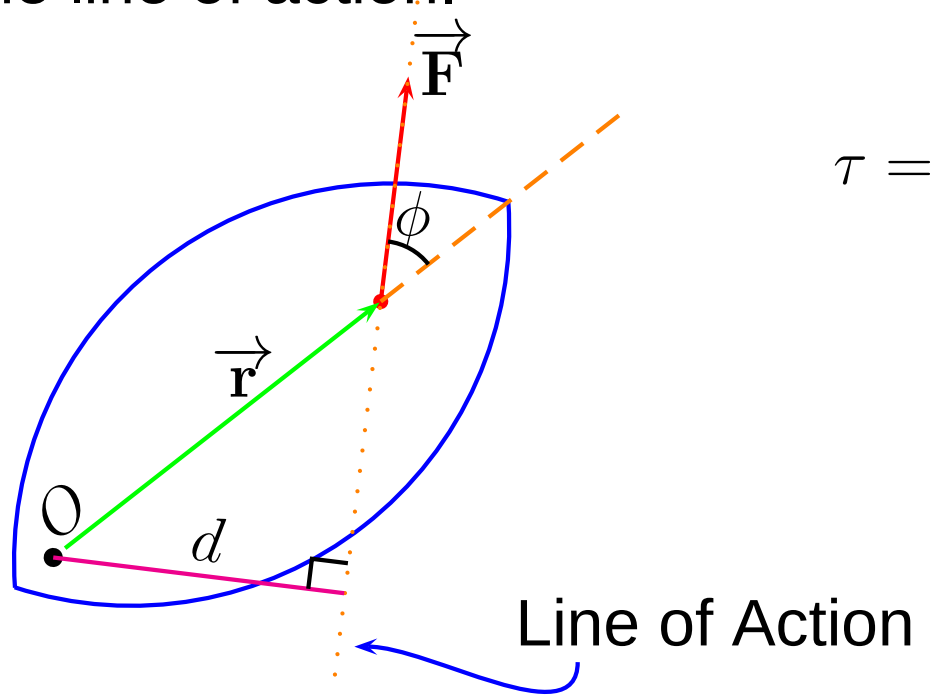

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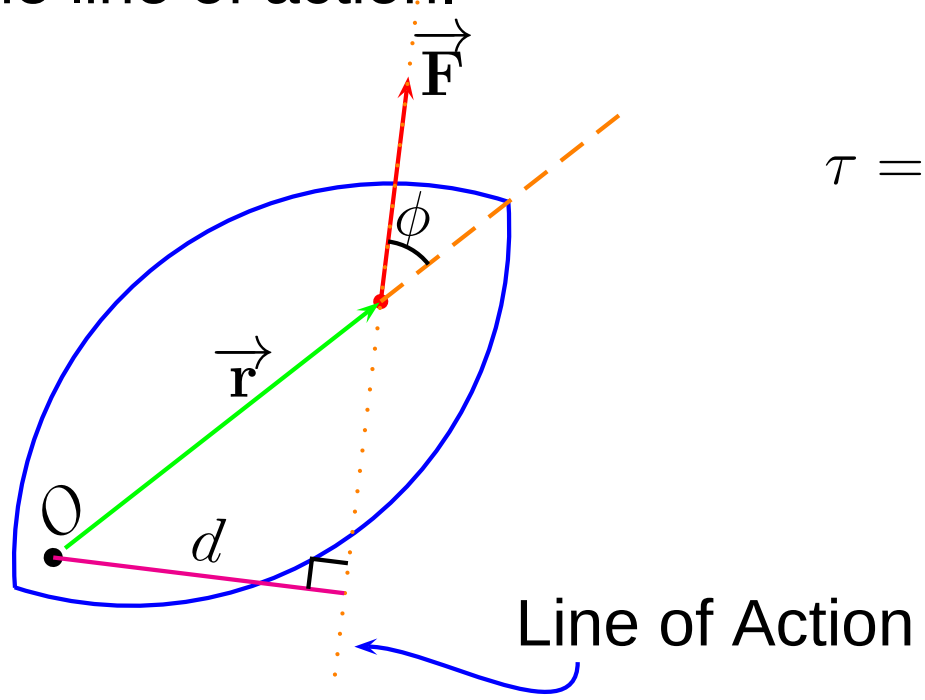

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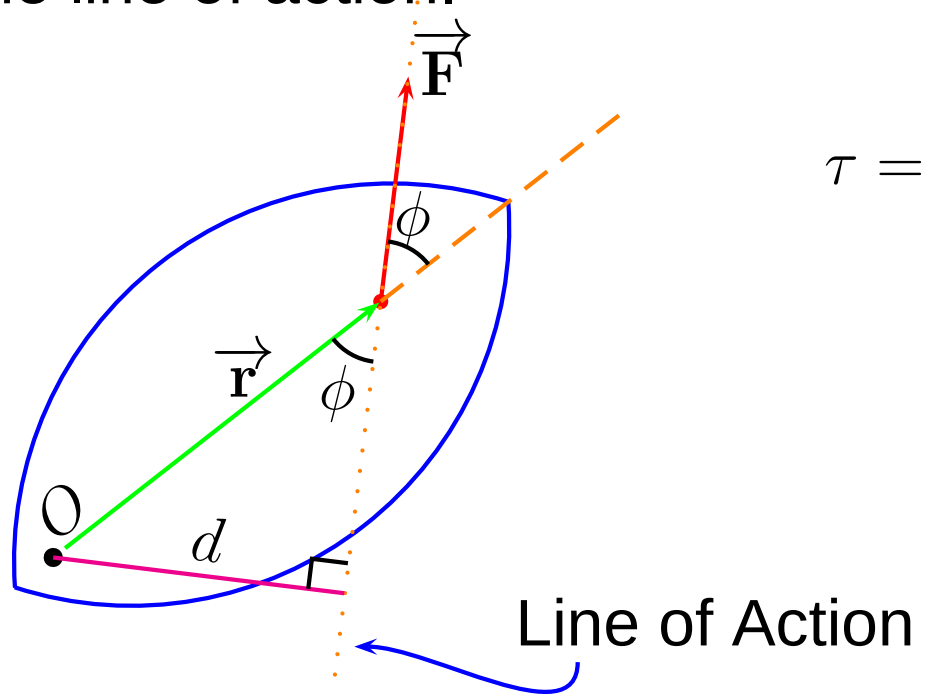

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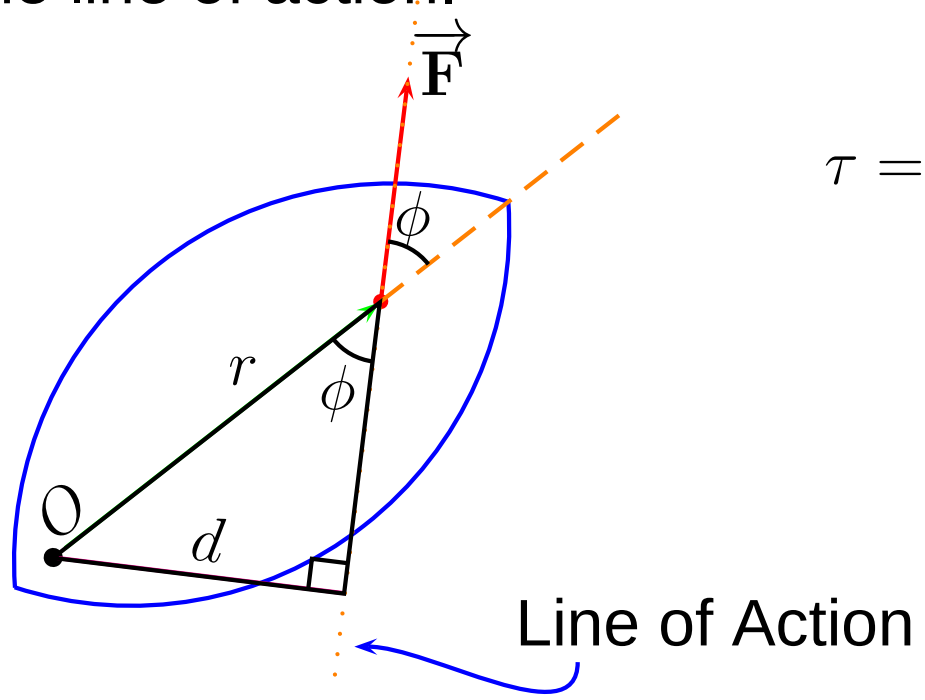

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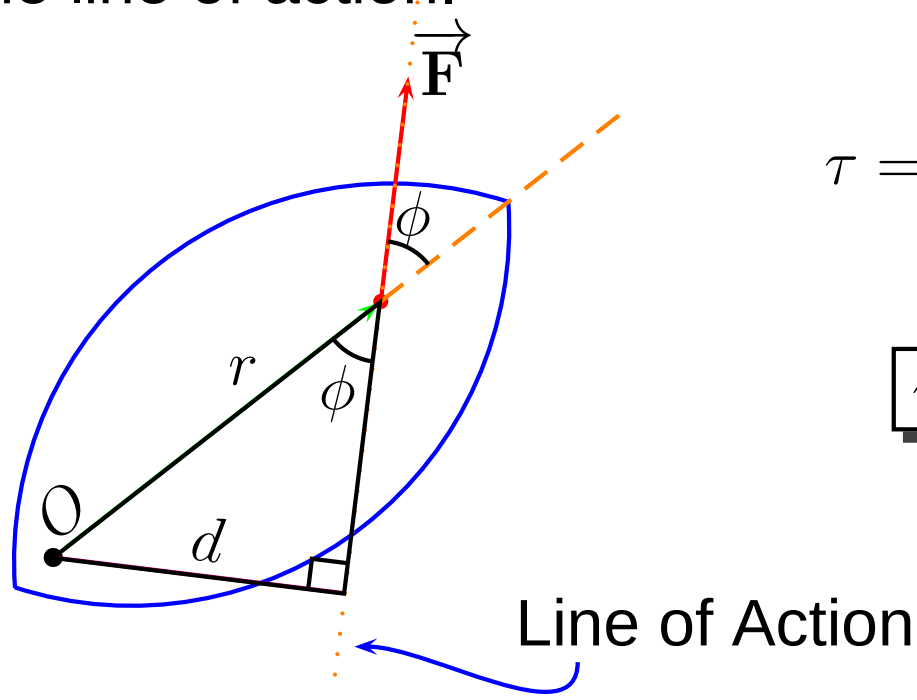

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$$\boxed{\tau = dF}$$

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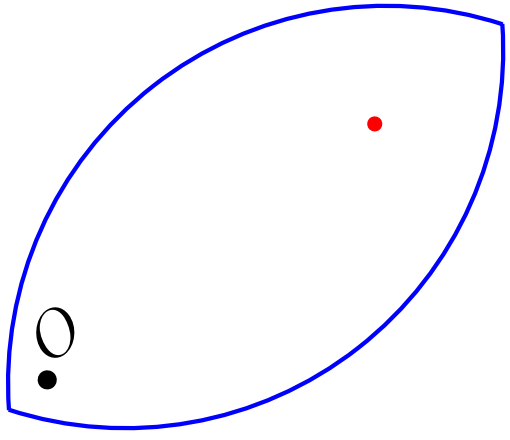

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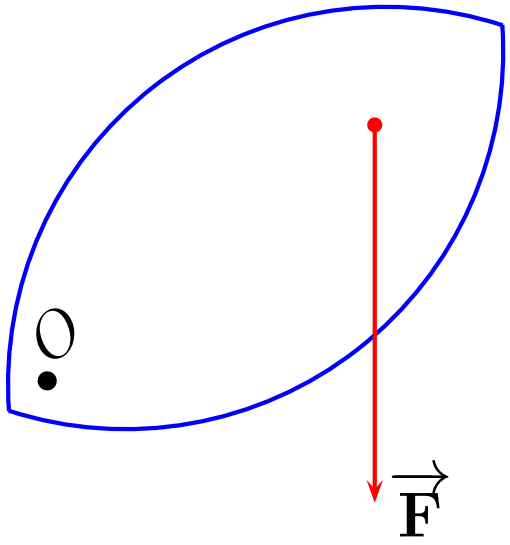

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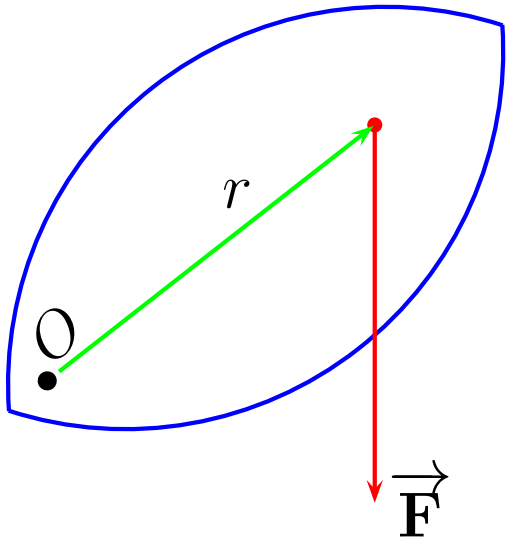

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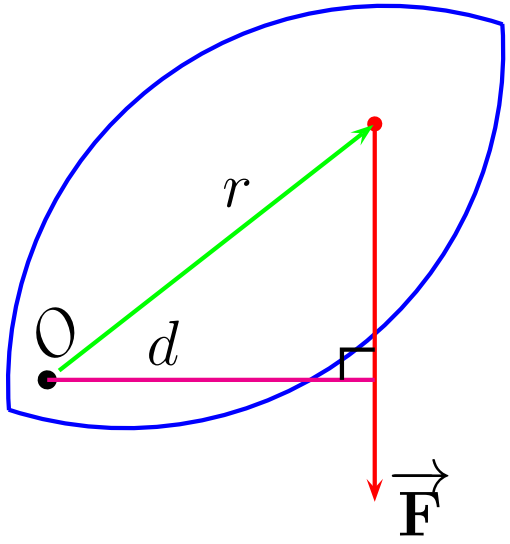

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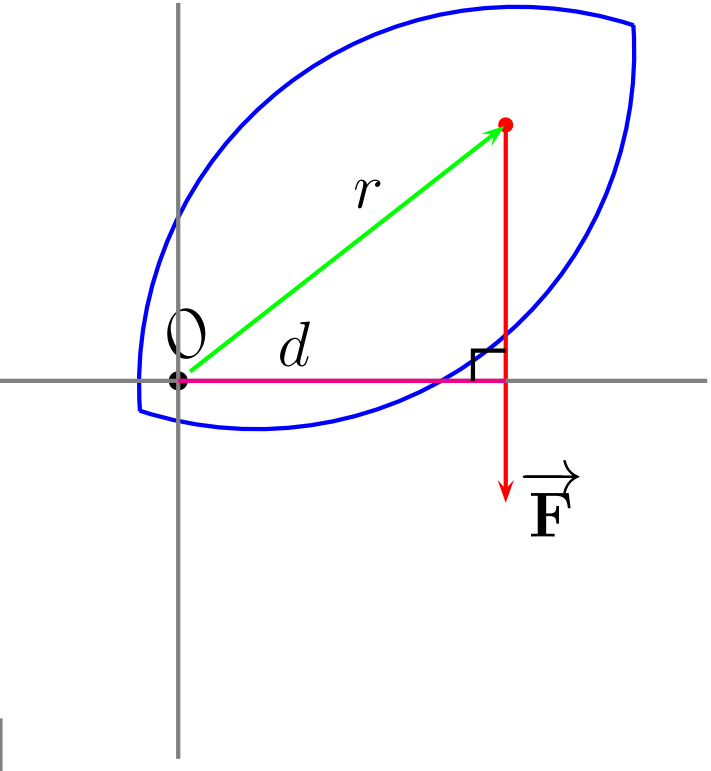

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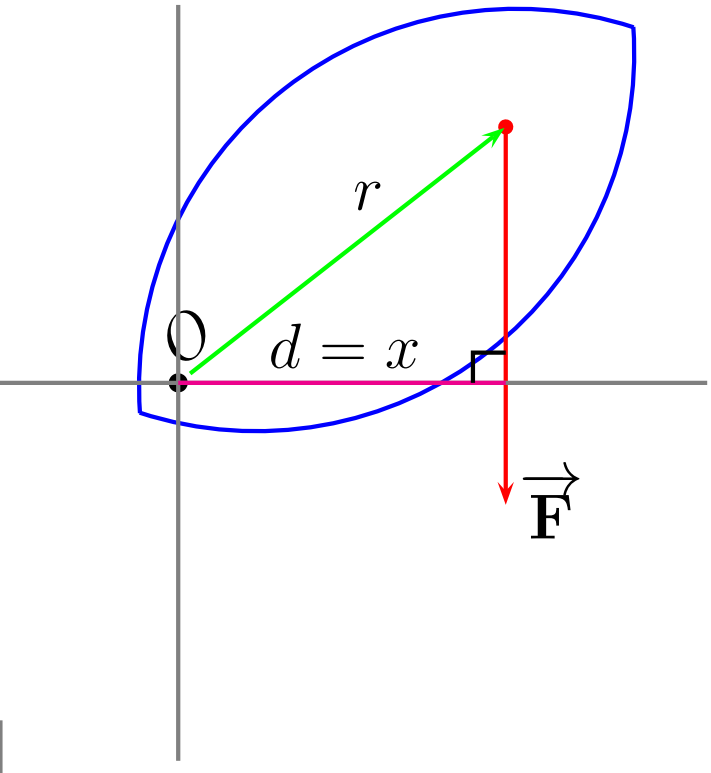

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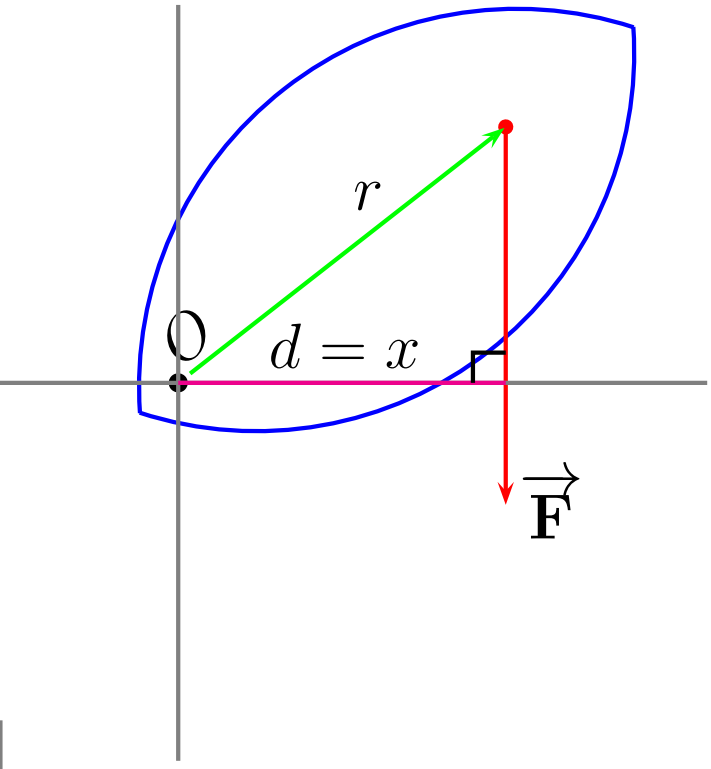

For vertical forces:

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

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.

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Example: A 30-kg child sits on the end of a 3-m long see-saw. Where must an 80-kg adult sit in order to keep the see-saw balanced at 30°?