April 11, Week 12

Today: Chapter 9, Rotational Energy

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

Test Scores:

C	Clicker Score	Since last Friday with 5 lowest scores dropped.
HW	Homework Average	Mastering Physics and written problems.
CA	Current Average	$\approx$ Your score going into the final if you don't take test #5.

Exam corrections due by start of class on Friday.

Review

The kinetic energy of a spinning object is given by:

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

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The moment of inertia tells us how “hard" it is to make an object rotate.

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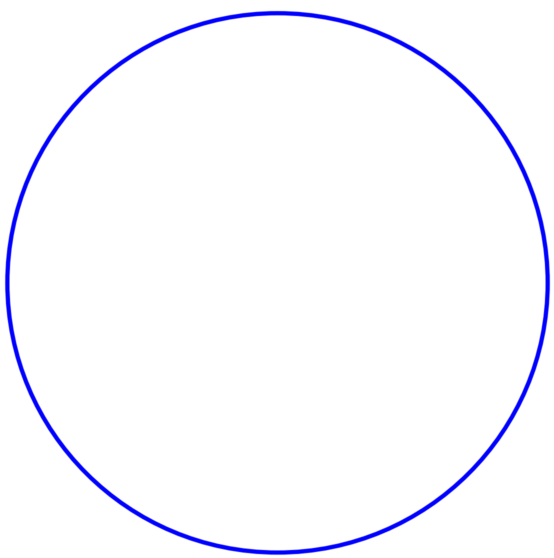

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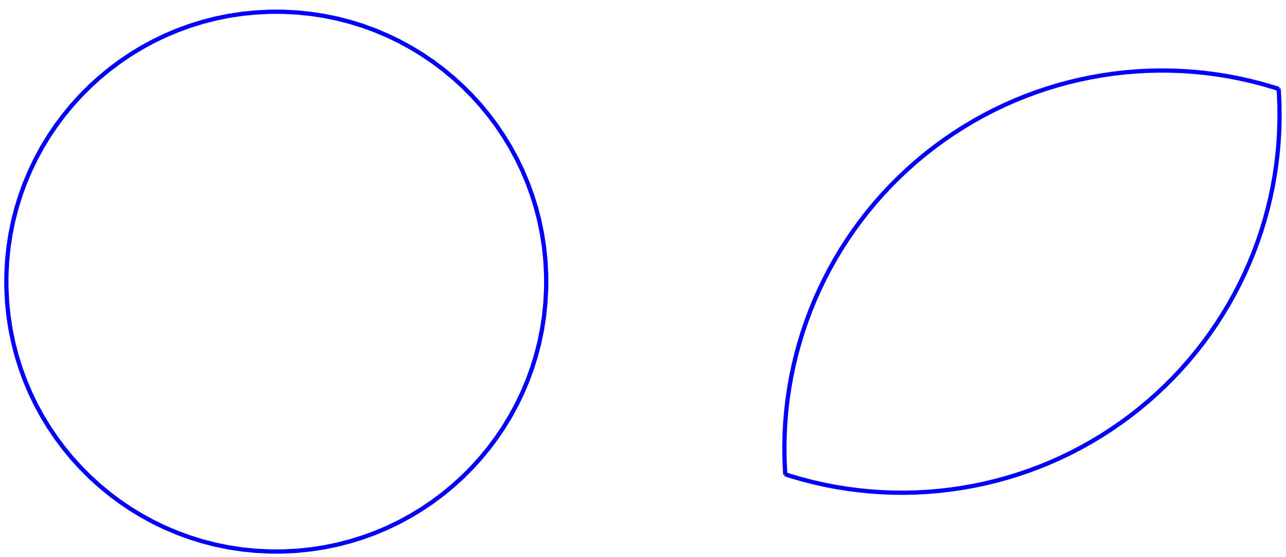

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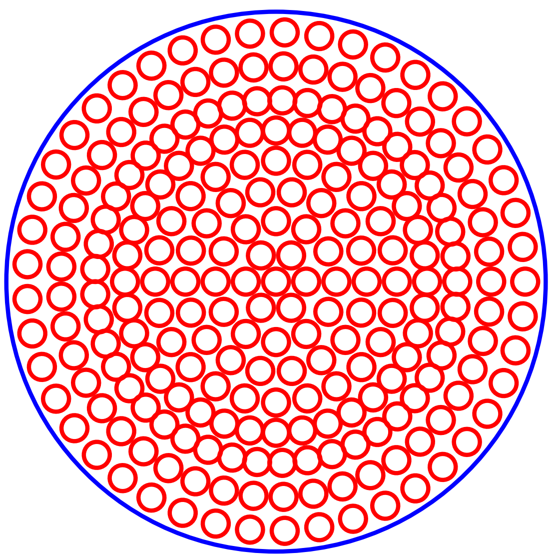

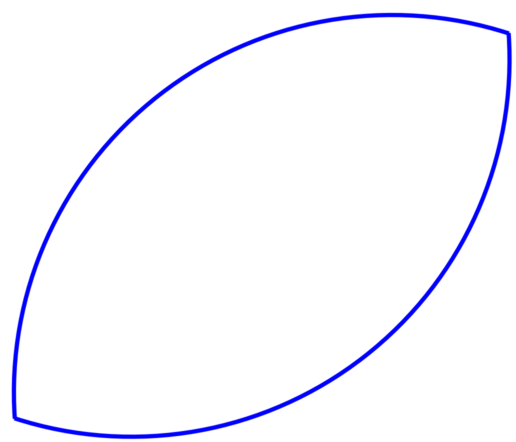

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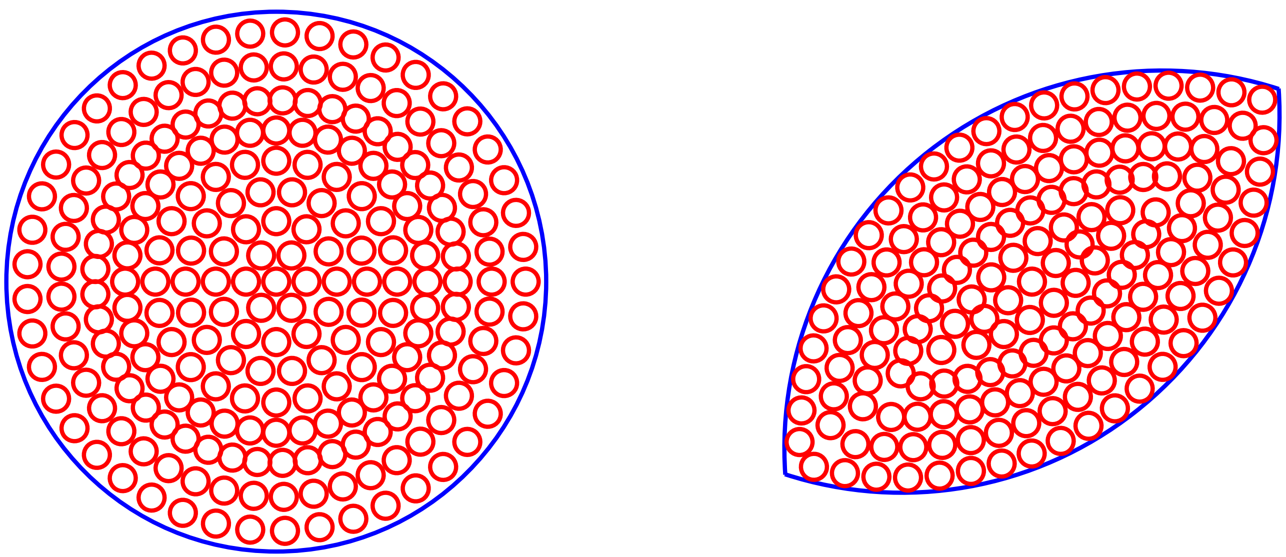

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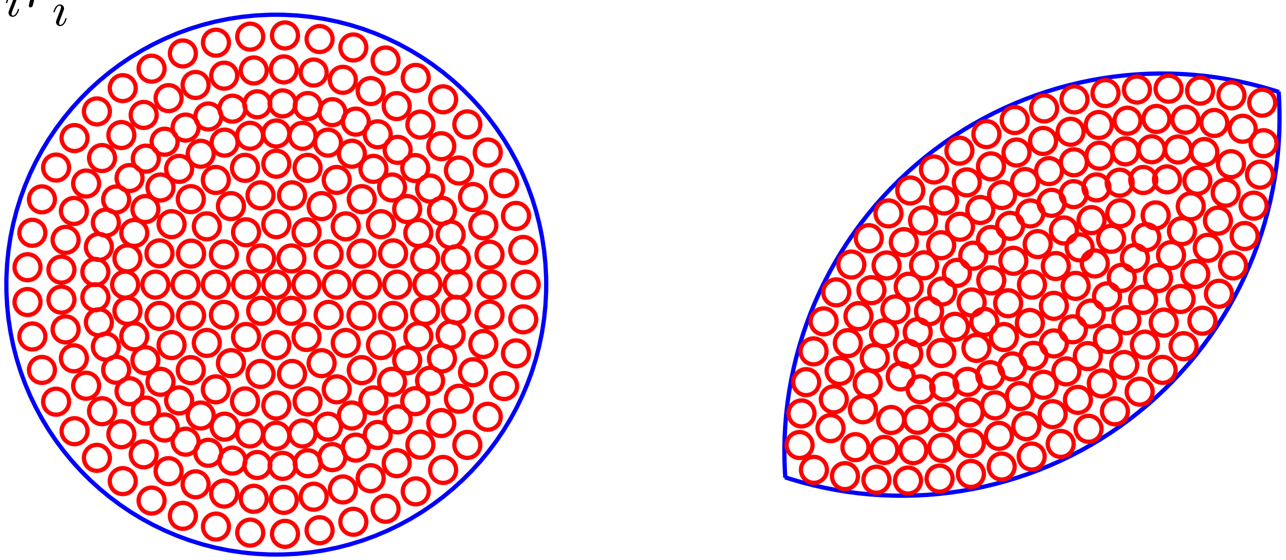

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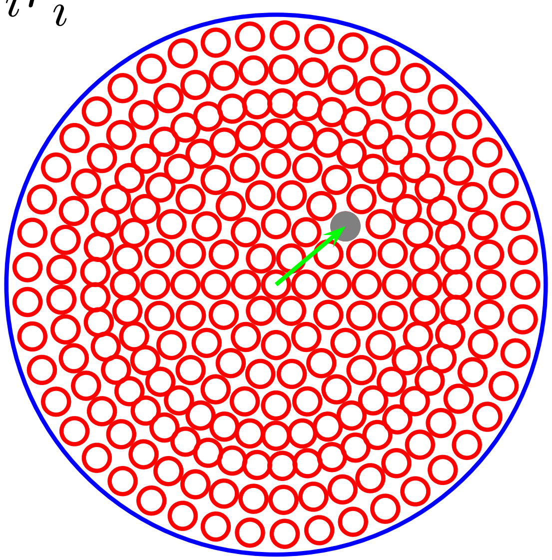

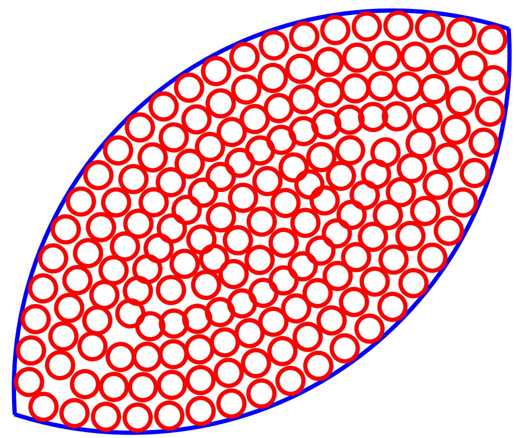

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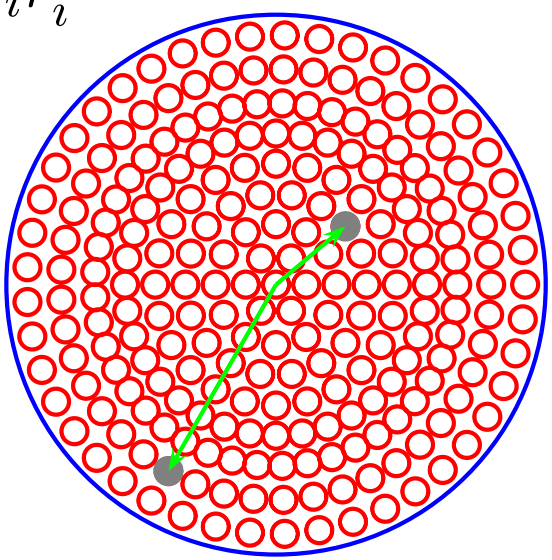

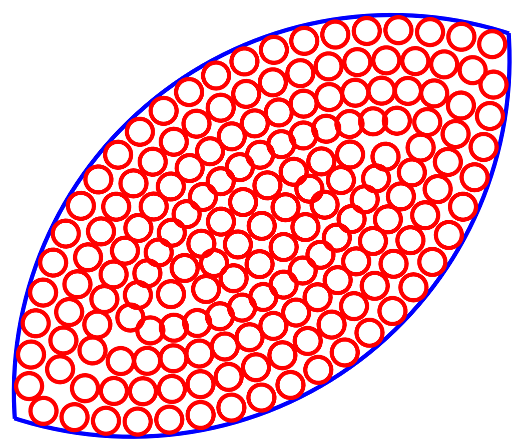

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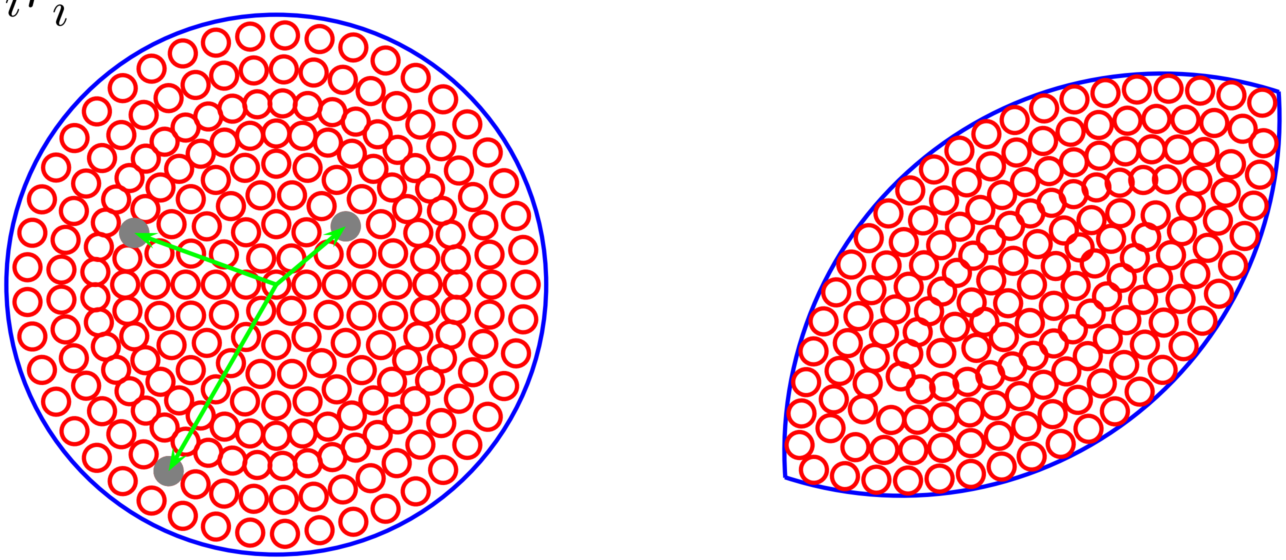

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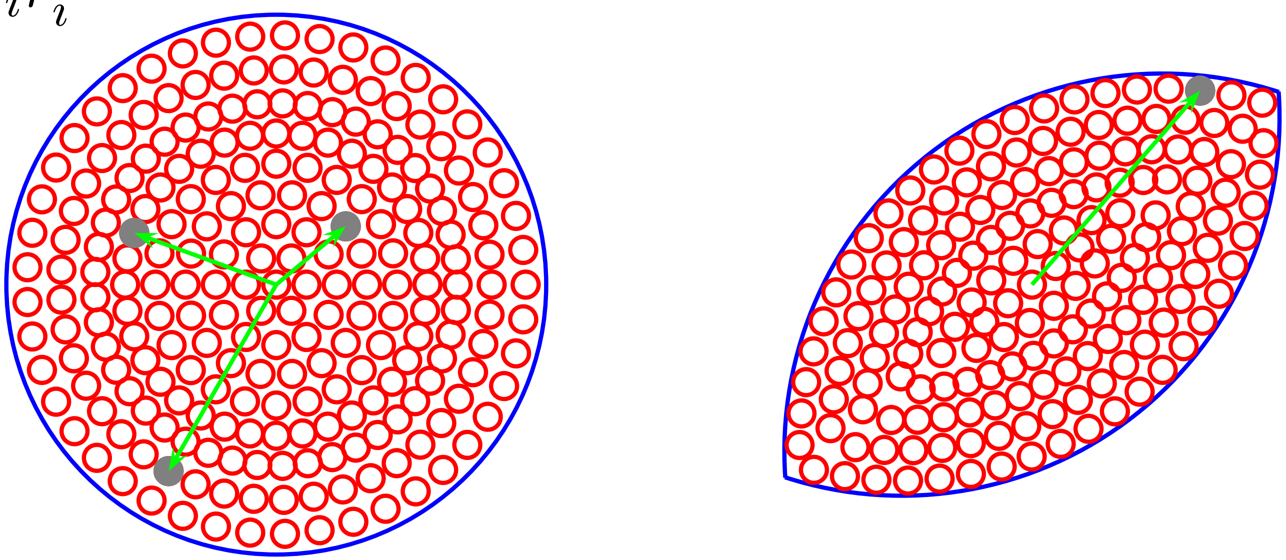

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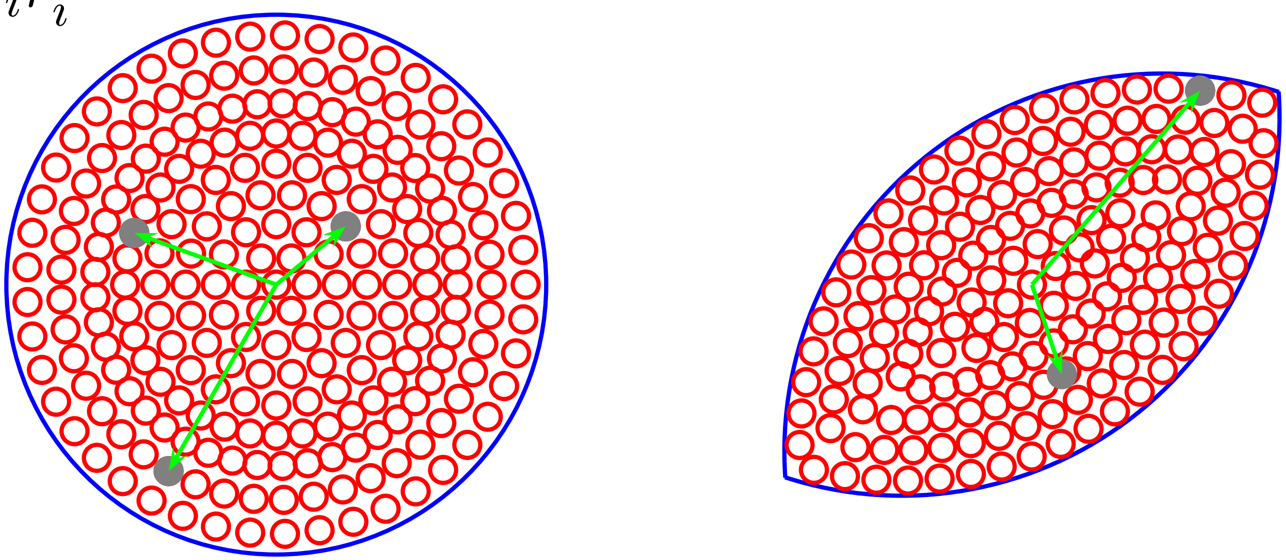

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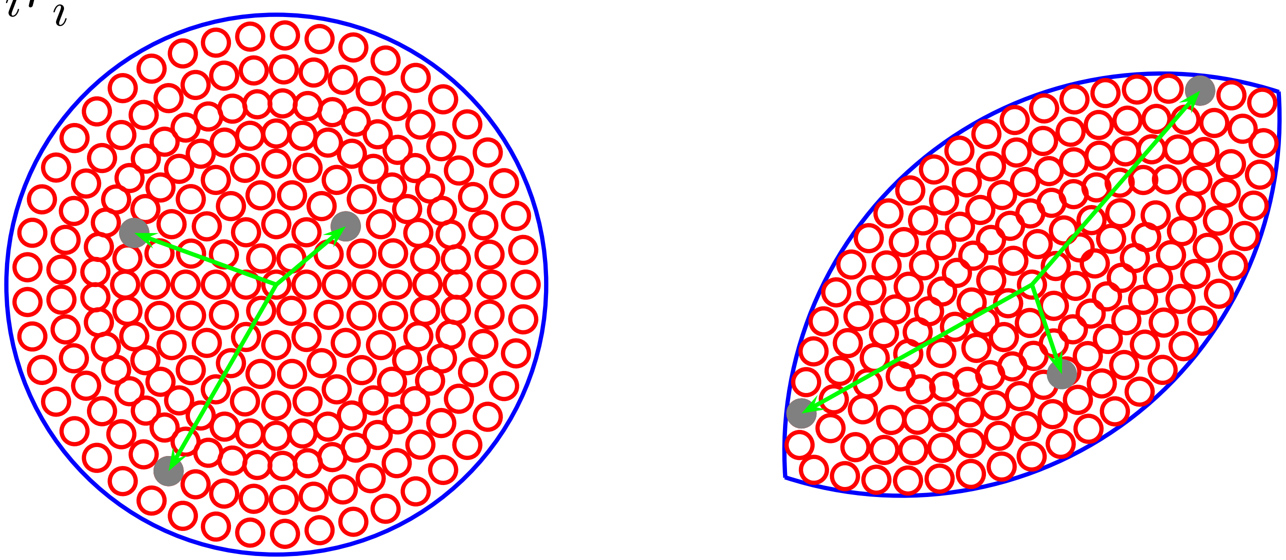

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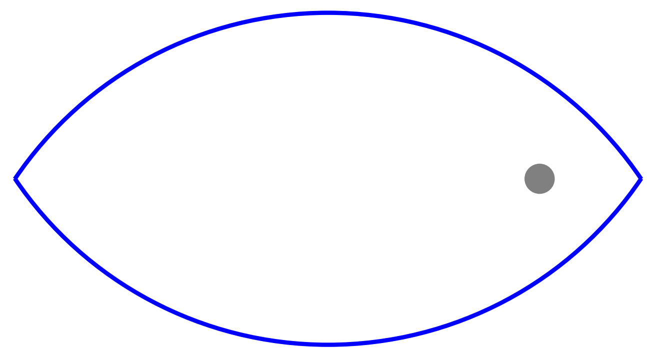

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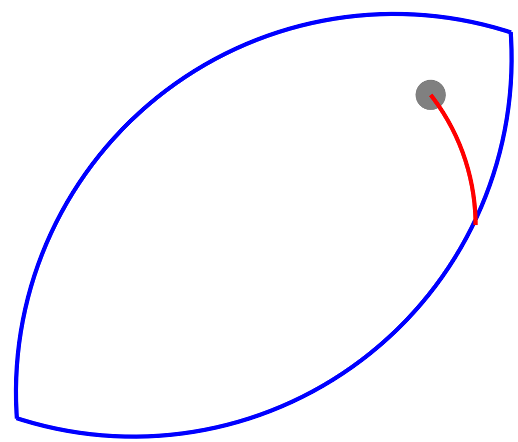

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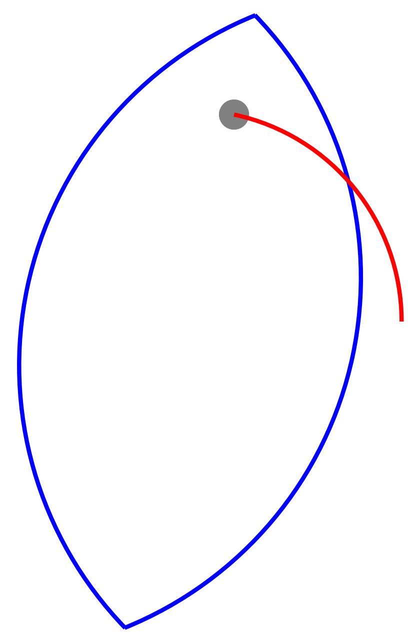

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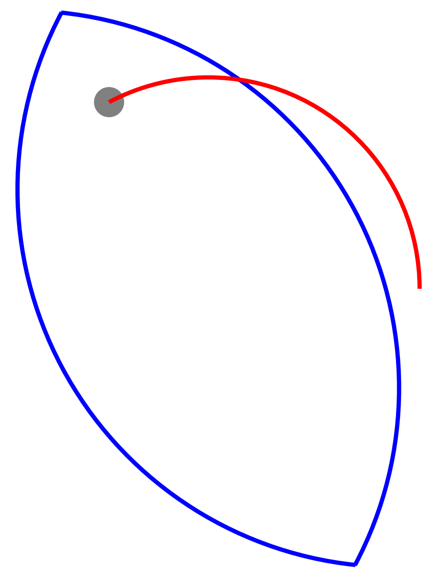

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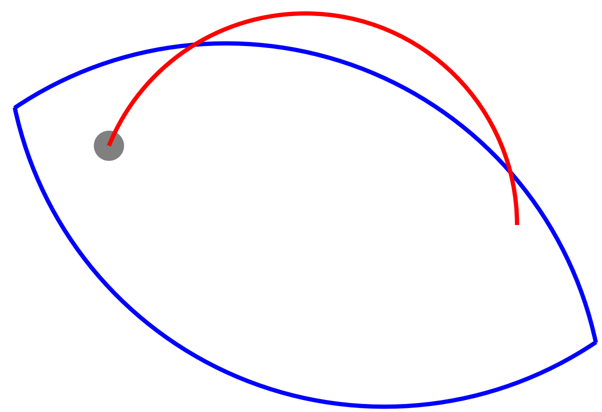

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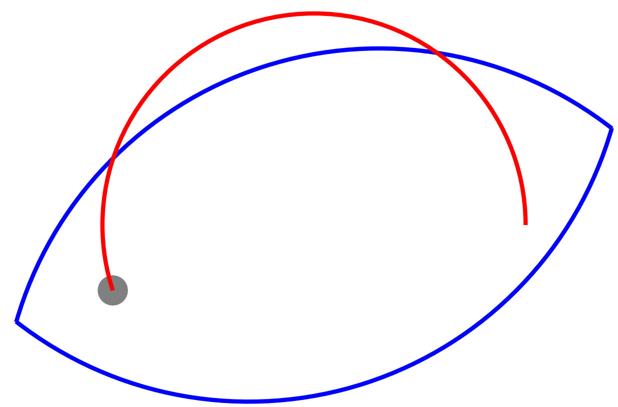

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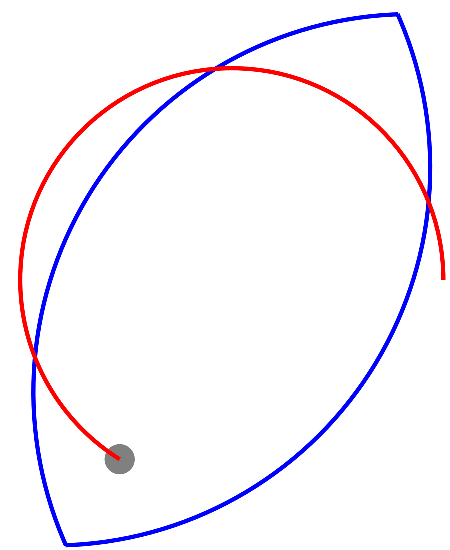

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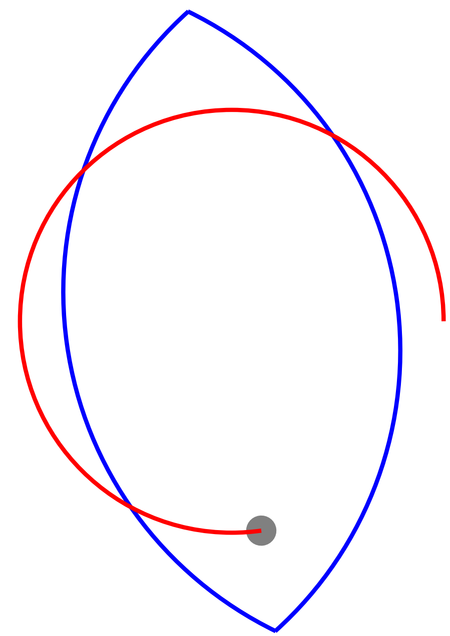

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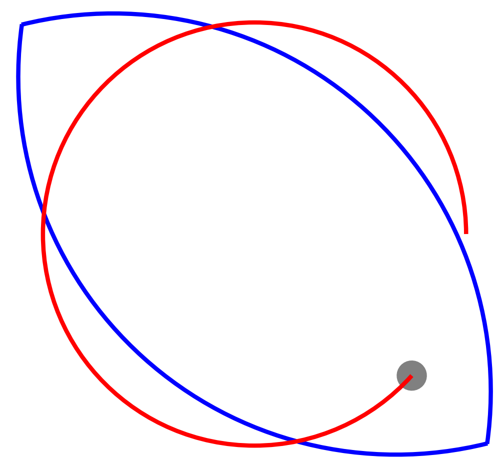

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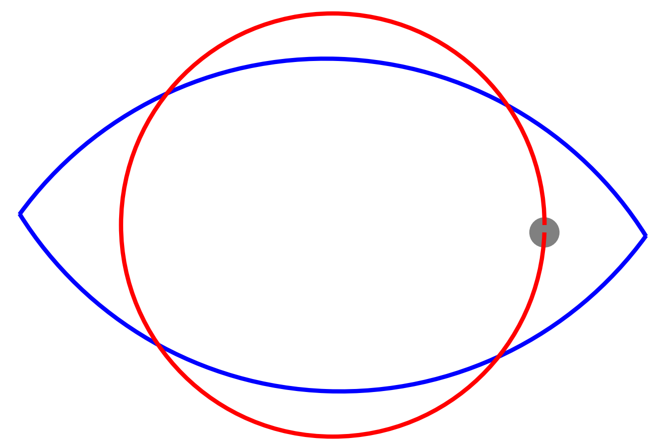

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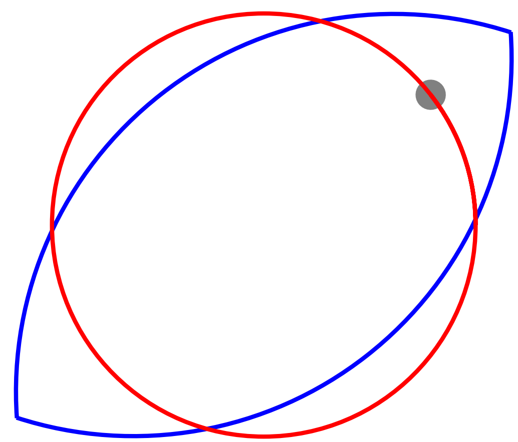

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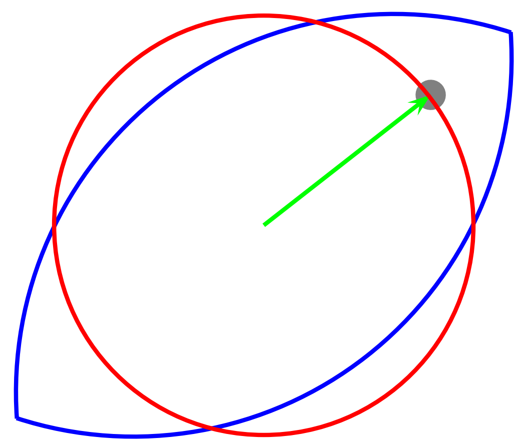

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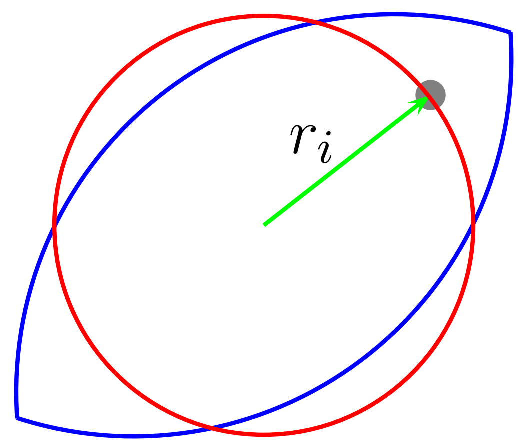

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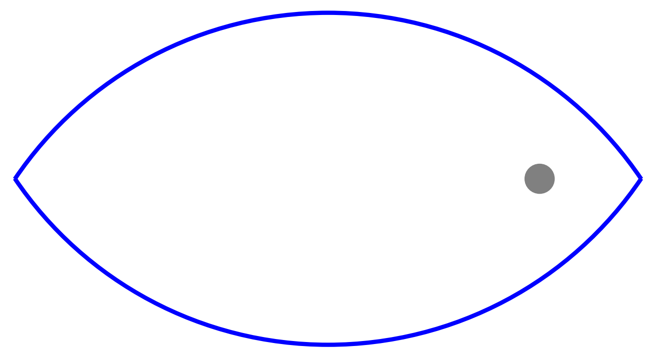

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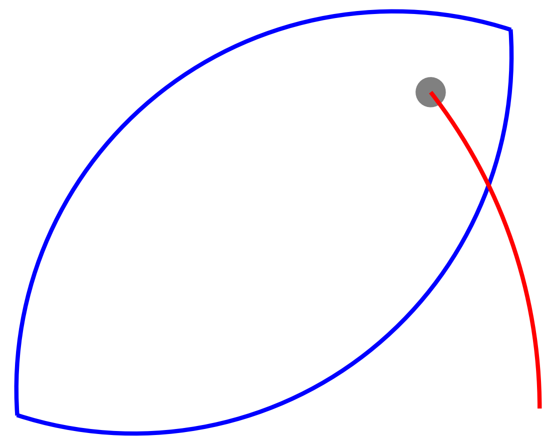

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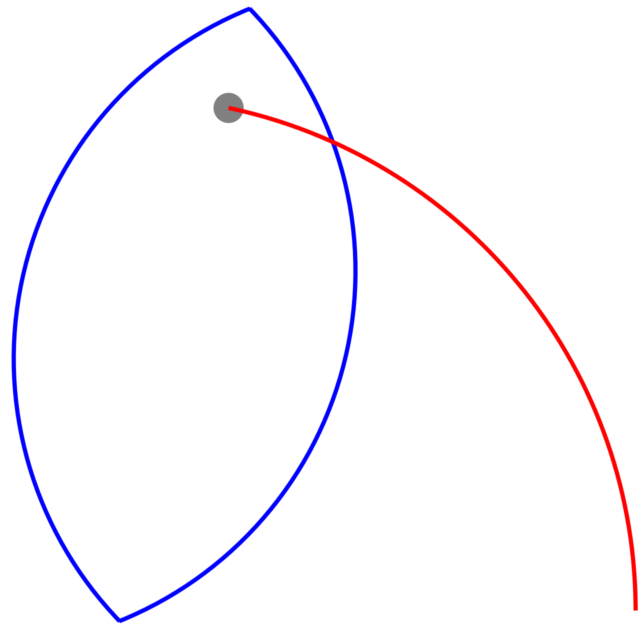

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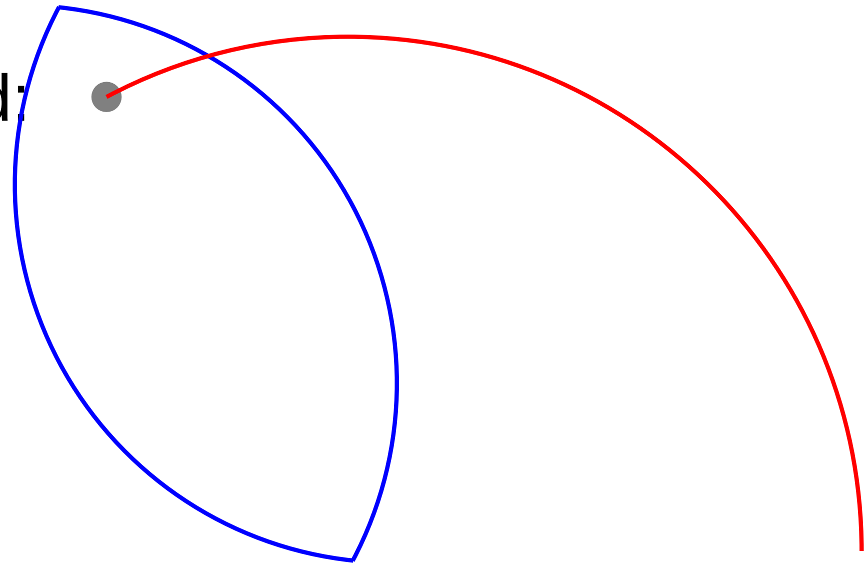

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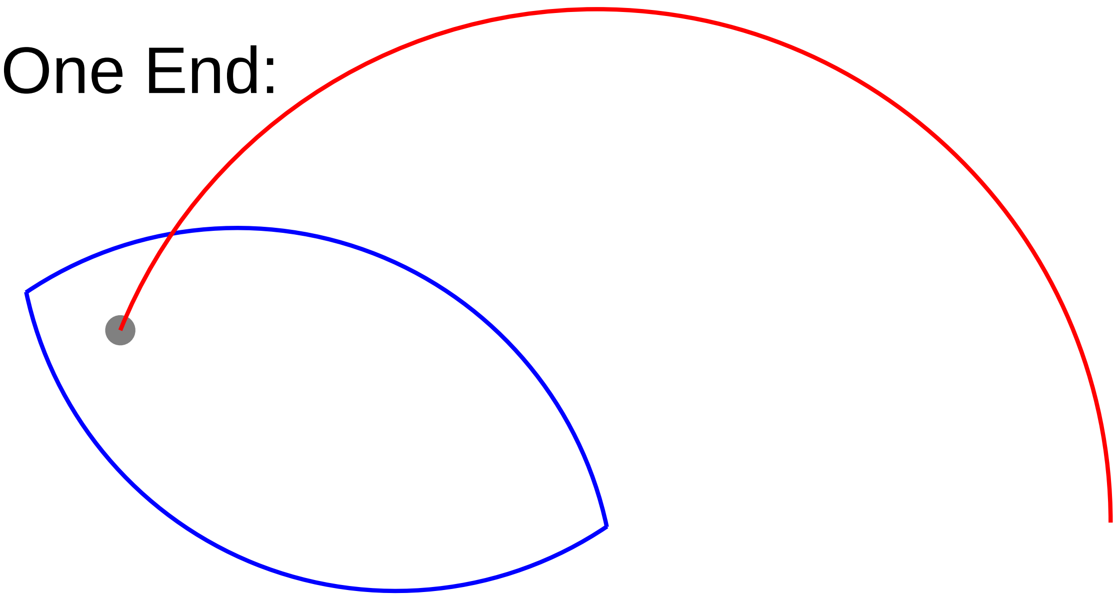

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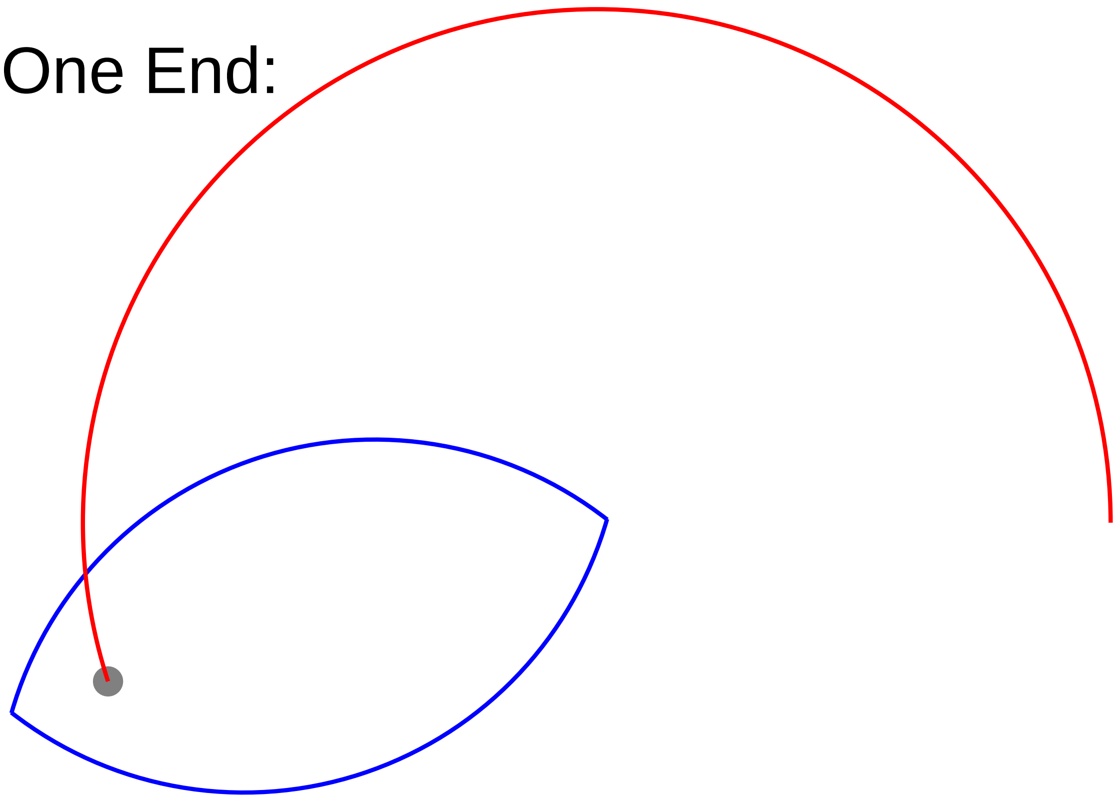

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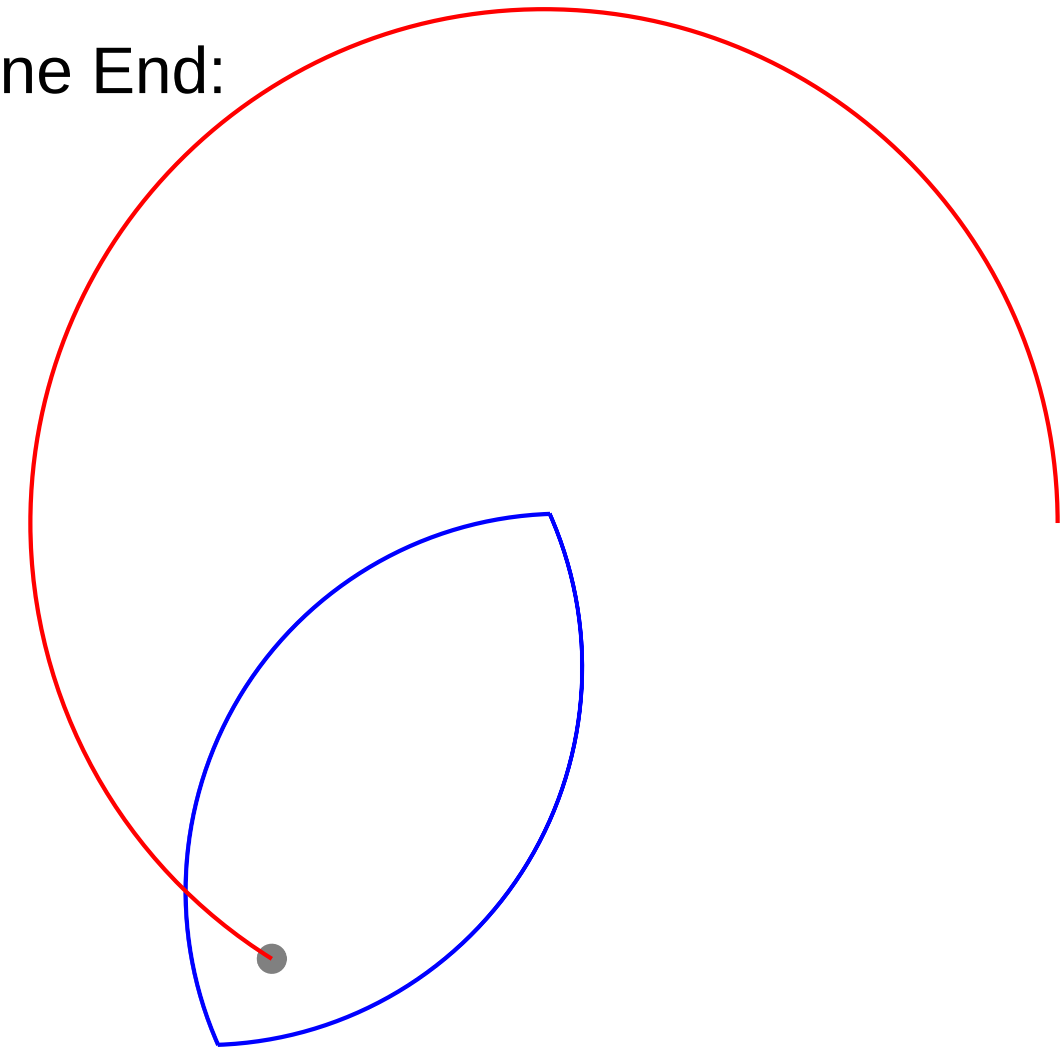

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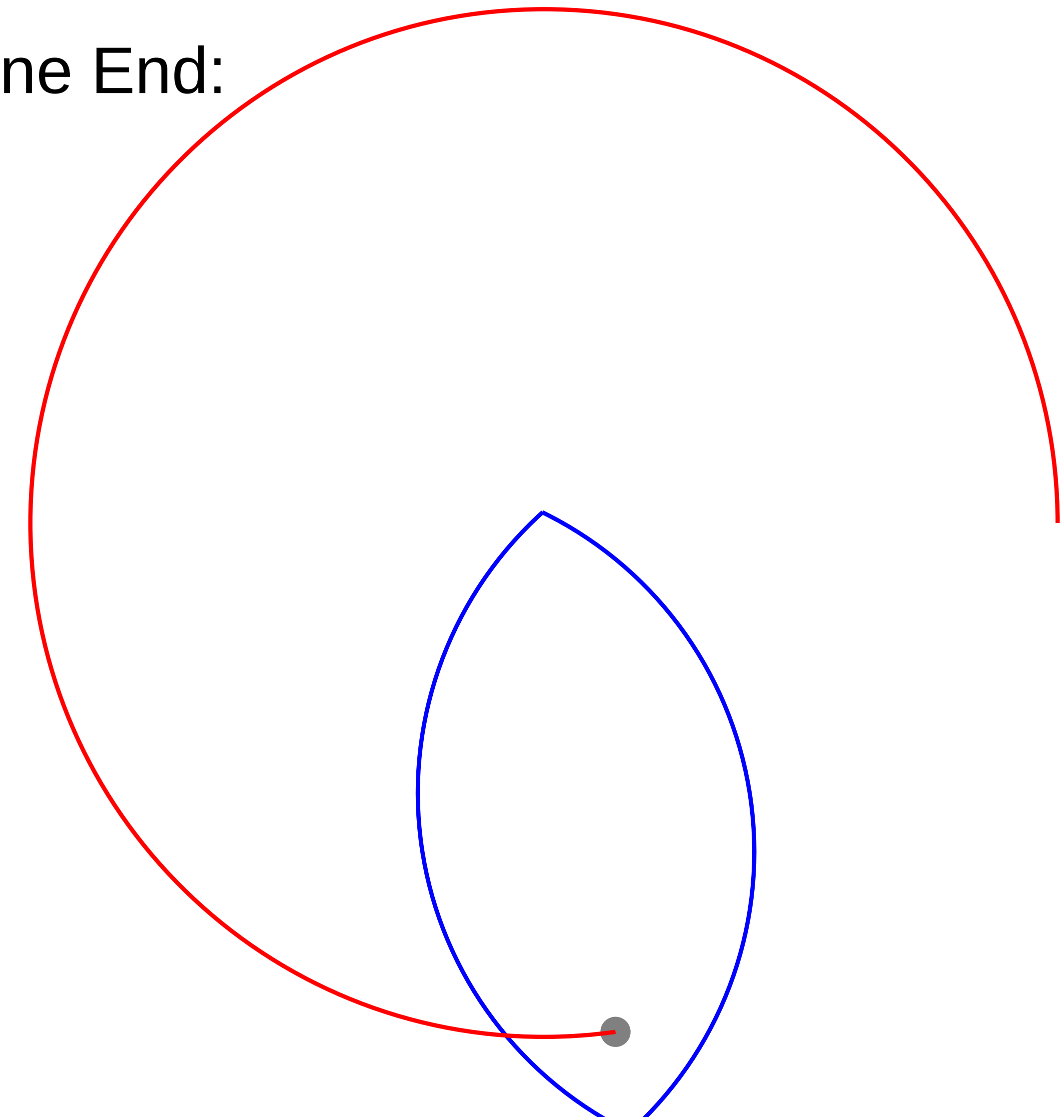

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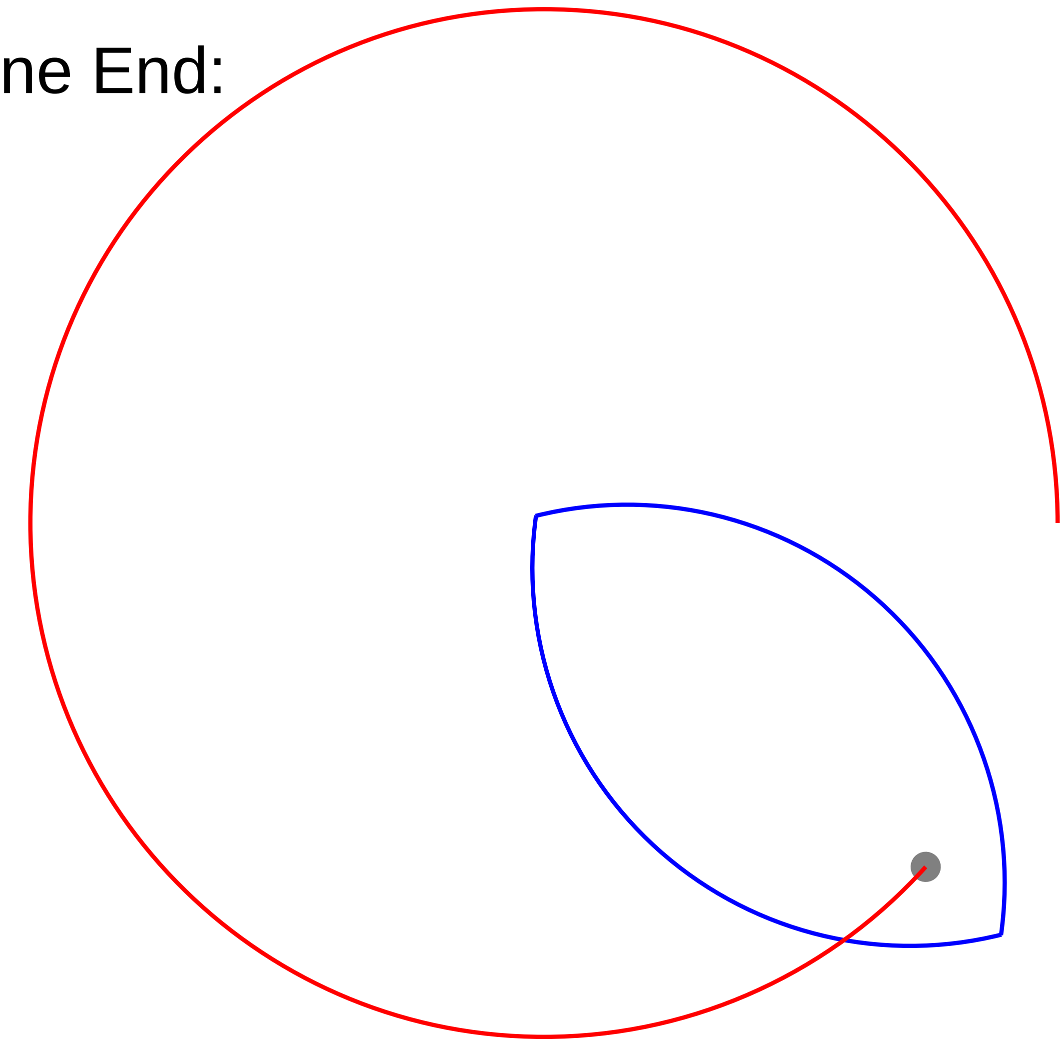

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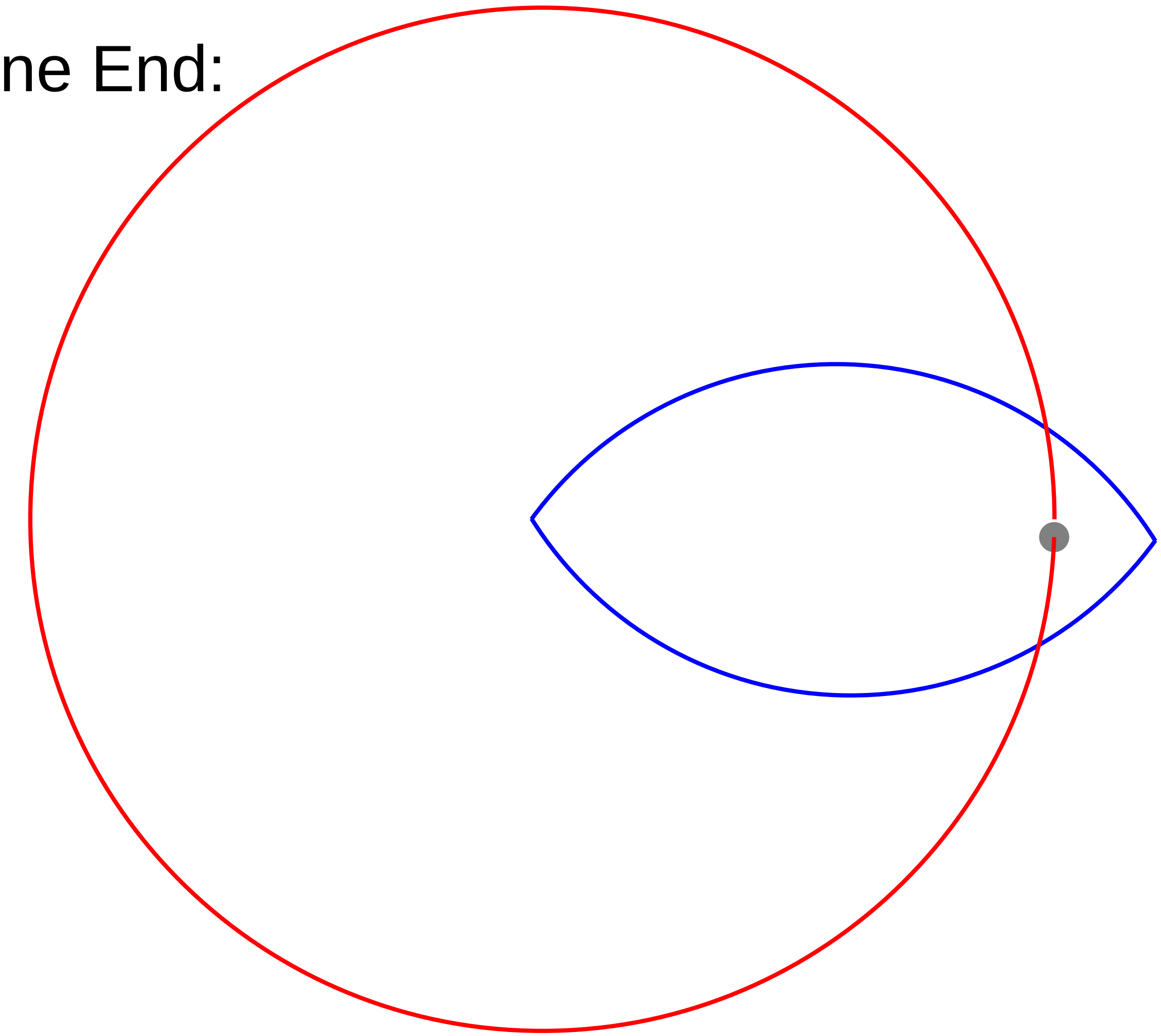

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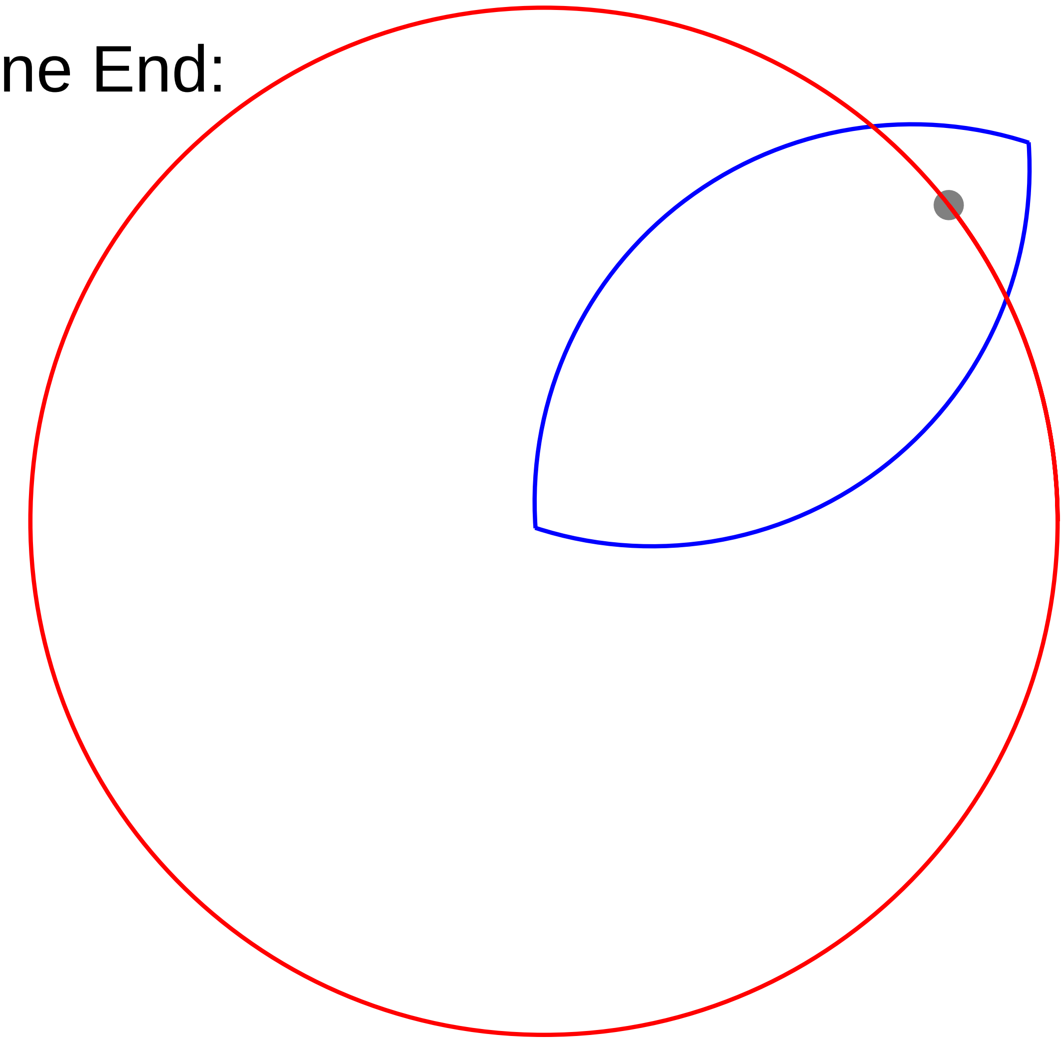

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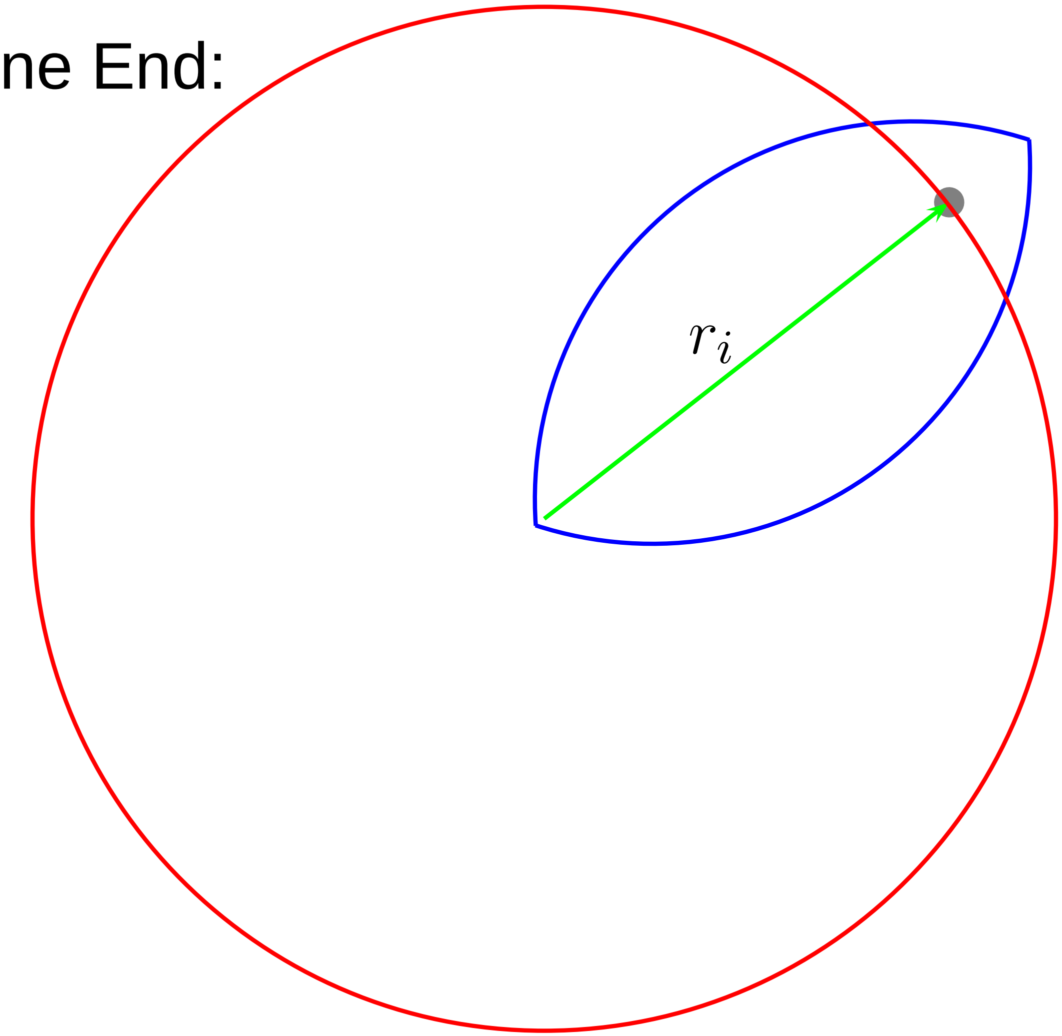

Parallel-Axis Theorem

For rotation about an axis that is parallel to the axis going through the center of an object, the moments of inertia are simply related.

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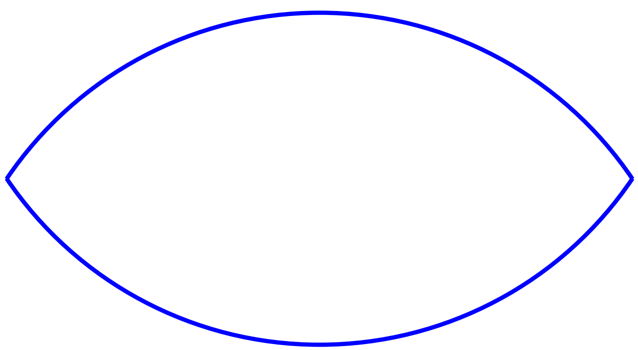

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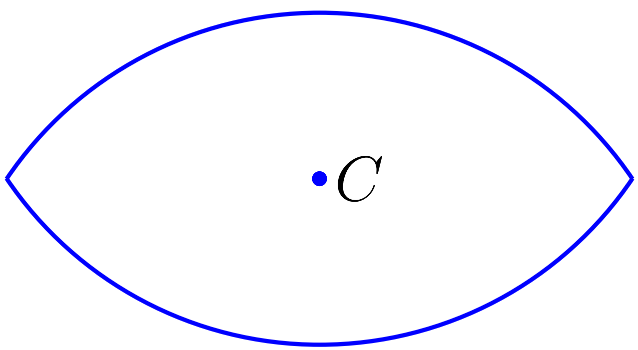

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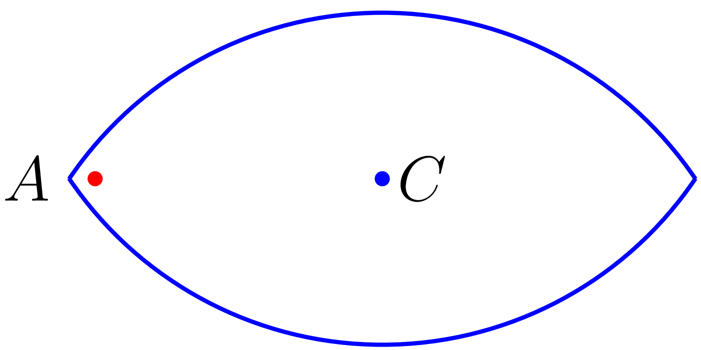

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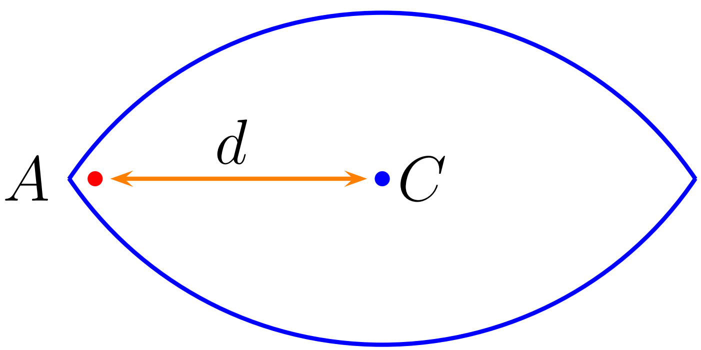

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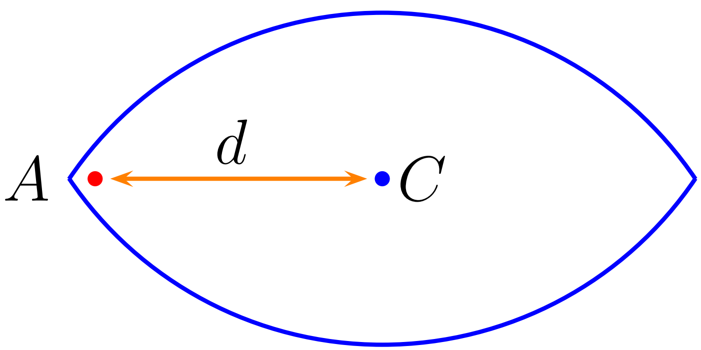

Parralel-Axis Theorem:

$$I_A = I_C + Md^2$$

Standard Shapes

For standard shapes and axes, equations for moments of inertia have already been calculated.

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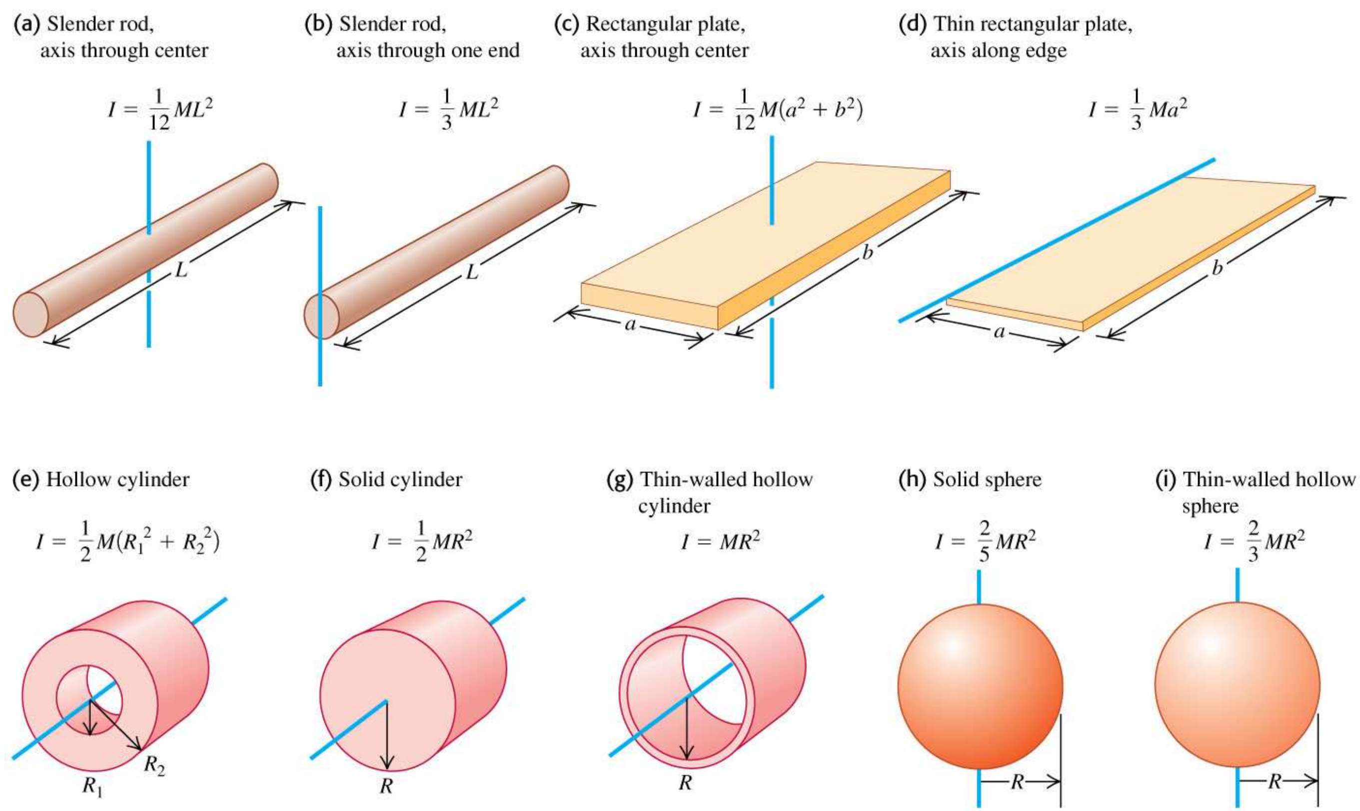
Table 9.2 Moments of Inertia of Various Bodies



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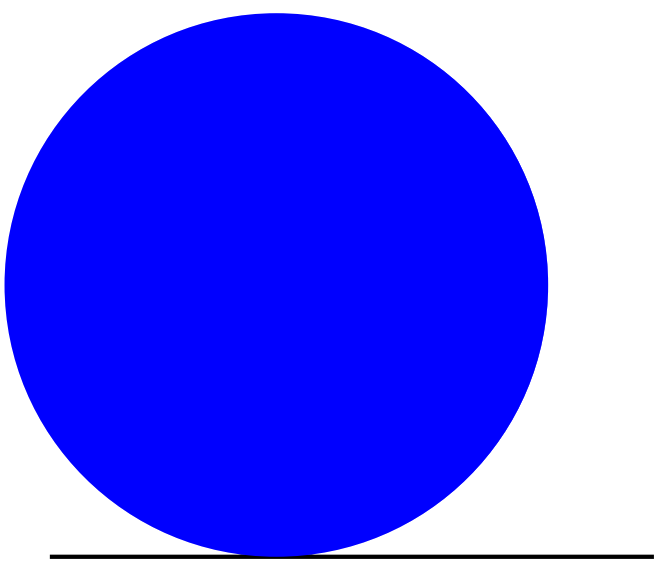

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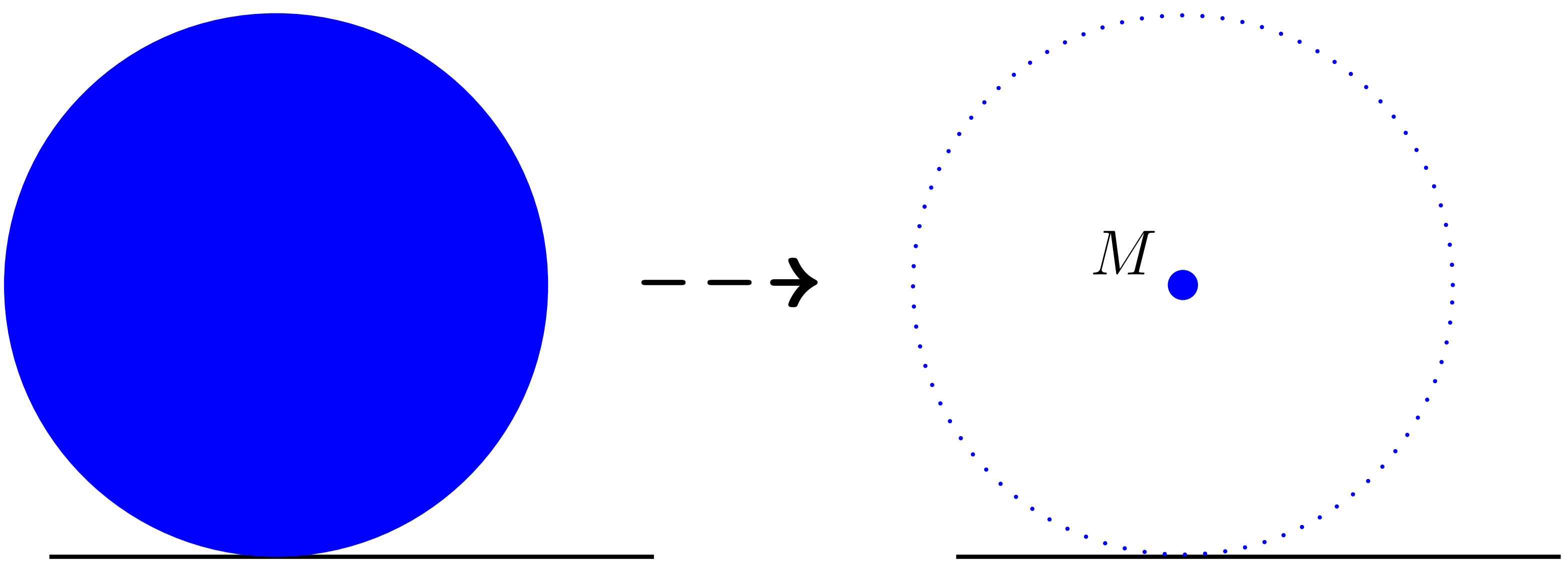

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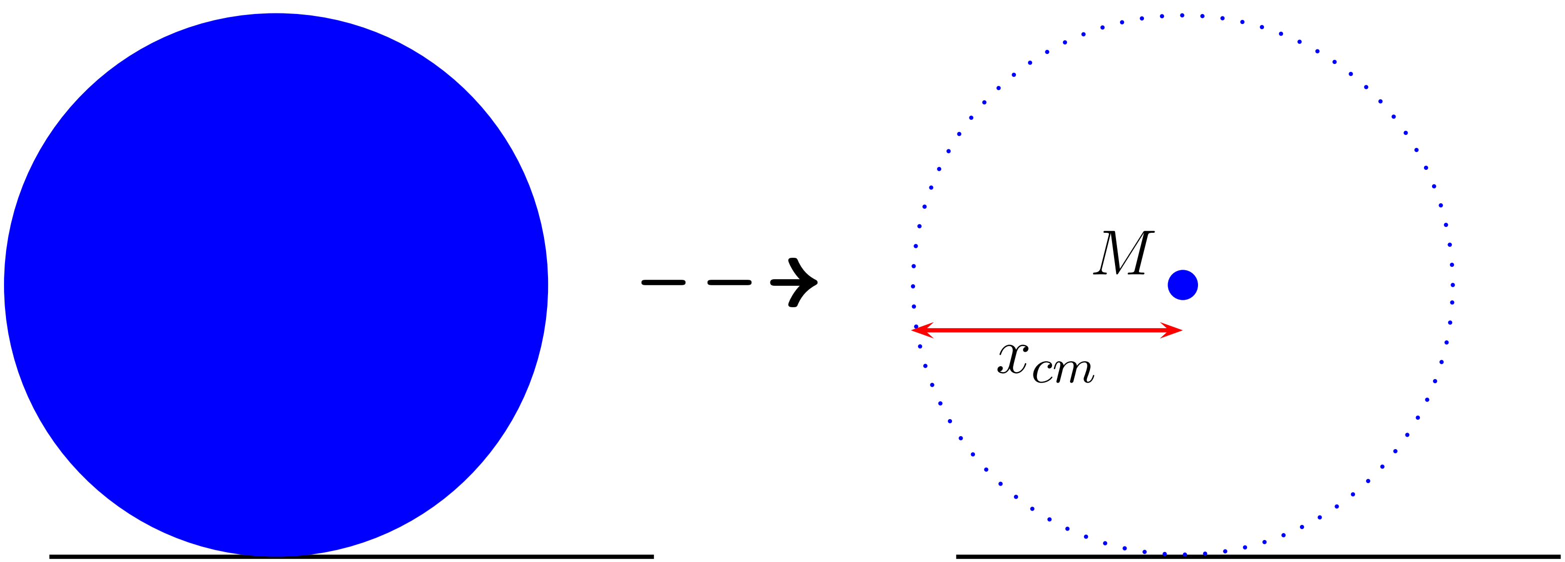

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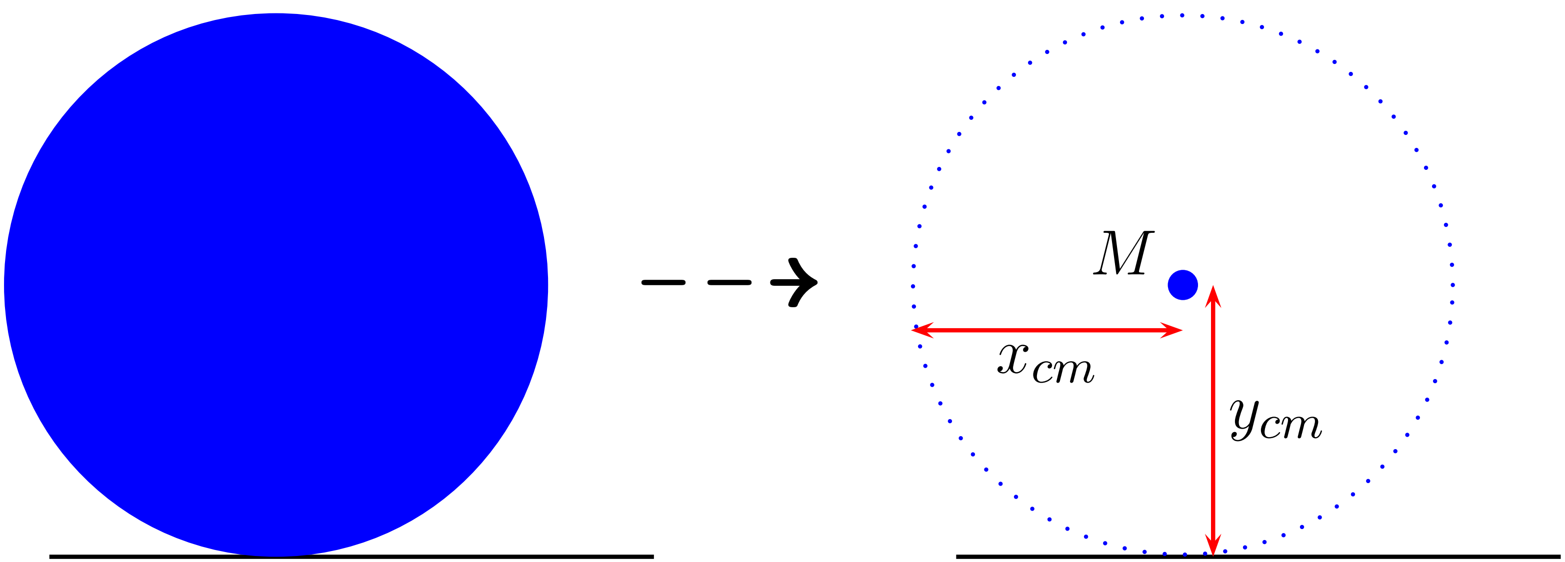

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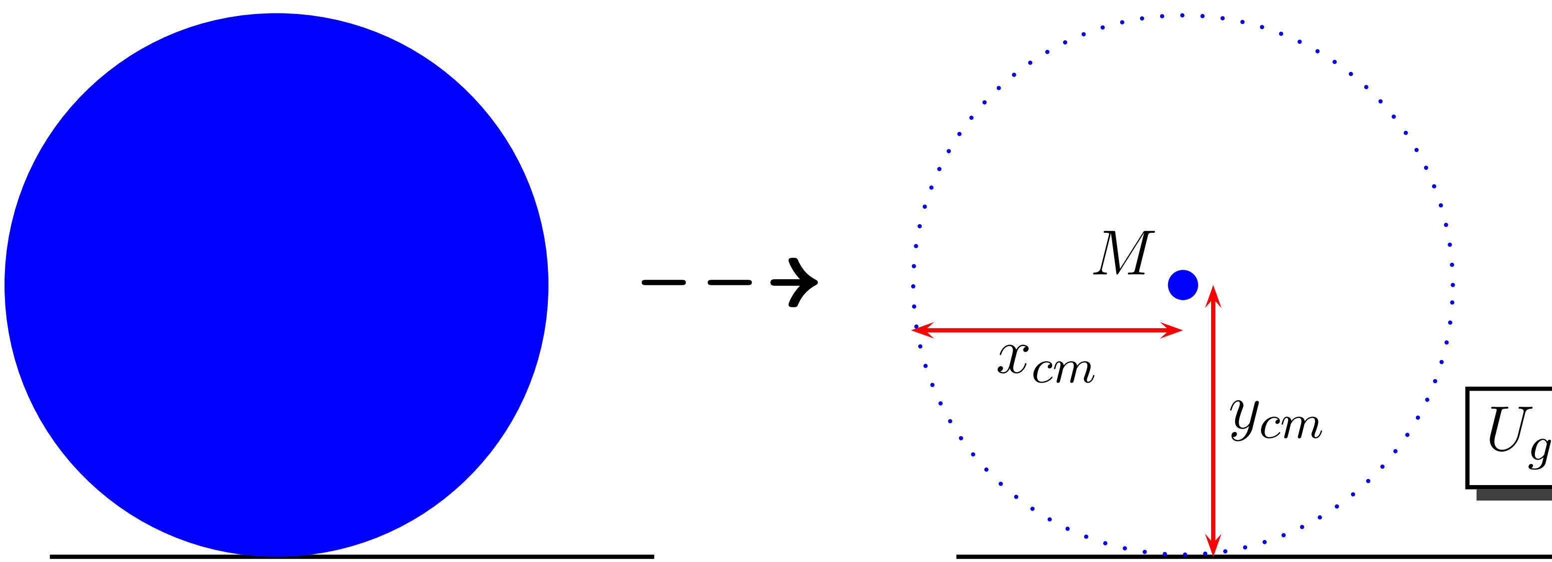
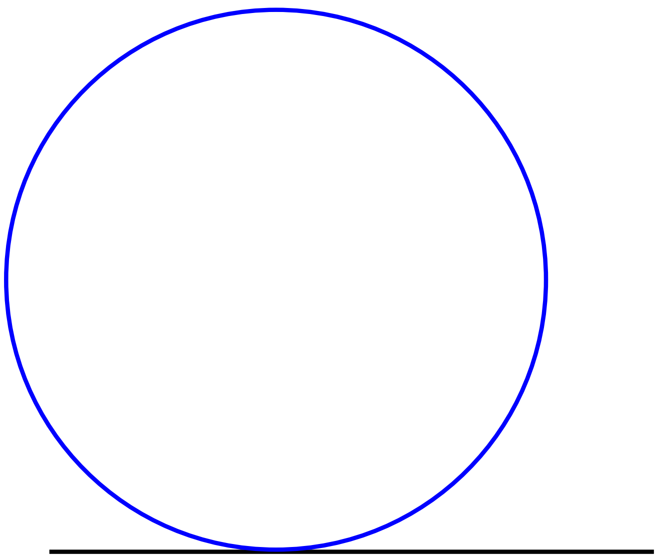


$$U_g = Mgy_{cm}$$

Rolling

When an object rolls, it rotates and its center moves.



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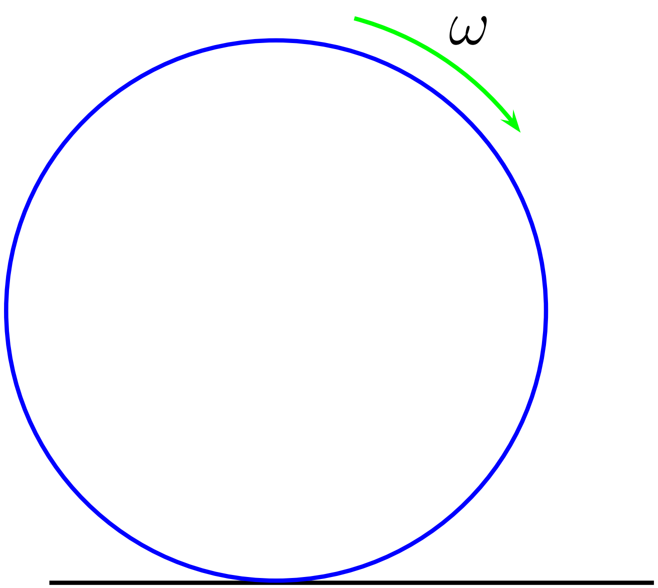

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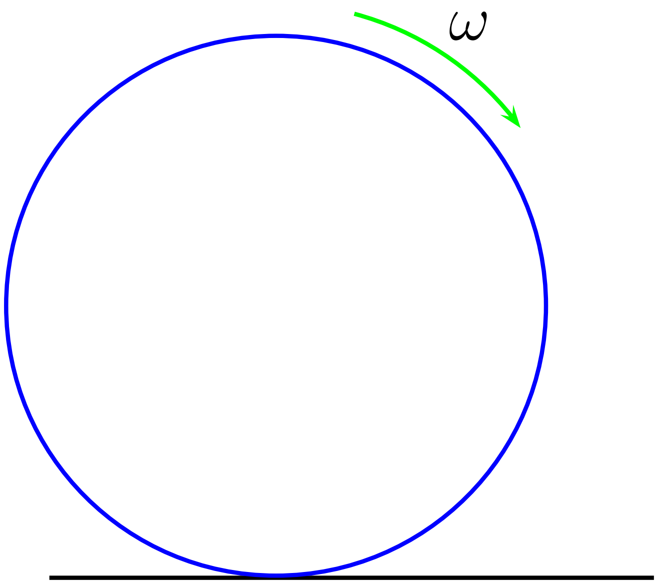
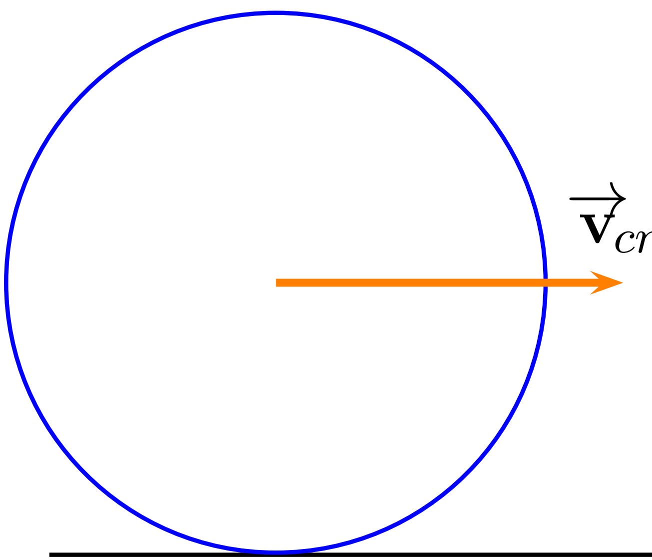


Rotational: $K_r = \frac{1}{2} I\omega^2$

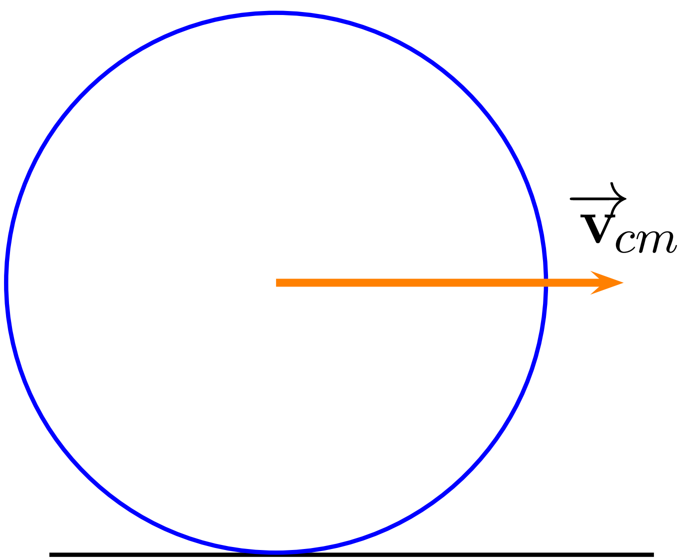
Rolling

When an object rolls, it rotates and its center moves.



Rolling

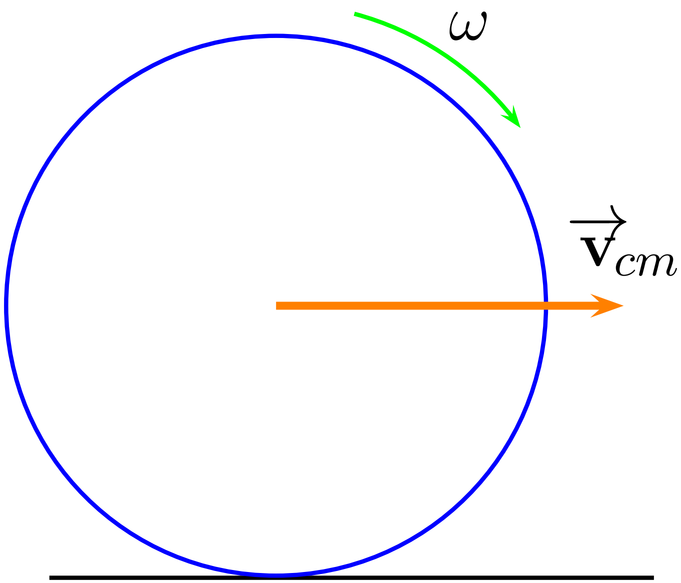
When an object rolls, it rotates and its center moves.



Translational: $K_t = \frac{1}{2} M v_{cm}^2$

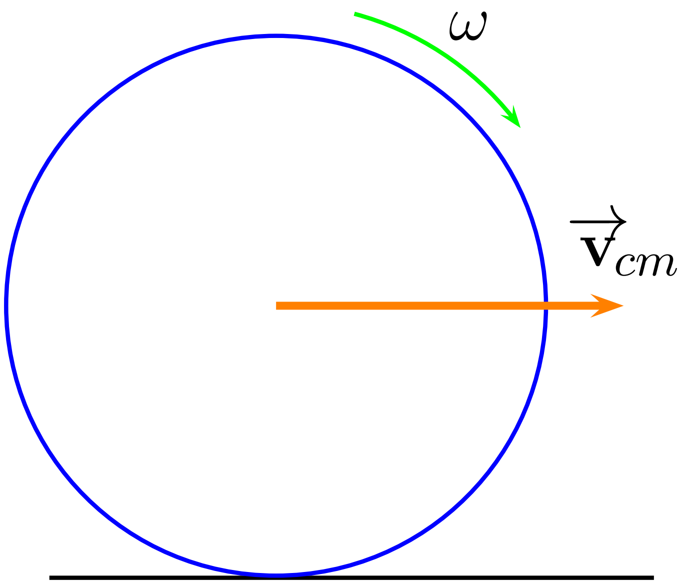
Rolling

When an object rolls, it rotates and its center moves.



Rolling

When an object rolls, it rotates and its center moves.

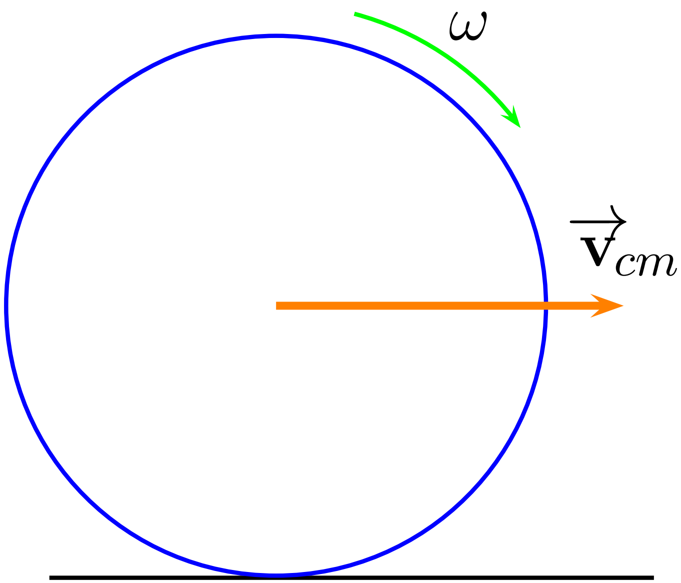


Translational: $K_t = \frac{1}{2}Mv_{cm}^2$

Rotational: $K_r = \frac{1}{2}I\omega^2$

Rolling

When an object rolls, it rotates and its center moves.



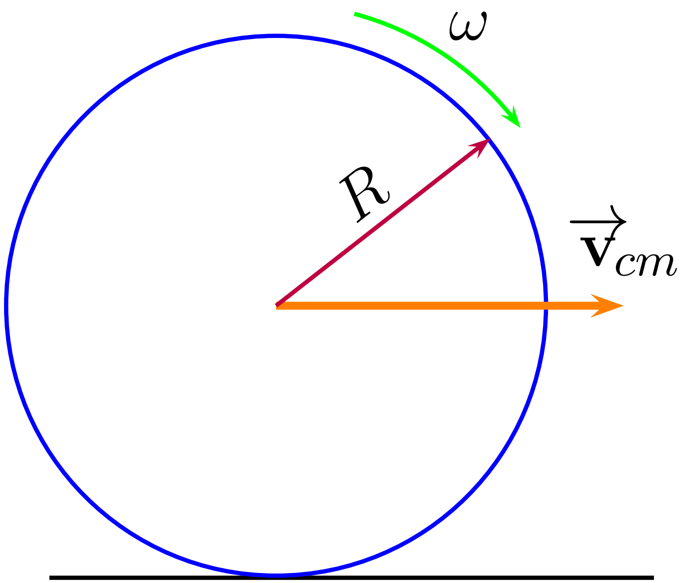
Translational: $K_t = \frac{1}{2}Mv_{cm}^2$

Rotational: $K_r = \frac{1}{2}I\omega^2$

Total: $K = K_t + K_r = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I\omega^2$

Rolling

When an object rolls, it rotates and its center moves.



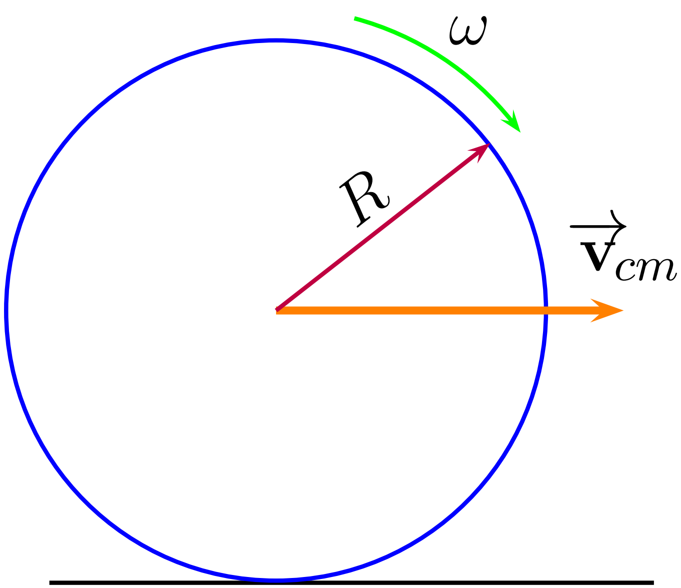
Translational: $K_t = \frac{1}{2}Mv_{cm}^2$

Rotational: $K_r = \frac{1}{2}I\omega^2$

Total: $K = K_t + K_r = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I\omega^2$

Rolling

When an object rolls, it rotates and its center moves.



Translational: $K_t = \frac{1}{2}Mv_{cm}^2$

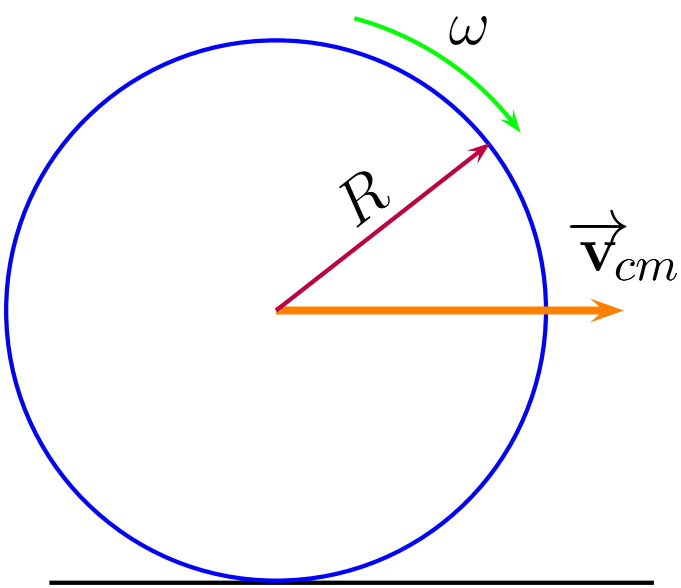
Rotational: $K_r = \frac{1}{2}I\omega^2$

Total: $K = K_t + K_r = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I\omega^2$

Rolling without slipping: $v_{cm} = \omega R$

Rolling

When an object rolls, it rotates and its center moves.



Translational: $K_t = \frac{1}{2}Mv_{cm}^2$

Rotational: $K_r = \frac{1}{2}I\omega^2$

Total: $K = K_t + K_r = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I\omega^2$

Rolling without slipping: $v_{cm} = \omega R$

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

Example

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

Example: Two cylinders are started from rest on an almost frictionless incline with their center of masses $1\,m$ above their ground height. The two cylinders have the same mass and radius, but one is hollow while the other is solid. Assuming there is just enough friction to cause the cylinders to roll without slipping, how fast is each going at the bottom of the incline?