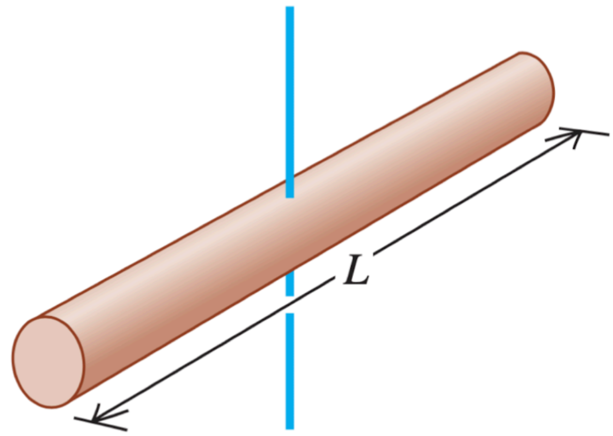
Rotational Inertia Calculations

Uniform rod of mass *M* and length *L* about its center

Determine the linear mass density λ of the rod.



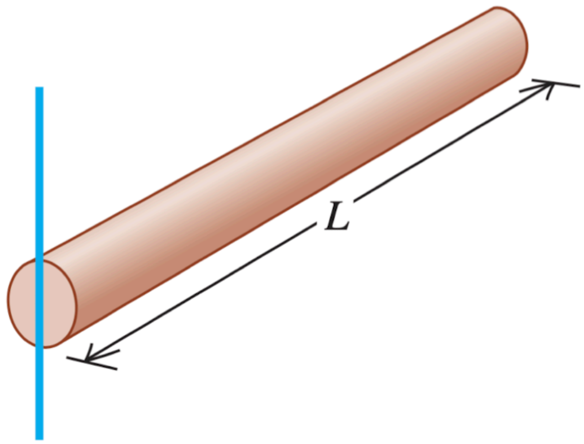
Divide the rod into small segments of length dx. Take one of these infinitesimally small segments of the rod located a distance *x* from the center, where $x = 0$.

Determine the mass dm of this segment.

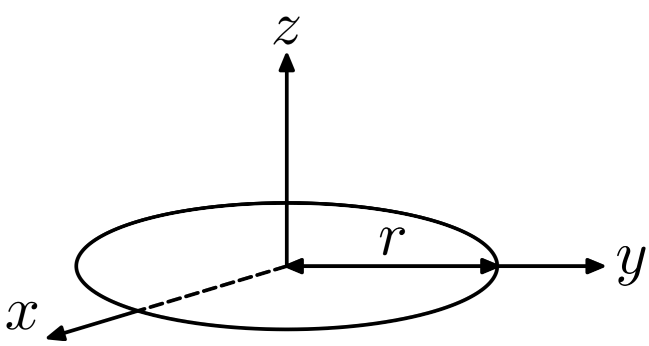
Determine the rotational inertia dI of this segment for an axis perpendicular to the rod and through its center of mass.

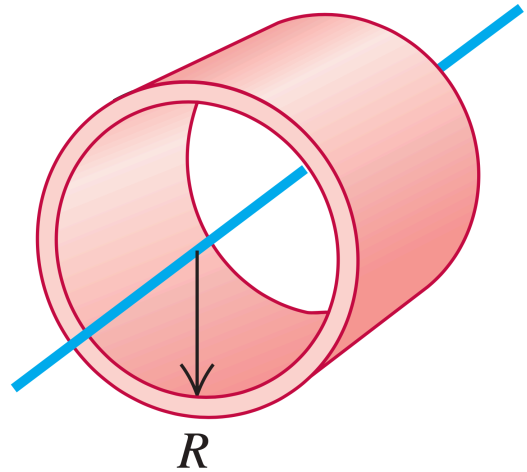
Integrate to get the rotational inertia I of the rod due to all the segments.

Uniform rod of mass M and length L about one end

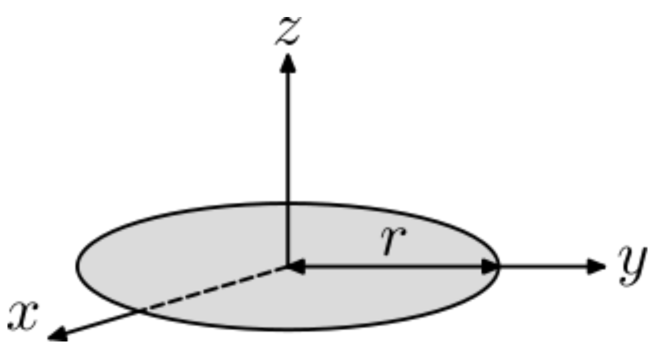


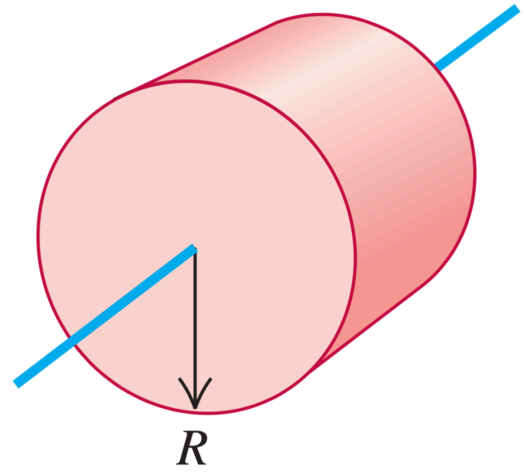
Thin loop of mass *M* and radius *R* (or thin cylindrical shell)





Uniform solid disk of mass *M* and radius *R* (or uniform solid cylinder)





Determine the area mass density σ of the disk.

Divide the disk into thin loops of width dr. Take one of these infinitesimally thin loops with radius r.

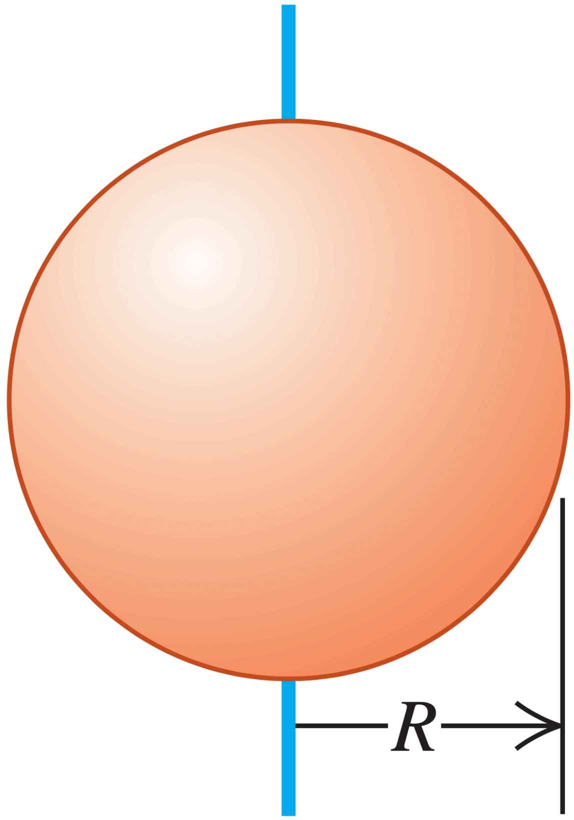
Determine the area dA of this loop.

Determine the mass dm of this loop.

Determine the rotational inertia dI of this loop.

Integrate to get the rotational inertia I of the disk due to all the loops.

Uniform spherical shell of mass M and radius R



Determine the area mass density σ of the spherical shell.

Divide the shell into thin loops of width ds. Take one of these infinitesimally thin loops with radius r.

Determine the radius of this loop r in terms of ϕ.

Determine the width ds of this loop in terms of $d\phi$.

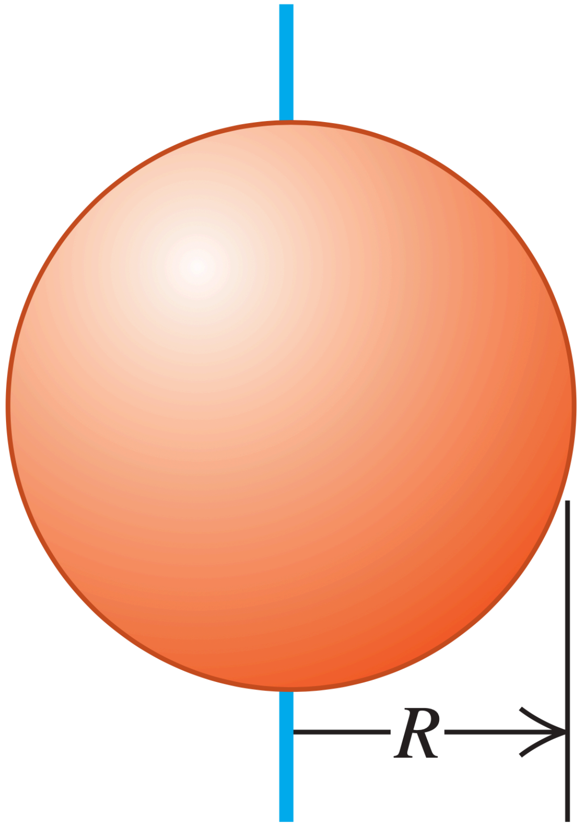
Determine the area dA of this loop.

Determine the mass dm of this loop.

Determine the rotational inertia dI of this loop.

Integrate to get the rotational inertia I of the spherical shell due to all the loops.

Uniform Solid Sphere of mass M and radius R



Determine the volume mass density ρ of the sphere.

Divide the sphere into thin spherical shells of thickness dr. Take one of these infinitesimally thin spherical shells with radius r.

Determine the volume dV of this spherical shell.

Determine the mass dm of this spherical shell.

Determine the rotational inertia dI of this spherical shell.

Integrate to get the rotational inertia I of the sphere due to all the spherical shells.