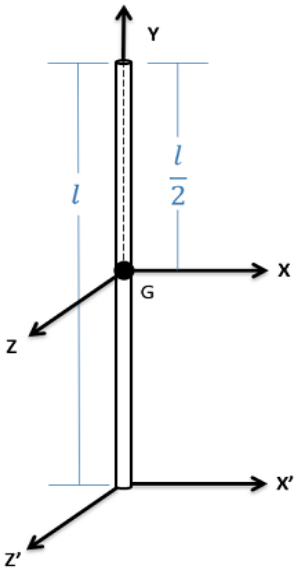
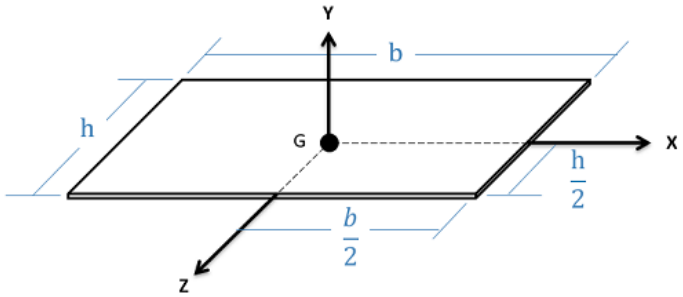
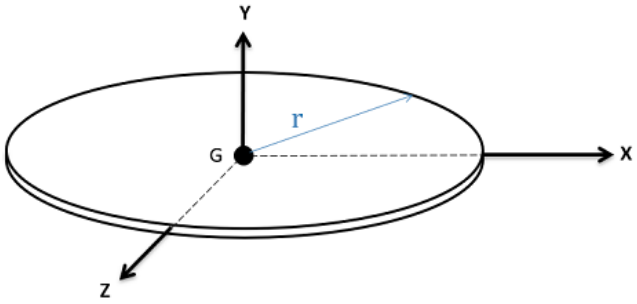
Mechanics Map
Open Textbook Project

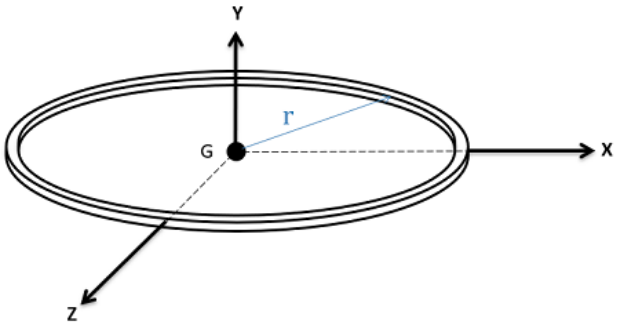
Engineering Mechanics

Center of Mass and Mass Moments of Inertia for Homogeneous Bodies

Shape with Volume and Center of Mass Location Shown	Mass Moments of Inertia
Slender Rod 	$I_{xx} = I_{zz} = \frac{1}{12}ml^2$ $I_{yy} = 0$ $I_{xx'} = I_{zz'} = \frac{1}{3}ml^2$
Flat Rectangular Plate 	$I_{xx} = \frac{1}{12}mh^2$ $I_{yy} = \frac{1}{12}m(h^2 + b^2)$ $I_{zz} = \frac{1}{12}mb^2$
Flat Circular Plate	$I_{xx} = I_{zz} = \frac{1}{4}mr^2$ $I_{yy} = \frac{1}{2}mr^2$



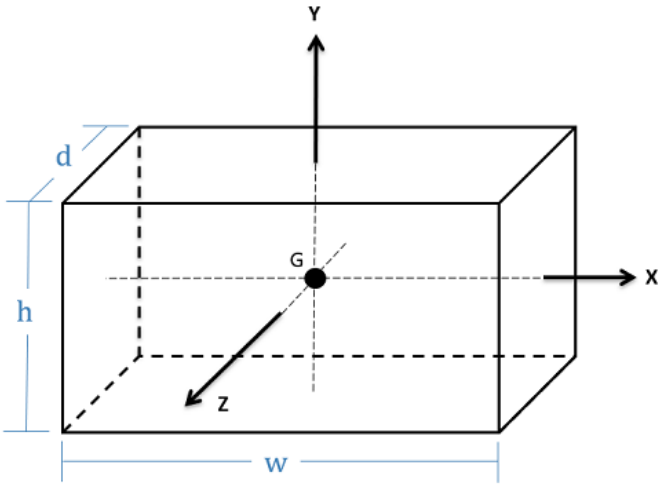
Thin Circular Ring



$$I_{xx} = I_{zz} = \frac{1}{2}mr^2$$

$$I_{yy} = mr^2$$

Rectangular Prism



$Volume = dhw$

$$I_{xx} = \frac{1}{12}m(h^2 + d^2)$$

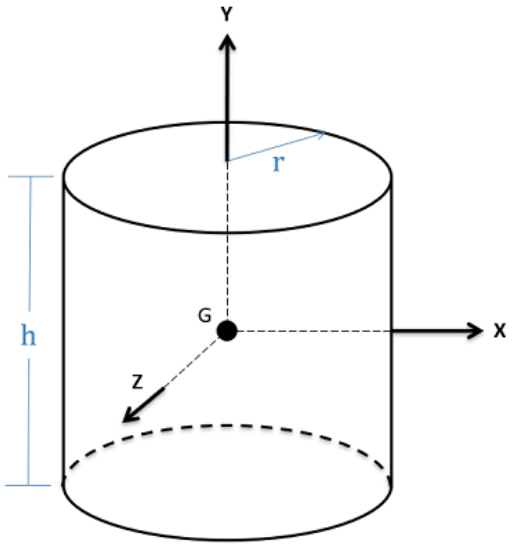
$$I_{yy} = \frac{1}{12}m(d^2 + w^2)$$

$$I_{zz} = \frac{1}{12}m(h^2 + w^2)$$

Cylinder

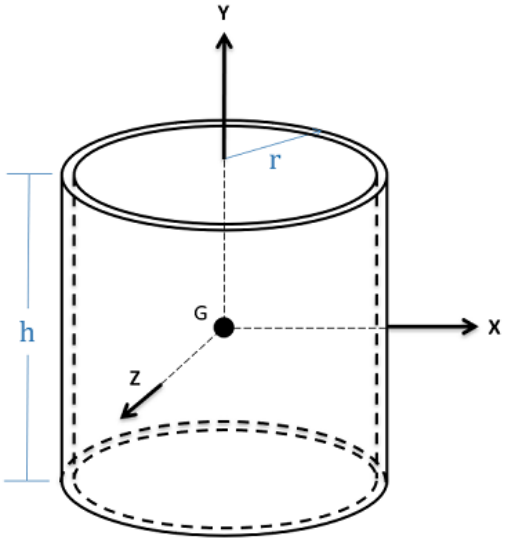
$$I_{xx} = I_{zz} = \frac{1}{12}m(3r^2 + h^2)$$

$$I_{yy} = \frac{1}{2}mr^2$$



$Volume = \pi r^2 h$

Thin Cylindrical Shell



$$I_{xx} = I_{zz} = \frac{1}{6} m(3r^2 + h^2)$$

$$I_{yy} = mr^2$$

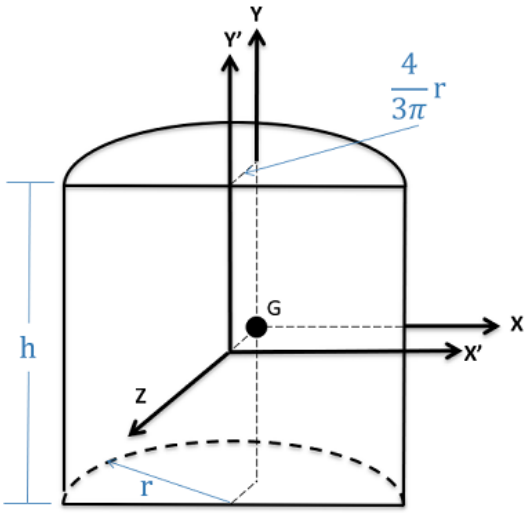
Half Cylinder

$$I_{xx} = I_{zz} = \left(\frac{1}{4} - \frac{16}{9\pi^2}\right) mr^2 + \frac{1}{12} mh^2$$

$$I_{yy} = \left(\frac{1}{2} - \frac{16}{9\pi^2}\right) mr^2$$

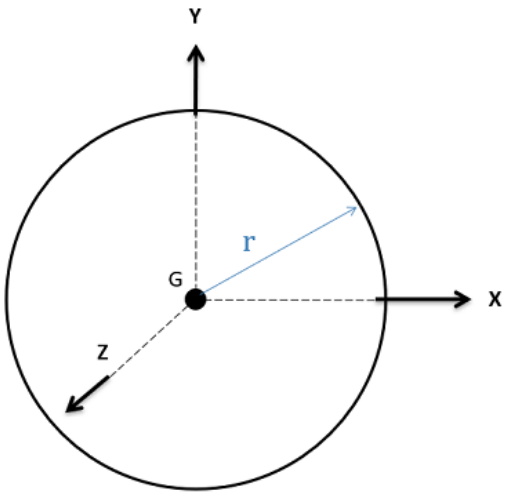
$$I_{xx'} = I_{zz'} = \frac{1}{12} m(3r^2 + h^2)$$

$$I_{yy'} = \frac{1}{2} mr^2$$



$$Volume = \frac{1}{2}\pi r^2 h$$

Sphere

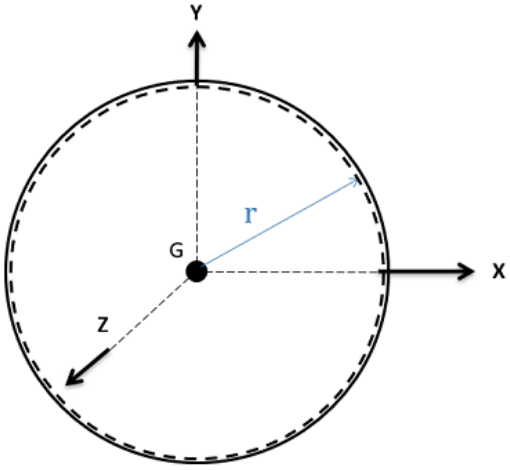


$$Volume = \frac{4}{3}\pi r^3$$

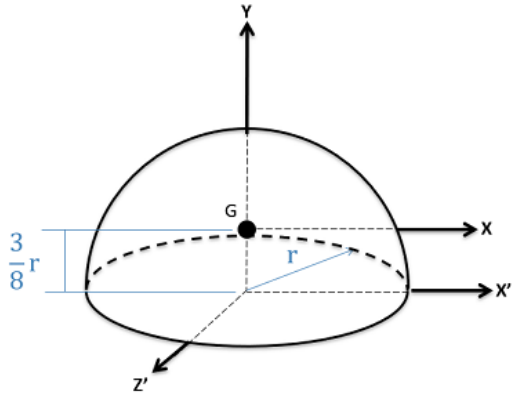
$$I_{xx} = I_{yy} = I_{zz} = \frac{2}{5}mr^2$$

Spherical Shell

$$I_{xx} = I_{yy} = I_{zz} = \frac{2}{3}mr^2$$



Hemisphere



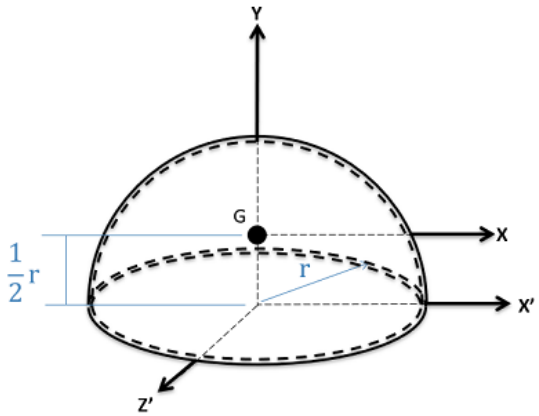
$$Volume = \frac{2}{3}\pi r^3$$

$$I_{xx} = I_{zz} = \frac{83}{320}mr^2$$

$$I_{yy} = \frac{2}{5}mr^2$$

$$I_{xx'} = I_{zz'} = \frac{2}{5}mr^2$$

Hemispherical Shell



$$I_{xx} = I_{zz} = \frac{5}{12}mr^2$$

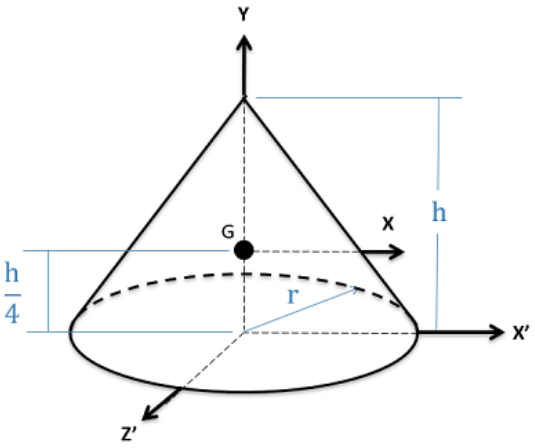
$$I_{yy} = \frac{2}{3}mr^2$$

$$I_{xx'} = I_{zz'} = \frac{2}{3}mr^2$$

Right Circular Cone

$$I_{xx} = I_{zz} = \frac{3}{80}m(4r^2 + h^2)$$

$$I_{yy} = \frac{3}{10}mr^2$$



$$Volume = \frac{1}{3}\pi r^2 h$$

$$I_{xx'} = I_{zz'} = \frac{1}{20}m(3r^2 + 2h^2)$$

This work was partially supported by the U.S. National Science Foundation Award # TUES-1044790 as well as the Affordable Course Transformation Program at PSU. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the sponsoring organizations