

SI Prefixes

<i>Multiple</i>	<i>Exponential Form</i>	<i>Prefix</i>	<i>SI Symbol</i>
1 000 000 000	10^9	giga	G
1 000 000	10^6	mega	M
1 000	10^3	kilo	k
<i>Submultiple</i>			
0.001	10^{-3}	milli	m
0.000 001	10^{-6}	micro	μ
0.000 000 001	10^{-9}	nano	n

Conversion Factors (SI) to (FPS)

<i>Quantity</i>	<i>Unit of Measurement (SI)</i>	<i>Equals</i>	<i>Unit of Measurement (FPS)</i>
Force	N		0.2248 lb
Mass	kg		0.06852 slug
Length	m		3.281 ft

Fundamental Equations of Statics

Cartesian Vector

$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

Magnitude

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

Directions

$$\begin{aligned} \mathbf{u}_A &= \frac{\mathbf{A}}{A} = \frac{A_x}{A} \mathbf{i} + \frac{A_y}{A} \mathbf{j} + \frac{A_z}{A} \mathbf{k} \\ &= \cos \alpha \mathbf{i} + \cos \beta \mathbf{j} + \cos \gamma \mathbf{k} \\ \cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma &= 1 \end{aligned}$$

Dot Product

$$\begin{aligned} \mathbf{A} \cdot \mathbf{B} &= AB \cos \theta \\ &= A_x B_x + A_y B_y + A_z B_z \end{aligned}$$

Cross Product

$$\mathbf{C} = \mathbf{A} \times \mathbf{B} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

Cartesian Position Vector

$$\mathbf{r} = (x_2 - x_1) \mathbf{i} + (y_2 - y_1) \mathbf{j} + (z_2 - z_1) \mathbf{k}$$

Cartesian Force Vector

$$\mathbf{F} = F \mathbf{u} = F \left(\frac{\mathbf{r}}{r} \right)$$

Moment of a Force

$$M_O = Fd$$

$$\mathbf{M}_O = \mathbf{r} \times \mathbf{F} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

Moment of a Force about a Specified Axis

$$M = \mathbf{u} \cdot \mathbf{r} \times \mathbf{F} = \begin{vmatrix} u_x & u_y & u_z \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

Simplification of a Force and Couple System

$$\begin{aligned} \mathbf{F}_R &= \Sigma \mathbf{F} \\ (\mathbf{M}_R)_O &= \Sigma \mathbf{M} + \Sigma \mathbf{M}_O \end{aligned}$$

Equilibrium

Particle

$$\Sigma F_x = 0, \Sigma F_y = 0, \Sigma F_z = 0$$

Rigid Body-Two Dimensions

$$\Sigma F_x = 0, \Sigma F_y = 0, \Sigma M_O = 0$$

Rigid Body-Three Dimensions

$$\begin{aligned} \Sigma F_x = 0, \Sigma F_y = 0, \Sigma F_z = 0 \\ \Sigma M_x = 0, \Sigma M_y = 0, \Sigma M_z = 0 \end{aligned}$$

Friction

Static (maximum) $F_s = \mu_s N$

Kinetic $F_k = \mu_k N$

Center of Gravity

Particles or Discrete Parts

$$\bar{\mathbf{r}} = \frac{\Sigma \tilde{\mathbf{r}} W}{\Sigma W}$$

Body

$$\bar{\mathbf{r}} = \frac{\int \tilde{\mathbf{r}} dW}{\int dW}$$

Area and Mass Moments of Inertia

$$I = \int r^2 dA \quad I = \int r^2 dm$$

Parallel-Axis Theorem

$$I = \bar{I} + Ad^2 \quad I = \bar{I} + md^2$$

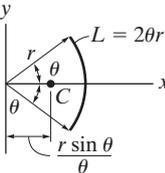
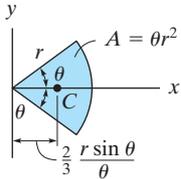
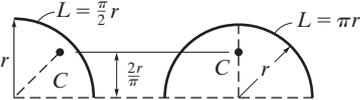
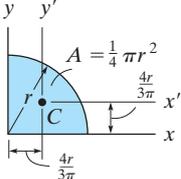
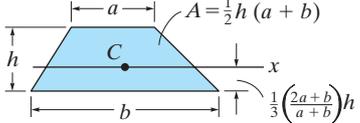
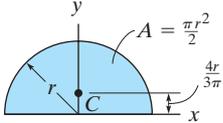
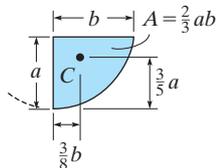
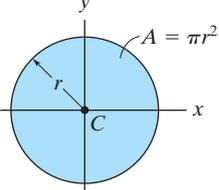
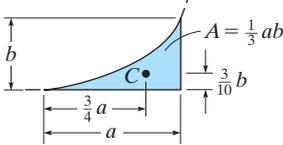
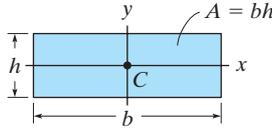
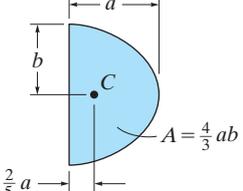
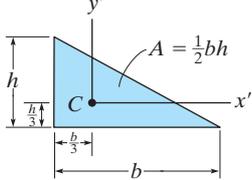
Radius of Gyration

$$k = \sqrt{\frac{\bar{I}}{A}} \quad k = \sqrt{\frac{\bar{I}}{m}}$$

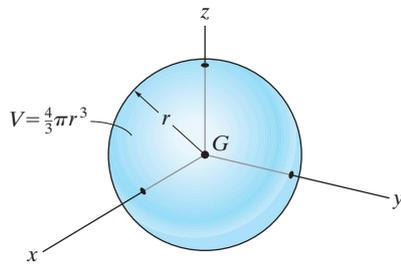
Virtual Work

$$\delta U = 0$$

Geometric Properties of Line and Area Elements

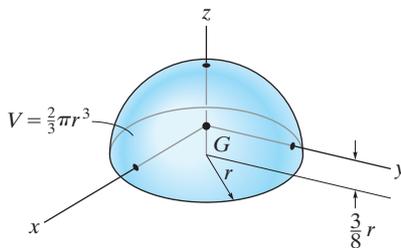
Centroid Location	Centroid Location	Area Moment of Inertia
 <p>Circular arc segment</p>	 <p>Circular sector area</p>	$I_x = \frac{1}{4} r^4 \left(\theta - \frac{1}{2} \sin 2\theta \right)$ $I_y = \frac{1}{4} r^4 \left(\theta + \frac{1}{2} \sin 2\theta \right)$
 <p>Quarter and semicircle arcs</p>	 <p>Quarter circle area</p>	$I_x = \frac{1}{16} \pi r^4$ $I_y = \frac{1}{16} \pi r^4$ $I_x' = \left(\frac{\pi}{16} - \frac{4}{9\pi} \right) r^4$ $I_y' = \left(\frac{\pi}{16} - \frac{4}{9\pi} \right) r^4$
 <p>Trapezoidal area</p>	 <p>Semicircular area</p>	$I_x = \frac{1}{8} \pi r^4$ $I_y = \frac{1}{8} \pi r^4$
 <p>Semiparabolic area</p>	 <p>Circular area</p>	$I_x = \frac{1}{4} \pi r^4$ $I_y = \frac{1}{4} \pi r^4$
 <p>Exparabolic area</p>	 <p>Rectangular area</p>	$I_x = \frac{1}{12} b h^3$ $I_y = \frac{1}{12} h b^3$
 <p>Parabolic area</p>	 <p>Triangular area</p>	$I_x' = \frac{1}{36} b h^3$ $I_y' = \frac{1}{36} h b^3$

Center of Gravity and Mass Moment of Inertia of Homogeneous Solids



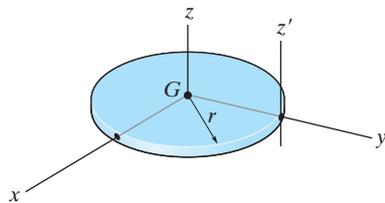
Sphere

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



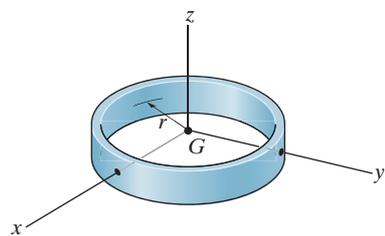
Hemisphere

$$I_{xx} = I_{yy} = 0.259 mr^2 \quad I_{zz} = \frac{2}{5} mr^2$$



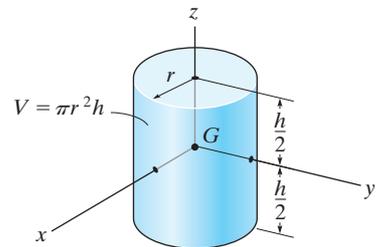
Thin circular disk

$$I_{xx} = I_{yy} = \frac{1}{4} mr^2 \quad I_{zz} = \frac{1}{2} mr^2 \quad I_{z'z'} = \frac{3}{2} mr^2$$



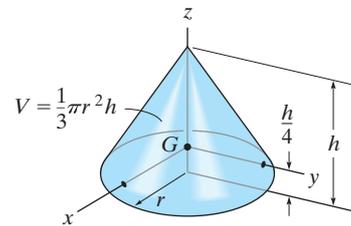
Thin ring

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



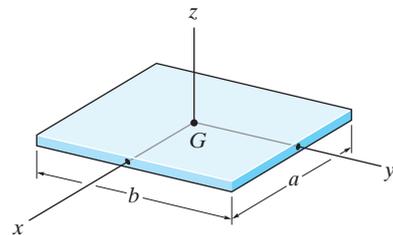
Cylinder

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



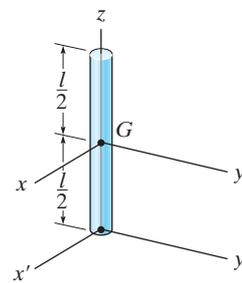
Cone

$$I_{xx} = I_{yy} = \frac{3}{80} m(4r^2 + h^2) \quad I_{zz} = \frac{3}{10} mr^2$$



Thin plate

$$I_{xx} = \frac{1}{12} mb^2 \quad I_{yy} = \frac{1}{12} ma^2 \quad I_{zz} = \frac{1}{12} m(a^2 + b^2)$$



Slender rod

$$I_{xx} = I_{yy} = \frac{1}{12} ml^2 \quad I_{x'x'} = I_{y'y'} = \frac{1}{3} ml^2 \quad I_{z'z'} = 0$$