



Properties of Planes and Solids Formulas

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Examples!

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List of 49 Properties of Planes and Solids Formulas

Properties of Planes and Solids 2

Mass Moment of Inertia

1) Mass Moment of Inertia of Circular Plate about x-axis Passing through Centroid

$$I_{
m xx} = rac{{
m M}\cdot{
m r}^2}{4}$$

Open Calculator 🗗

ex
$$11.72066 \mathrm{kg \cdot m^2} = \frac{35.45 \mathrm{kg \cdot (1.15m)^2}}{4}$$

2) Mass Moment of Inertia of Circular Plate about y-axis Passing through Centroid

$$extbf{I}_{ ext{yy}} = rac{ ext{M} \cdot ext{r}^2}{4}$$

Open Calculator 🗗

$$oxed{11.72066 ext{kg} \cdot ext{m}^2 = rac{35.45 ext{kg} \cdot \left(1.15 ext{m}
ight)^2}{4}}$$



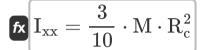
3) Mass Moment of Inertia of Circular Plate about z-axis through Centroid, Perpendicular to Plate

$$I_{
m zz}=rac{{
m M}\cdot{
m r}^2}{2}$$

Open Calculator 🚰

$$\boxed{ 23.44131 \text{kg} \cdot \text{m}^{_2} = \frac{35.45 \text{kg} \cdot (1.15 \text{m})^2}{2} }$$

4) Mass Moment of Inertia of Cone about x-axis Passing through Centroid, Perpendicular to Base



Open Calculator

$$\mathbf{ex} = 11.50282 \mathrm{kg \cdot m^2} = rac{3}{10} \cdot 35.45 \mathrm{kg \cdot (1.04m)^2}$$

5) Mass Moment of Inertia of Cone about y-axis Perpendicular to Height, Passing through Apex Point

$$extbf{I}_{ ext{yy}} = rac{3}{20} \cdot ext{M} \cdot \left(ext{R}_{ ext{c}}^2 + 4 \cdot ext{H}_{ ext{c}}^2
ight)$$

Open Calculator 🗗

$$ext{ex} \left[11.61395 ext{kg} \cdot ext{m}^2 = rac{3}{20} \cdot 35.45 ext{kg} \cdot \left(\left(1.04 ext{m}
ight)^2 + 4 \cdot \left(0.525 ext{m}
ight)^2
ight)$$



6) Mass Moment of Inertia of Cuboid about x-axis Passing through Centroid, Parallel to Length

 $I_{\mathrm{xx}} = rac{\mathrm{M}}{12} \cdot \left(\mathrm{w}^2 + \mathrm{H}^2
ight)$

Open Calculator 🗗

 $ext{ex} \left[11.72435 ext{kg} \cdot ext{m}^2 = rac{35.45 ext{kg}}{12} \cdot \left((1.693 ext{m})^2 + (1.05 ext{m})^2
ight)$

7) Mass Moment of Inertia of Cuboid about y-axis Passing through Centroid

 $I_{
m yy} = rac{
m M}{12} \cdot \left(
m L^2 +
m w^2
ight)$

Open Calculator

 $ext{ex} \left[11.75544 ext{kg} \cdot ext{m}^2 = rac{35.45 ext{kg}}{12} \cdot \left(\left(1.055 ext{m}
ight)^2 + \left(1.693 ext{m}
ight)^2
ight)$

8) Mass Moment of Inertia of Cuboid about z-axis Passing through Centroid

 $I_{
m zz} = rac{
m M}{12} \cdot \left(
m L^2 +
m H^2
ight)$

Open Calculator

 $oxed{ex} 6.54503 ext{kg} \cdot ext{m}^2 = rac{35.45 ext{kg}}{12} \cdot \Big((1.055 ext{m})^2 + (1.05 ext{m})^2 \Big)$



9) Mass Moment of Inertia of Rectangular Plate about x-axis through Centroid, Parallel to Length

$$extbf{I}_{ ext{xx}} = rac{ ext{M} \cdot ext{B}^2}{12}$$

Open Calculator 🚰

$$\boxed{ 11.6988 \text{kg} \cdot \text{m}^2 = \frac{35.45 \text{kg} \cdot (1.99 \text{m})^2}{12} }$$

10) Mass Moment of Inertia of Rectangular Plate about y-axis through Centroid, Parallel to Breadth

$$I_{
m yy} = rac{{
m M}\cdot {
m L}_{
m rect}^2}{12}$$

Open Calculator

ex
$$11.93513 \text{kg} \cdot \text{m}^2 = \frac{35.45 \text{kg} \cdot (2.01 \text{m})^2}{12}$$

11) Mass Moment of Inertia of Rectangular Plate about z-axis through Centroid, Perpendicular to Plate

$$extbf{I}_{ ext{zz}} = rac{ ext{M}}{12} \cdot \left(ext{L}_{ ext{rect}}^2 + ext{B}^2
ight)$$

Open Calculator 🛂

$$oxed{ex} 23.63392 ext{kg} \cdot ext{m}^2 = rac{35.45 ext{kg}}{12} \cdot \left((2.01 ext{m})^2 + (1.99 ext{m})^2
ight)$$



12) Mass Moment of Inertia of Rod about y-axis Passing through Centroid, Perpendicular to Length of Rod

 $\mathbf{f}_{\mathbf{z}} \mathbf{I}_{\mathrm{yy}} = rac{\mathbf{M} \cdot \mathbf{L}_{\mathrm{rod}}^2}{12}$

Open Calculator 🗗

ex $11.81667 \text{kg} \cdot \text{m}^2 = \frac{35.45 \text{kg} \cdot (2\text{m})^2}{12}$

13) Mass Moment of Inertia of Rod about z-axis Passing through Centroid, Perpendicular to Length of Rod

 $extbf{I}_{
m zz} = rac{ ext{M} \cdot ext{L}_{
m rod}^2}{12}$

Open Calculator

 $ext{ex} 11.81667 ext{kg} \cdot ext{m}^2 = rac{35.45 ext{kg} \cdot \left(2 ext{m}
ight)^2}{12}$

14) Mass Moment of Inertia of Solid Cylinder about x-axis through Centroid, Perpendicular to Length

 $\mathrm{I_{xx}} = rac{\mathrm{M}}{12} \cdot \left(3 \cdot \mathrm{R_{cyl}^2} + \mathrm{H_{cyl}^2}
ight)$

Open Calculator

 $oxed{ex} 11.85854 ext{kg} \cdot ext{m}^2 = rac{35.45 ext{kg}}{12} \cdot \left(3 \cdot \left(1.155 ext{m}
ight)^2 + \left(0.11 ext{m}
ight)^2
ight)$



15) Mass Moment of Inertia of Solid Cylinder about y-axis through Centroid, Parallel to Length

 $\mathbf{K} \left[\mathrm{I}_{\mathrm{yy}} = rac{\mathrm{M} \cdot \mathrm{R}_{\mathrm{cyl}}^2}{2}
ight]$

Open Calculator 🚰

 $\mathbf{ex} \ 23.64559 \mathrm{kg} \cdot \mathrm{m}^{_{2}} = \frac{35.45 \mathrm{kg} \cdot (1.155 \mathrm{m})^{^{2}}}{2}$

16) Mass Moment of Inertia of Solid Cylinder about z-axis through Centroid, Perpendicular to Length

 $I_{
m zz} = rac{
m M}{12} \cdot \left(3 \cdot
m R_{
m cyl}^2 +
m H_{
m cyl}^2
ight)^{-1}$

Open Calculator

 $ext{ex} \left[11.85854 ext{kg} \cdot ext{m}^2 = rac{35.45 ext{kg}}{12} \cdot \left(3 \cdot \left(1.155 ext{m}
ight)^2 + \left(0.11 ext{m}
ight)^2
ight)$

17) Mass Moment of Inertia of Solid Sphere about x-axis Passing through Centroid

 $I_{
m xx} = rac{2}{5} \cdot {
m M} \cdot {
m R}_{
m s}^2$

Open Calculator 🗗

 $\boxed{ 11.74246 \text{kg} \cdot \text{m}^2 = \frac{2}{5} \cdot 35.45 \text{kg} \cdot (0.91 \text{m})^2 }$



18) Mass Moment of Inertia of Solid Sphere about y-axis Passing through Centroid

 $I_{
m yy} = rac{2}{5} \cdot {
m M} \cdot {
m R}_{
m s}^2$

Open Calculator 🚰

ex $11.74246 \mathrm{kg \cdot m^2} = \frac{2}{5} \cdot 35.45 \mathrm{kg \cdot (0.91 m)}^2$

19) Mass Moment of Inertia of Solid Sphere about z-axis Passing through Centroid

 $I_{zz} = rac{2}{5} \cdot M \cdot R_s^2$

Open Calculator

ex $11.74246 ext{kg} \cdot ext{m}^2 = rac{2}{5} \cdot 35.45 ext{kg} \cdot (0.91 ext{m})^2$

20) Mass Moment of Inertia of Triangular Plate about x-axis Passing through Centroid, Parallel to Base

 $extbf{I}_{ ext{xx}} = rac{ ext{M} \cdot ext{H}_{ ext{tri}}^2}{18} \, \Big|$

Open Calculator

 $\mathbf{ex} = \frac{11.62937 \mathrm{kg} \cdot \mathrm{m}^2}{18} = \frac{35.45 \mathrm{kg} \cdot \left(2.43 \mathrm{m}\right)^2}{18}$



21) Mass Moment of Inertia of Triangular Plate about y-axis Passing through Centroid, Parallel to Height

 $\mathbf{f}_{\mathbf{x}}igg| \mathrm{I}_{\mathrm{yy}} = rac{\mathrm{M}\cdot\mathrm{b}_{\mathrm{tri}}^2}{24}igg|$

Open Calculator 🚰

 $\mathbf{ex} = 11.74636 \mathrm{kg \cdot m^2} = \frac{35.45 \mathrm{kg \cdot (2.82 m)^2}}{24}$

22) Mass Moment of Inertia of Triangular Plate about z-axis through Centroid, Perpendicular to Plate

 $I_{
m zz} = rac{
m M}{72} \cdot \left(3 \cdot
m b_{
m tri}^2 + 4 \cdot
m H_{
m tri}^2
ight)$

Open Calculator

 $\mathbf{ex} \left[23.37573 \mathrm{kg \cdot m^2} = rac{35.45 \mathrm{kg}}{72} \cdot \left(3 \cdot (2.82 \mathrm{m})^2 + 4 \cdot (2.43 \mathrm{m})^2
ight)
ight]$

Mass of Solids

23) Mass of Cone

 $\mathbf{M}_{\mathrm{co}} = rac{1}{3} \cdot \pi \cdot
ho \cdot \mathrm{H_c} \cdot \mathrm{R_c}^2$

Open Calculator

$$\mathbf{ex} = 593.4514 \mathrm{kg} = \frac{1}{3} \cdot \pi \cdot 998 \mathrm{kg/m^3} \cdot 0.525 \mathrm{m} \cdot (1.04 \mathrm{m})^2$$



Open Calculator

Open Calculator 2

Open Calculator 2

Open Calculator

Open Calculator

fx $M_{cu} = \rho \cdot L \cdot H \cdot w$

ex $1871.67 \text{kg} = 998 \text{kg/m}^3 \cdot 1.055 \text{m} \cdot 1.05 \text{m} \cdot 1.693 \text{m}$

25) Mass of Rectangular Plate

fx $M_{
m rp} =
ho \cdot B \cdot t \cdot L_{
m rect}$

 $4790.28 \text{kg} = 998 \text{kg/m}^3 \cdot 1.99 \text{m} \cdot 1.2 \text{m} \cdot 2.01 \text{m}$

26) Mass of Solid Cylinder 🔽 fx $m M_{sc} = \pi \cdot ho \cdot H \cdot R_{cvl}^2$



 $\mathbf{M}_{\mathrm{ss}} = rac{4}{3} \cdot \pi \cdot \mathbf{p} \cdot \mathrm{R}_{\mathrm{s}}^3$

ex $3150.238 \text{kg} = \frac{4}{3} \cdot \pi \cdot 998 \text{kg/m}^3 \cdot (0.91 \text{m})^3$

28) Mass of Triangular Plate 💪 $M_{\mathrm{tp}} = rac{1}{2} \cdot
ho \cdot b_{\mathrm{tri}} \cdot H_{\mathrm{tri}} \cdot t$





Mechanics and Statistics of Materials

29) Inclination of Resultant of Two Forces Acting on Particle

$$lpha = a anigg(rac{\mathrm{F}_2\cdot\sin(heta)}{\mathrm{F}_1+\mathrm{F}_2\cdot\cos(heta)}igg)$$

Open Calculator 🚰

 $oxed{ex} 2.647362 \ = a anigg(rac{12 ext{N} \cdot \sin(16 \)}{60 ext{N} + 12 ext{N} \cdot \cos(16 \)}igg)$

30) Moment of Couple

fx $M_{
m c} = F \cdot r_{
m F-F}$

Open Calculator 🗗

31) Moment of Force

fx $M_{
m f} = F \cdot r_{
m FP}$

Open Calculator

 $\texttt{ex} \ 10 \text{N*m} = 2.5 \text{N} \cdot 4 \text{m}$

32) Moment of inertia given radius of gyration

fx $I_{
m r}=A\cdot k_{
m G}^2$

Open Calculator

 $\mathbf{ex} \ 981.245 \mathrm{m}^{\scriptscriptstyle 4} = 50 \mathrm{m}^{\scriptscriptstyle 2} \cdot \left(4.43 \mathrm{m}\right)^{\scriptscriptstyle 2}$



33) Moment of inertia of circle about diametrical axis

 $\left| extbf{I}_{ ext{r}} = rac{\pi \cdot ext{d}^4}{64}
ight|$

Open Calculator 🖸

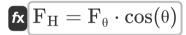
34) Radius of gyration given moment of inertia and area



Open Calculator

ex $4.429447 \mathrm{m} = \sqrt{\frac{981 \mathrm{m}^4}{50 \mathrm{m}^2}}$

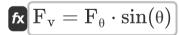
35) Resolution of Force with Angle along Horizontal Direction



Open Calculator 🚰

 $= 11.55437 N = 12.02 N \cdot \cos(16°)$

36) Resolution of Force with Angle along Vertical Direction



Open Calculator

 $\mathbf{ex} \ 3.313161 \mathrm{N} = 12.02 \mathrm{N} \cdot \sin(16\degree)$



37) Resultant of Two Forces Acting on Particle at 0 Degrees

 $R_{par} = F_1 + F_2$

Open Calculator

38) Resultant of Two Forces Acting on Particle at 180 Degrees

fx $R = F_1 - F_2$

Open Calculator

48N = 60N - 12N

39) Resultant of Two Forces Acting on Particle at 90 Degrees

Open Calculator

 $m_R = \sqrt{F_1^2 + F_2^2}$

 $ext{ex} 61.18823 ext{N} = \sqrt{\left(60 ext{N}
ight)^2 + \left(12 ext{N}
ight)^2}$

40) Resultant of Two Forces acting on Particle with Angle

Open Calculator

 $\mathbf{R}_{\mathrm{par}} = \sqrt{\mathrm{F}_1^2 + 2\cdot\mathrm{F}_1\cdot\mathrm{F}_2\cdot\cos(heta) + \mathrm{F}_2^2}$

 $ext{ex} \ 71.61157 ext{N} = \sqrt{(60 ext{N})^2 + 2 \cdot 60 ext{N} \cdot 12 ext{N} \cdot \cos(16\degree) + (12 ext{N})^2}$

41) Resultant of Two like Parallel Forces

Open Calculator

fx $R_{
m par} = F_1 + F_2$





42) Resultant of Two Unlike Parallel Forces Unequal in Magnitude



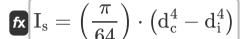
fx $m R =
m F_1 -
m F_2$

Open Calculator 2

|48N| = 60N - 12N

Moment of Inertia in Solids

43) Moment of inertia of hollow circle about diametrical axis



Open Calculator

 $\left[\frac{\pi}{64} \right] 9.536623 \text{m}^4 = \left(\frac{\pi}{64} \right) \cdot \left((3.999 \text{m})^4 - (2.8 \text{m})^4 \right)$

44) Moment of Inertia of Hollow Rectangle about Centroidal Axis x-x Parallel to Breadth

$$\mathbf{J}_{\mathrm{xx}} = rac{\left(\mathrm{B}\cdot\mathrm{L}_{\mathrm{rect}}^{3}
ight)-\left(\mathrm{B}_{\mathrm{i}}\cdot\mathrm{L}_{\mathrm{i}}^{3}
ight)}{12}$$

Open Calculator

$$\boxed{1.224596 \mathrm{m}^{\scriptscriptstyle 4} = \frac{\left(1.99\mathrm{m}\cdot(2.01\mathrm{m})^3\right) - \left(0.75\mathrm{m}\cdot(1.25\mathrm{m})^3\right)}{12} }$$



45) Moment of inertia of rectangle about centroidal axis along x-x parallel to breadth

 $\left|\mathbf{fx}
ight| \mathrm{J}_{\mathrm{xx}} = \mathrm{B} \cdot \left(\left. rac{\mathrm{L}_{\mathrm{rect}}^3}{12}
ight)
ight|$

Open Calculator

 $oxed{ex} 1.346666 \mathrm{m}^{\scriptscriptstyle 4} = 1.99 \mathrm{m} \cdot \left(rac{\left(2.01 \mathrm{m}
ight)^3}{12}
ight)$

46) Moment of inertia of rectangle about centroidal axis along y-y parallel to length

 \mathbf{f} $\mathbf{J}_{\mathrm{yy}} = \mathrm{L}_{\mathrm{rect}} \cdot rac{\mathrm{B}^3}{12}$

Open Calculator 🖸

ex $1.32\text{m}^4 = 2.01\text{m} \cdot \frac{(1.99\text{m})^3}{12}$

47) Moment of inertia of semicircular section about its base 🖸

fx $m I_s = 0.393 \cdot r_{sc}^4$

Open Calculator 🕝

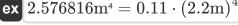
 $\texttt{ex} \ 9.206261 \text{m}^{\scriptscriptstyle 4} = 0.393 \cdot \left(2.2 \text{m}\right)^4$

48) Moment of inertia of semicircular section through center of gravity, parallel to base

fx $m I_s = 0.11 \cdot r_{sc}^4$

Open Calculator

 $\mathbf{ex} \ 2.576816 \mathrm{m}^{\scriptscriptstyle 4} = 0.11 \cdot (2.2 \mathrm{m})^4$



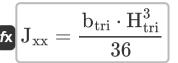






49) Moment of inertia of triangle about centroidal axis x-x parallel to base





Open Calculator





Variables Used

- A Area of Cross-Section (Square Meter)
- **B** Breadth of Rectangular Section (Meter)
- Bi Inner Breadth of Hollow Rectangular Section (Meter)
- **b**_{tri} Base of Triangle (Meter)
- **d** Diameter of Circle (Meter)
- d_c Outer Diameter of Hollow Circular Section (Meter)
- di Inner Diameter of Hollow Circular Section (Meter)
- F Force (Newton)
- **F**₁ First Force (Newton)
- **F**₂ Second Force (Newton)
- F_H Horizontal Component of Force (Newton)
- **F**_v Vertical component of force (Newton)
- F_A Force at Angle (Newton)
- **H** Height (Meter)
- **H**_c Height of Cone (Meter)
- **H**_{cvl} Cylinder Height (Meter)
- **H**_{tri} Height of Triangle (*Meter*)
- I_r Rotational Inertia (Meter⁴)
- I_s Moment of Inertia for Solids (Meter⁴)
- Ixx Mass Moment of Inertia about X-axis (Kilogram Square Meter)
- I_{yy} Mass Moment of Inertia about Y-axis (Kilogram Square Meter)





- I_{zz} Mass Moment of Inertia about Z-axis (Kilogram Square Meter)
- J_{xx} Moment of Inertia about x-x axis (Meter⁴)
- J_{VV} Moment of Inertia about y-y axis (Meter⁴)
- **k**_G Radius of Gyration (Meter)
- L Length (Meter)
- Li Inner Length of Hollow Rectangle (Meter)
- Lrect Length of Rectangular Section (Meter)
- L_{rod} Length of Rod (Meter)
- **M** Mass (Kilogram)
- M_C Moment of Couple (Newton Meter)
- M_{CO} Mass of Cone (Kilogram)
- M_{CU} Mass of Cuboid (Kilogram)
- **M**_f Moment of force (Newton Meter)
- M_{rp} Mass of Rectangular Plate (Kilogram)
- M_{SC} Mass of Solid Cylinder (Kilogram)
- M_{SS} Mass of Solid Sphere (Kilogram)
- M_{tp} Mass of Triangle Plate (Kilogram)
- **r** Radius (Meter)
- R Resultant force (Newton)
- R_c Radius of Cone (Meter)
- R_{cvl} Cylinder Radius (Meter)
- **r**_{F-F} Perpendicular Distance between Two Forces (Meter)
- r_{FP} Perpendicular Distance between Force and Point (Meter)





- Rpar Parallel Resultant Force (Newton)
- R_s Radius of Sphere (Meter)
- r_{sc} Radius of semi circle (Meter)
- **t** Thickness (Meter)
- w Width (Meter)
- α Inclination of Resultant forces (Degree)
- θ Angle (Degree)
- p Density (Kilogram per Cubic Meter)





Constants, Functions, Measurements used

- Constant: pi, 3.14159265358979323846264338327950288
 Archimedes' constant
- Function: atan, atan(Number)
 Inverse tan is used to calculate the angle by applying the tangent ratio of
 the angle, which is the opposite side divided by the adjacent side of the
 right triangle.
- Function: cos, cos(Angle)
 Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: sin, sin(Angle)
 Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Function: sqrt, sqrt(Number)

 A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Function: tan, tan(Angle)
 The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- Measurement: Length in Meter (m)
 Length Unit Conversion
- Measurement: Weight in Kilogram (kg)
 Weight Unit Conversion
- Measurement: Area in Square Meter (m²)

 Area Unit Conversion
- Measurement: Force in Newton (N)
 Force Unit Conversion





- Measurement: Angle in Degree (°)
 Angle Unit Conversion
- Measurement: Density in Kilogram per Cubic Meter (kg/m³)
 Density Unit Conversion
- Measurement: Torque in Newton Meter (N*m)

 Torque Unit Conversion
- Measurement: Moment of Inertia in Kilogram Square Meter (kg·m²)

 Moment of Inertia Unit Conversion
- Measurement: Second Moment of Area in Meter⁴ (m⁴)
 Second Moment of Area Unit Conversion





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