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Properties of Planes and Solids Formulas

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List of 49 Properties of Planes and Solids Formulas

Properties of Planes and Solids

Mass Moment of Inertia

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

Open Calculator

fx $$I_{xx} = \frac{M \cdot r^2}{4}$$

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

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

Open Calculator

fx $$I_{yy} = \frac{M \cdot r^2}{4}$$

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

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

Open Calculator

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

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

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

Open Calculator

$$I_{xx} = \frac{3}{10} \cdot M \cdot R_c^2$$

$$11.50282\text{kg·m}^2 = \frac{3}{10} \cdot 35.45\text{kg} \cdot (1.04\text{m})^2$$

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

Open Calculator

$$I_{yy} = \frac{3}{20} \cdot M \cdot \left(R_c^2 + 4 \cdot H_c^2\right)$$

$$11.61395\text{kg·m}^2 = \frac{3}{20} \cdot 35.45\text{kg} \cdot \left((1.04\text{m})^2 + 4 \cdot (0.525\text{m})^2\right)$$

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

Open Calculator

fx $$I_{xx} = \frac{M}{12} \cdot \left(w^2 + H^2\right)$$

ex $$11.72435\text{kg·m}^2 = \frac{35.45\text{kg}}{12} \cdot \left((1.693\text{m})^2 + (1.05\text{m})^2\right)$$

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

Open Calculator

fx $$I_{yy} = \frac{M}{12} \cdot \left(L^2 + w^2\right)$$

ex $$11.75544\text{kg·m}^2 = \frac{35.45\text{kg}}{12} \cdot \left((1.055\text{m})^2 + (1.693\text{m})^2\right)$$

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

Open Calculator

fx $$I_{zz} = \frac{M}{12} \cdot \left(L^2 + H^2\right)$$

ex $$6.54503\text{kg·m}^2 = \frac{35.45\text{kg}}{12} \cdot \left((1.055\text{m})^2 + (1.05\text{m})^2\right)$$

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

Open Calculator

$$I_{xx} = \frac{M \cdot B^2}{12}$$

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

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

Open Calculator

$$I_{yy} = \frac{M \cdot L_{rect}^2}{12}$$

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

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

Open Calculator

$$I_{zz} = \frac{M}{12} \cdot \left(L_{rect}^2 + B^2\right)$$

$$23.63392\text{kg·m}^2 = \frac{35.45\text{kg}}{12} \cdot \left((2.01\text{m})^2 + (1.99\text{m})^2\right)$$

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

Open Calculator

$$I_{yy} = \frac{M \cdot L_{rod}^2}{12}$$

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

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

Open Calculator

$$I_{zz} = \frac{M \cdot L_{rod}^2}{12}$$

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

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

Open Calculator

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

$$11.85854\text{kg·m}^2 = \frac{35.45\text{kg}}{12} \cdot \left(3 \cdot (1.155\text{m})^2 + (0.11\text{m})^2\right)$$

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

Open Calculator

fx $$I_{yy} = \frac{M \cdot R_{cyl}^2}{2}$$

ex $$23.64559\text{kg·m}^2 = \frac{35.45\text{kg} \cdot (1.155\text{m})^2}{2}$$

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

Open Calculator

fx $$I_{zz} = \frac{M}{12} \cdot \left(3 \cdot R_{cyl}^2 + H_{cyl}^2\right)$$

ex $$11.85854\text{kg·m}^2 = \frac{35.45\text{kg}}{12} \cdot \left(3 \cdot (1.155\text{m})^2 + (0.11\text{m})^2\right)$$

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

Open Calculator

fx $$I_{xx} = \frac{2}{5} \cdot M \cdot R_s^2$$

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

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

Open Calculator

fx $$I_{yy} = \frac{2}{5} \cdot M \cdot R_s^2$$

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

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

Open Calculator

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

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

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

Open Calculator

fx $$I_{xx} = \frac{M \cdot H_{tri}^2}{18}$$

ex $$11.62937\text{kg·m}^2 = \frac{35.45\text{kg} \cdot (2.43\text{m})^2}{18}$$

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

Open Calculator

fx $$I_{yy} = \frac{M \cdot b_{tri}^2}{24}$$

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

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

Open Calculator

fx $$I_{zz} = \frac{M}{72} \cdot \left(3 \cdot b_{tri}^2 + 4 \cdot H_{tri}^2\right)$$

ex $$23.37573\text{kg·m}^2 = \frac{35.45\text{kg}}{72} \cdot \left(3 \cdot (2.82\text{m})^2 + 4 \cdot (2.43\text{m})^2\right)$$

Mass of Solids

23) Mass of Cone

Open Calculator

fx $$M_{co} = \frac{1}{3} \cdot \pi \cdot \rho \cdot H_c \cdot R_c^2$$

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

24) Mass of Cuboid

Open Calculator

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

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

25) Mass of Rectangular Plate

Open Calculator

$$\mathrm{M_{rp}} = \rho \cdot \mathrm{B} \cdot \mathrm{t} \cdot \mathrm{L_{rect}}$$

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

26) Mass of Solid Cylinder

Open Calculator

$$\mathrm{M_{sc}} = \pi \cdot \rho \cdot \mathrm{H} \cdot \mathrm{R_{cyl}^2}$$

$$4391.71\mathrm{kg} = \pi \cdot 998\mathrm{kg/m^3} \cdot 1.05\mathrm{m} \cdot (1.155\mathrm{m})^2$$

27) Mass of Solid Sphere

Open Calculator

$$\mathrm{M_{ss}} = \frac{4}{3} \cdot \pi \cdot \rho \cdot \mathrm{R_s^3}$$

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

28) Mass of Triangular Plate

Open Calculator

$$\mathrm{M_{tp}} = \frac{1}{2} \cdot \rho \cdot \mathrm{b_{tri}} \cdot \mathrm{H_{tri}} \cdot \mathrm{t}$$

$$4103.337\mathrm{kg} = \frac{1}{2} \cdot 998\mathrm{kg/m^3} \cdot 2.82\mathrm{m} \cdot 2.43\mathrm{m} \cdot 1.2\mathrm{m}$$

Mechanics and Statistics of Materials

29) Inclination of Resultant of Two Forces Acting on Particle

Open Calculator

$$\alpha = a\tan\left(\frac{F_2 \cdot \sin(\theta)}{F_1 + F_2 \cdot \cos(\theta)}\right)$$

$$2.647362^\circ = a\tan\left(\frac{12\text{N} \cdot \sin(16^\circ)}{60\text{N} + 12\text{N} \cdot \cos(16^\circ)}\right)$$

30) Moment of Couple

Open Calculator

$$M_c = F \cdot r_{F\text{-}F}$$

$$12.5\text{N*m} = 2.5\text{N} \cdot 5\text{m}$$

31) Moment of Force

Open Calculator

$$M_f = F \cdot r_{FP}$$

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

32) Moment of inertia given radius of gyration

Open Calculator

$$I_r = A \cdot k_G^2$$

$$981.245\text{m}^4 = 50\text{m}^2 \cdot (4.43\text{m})^2$$

33) Moment of inertia of circle about diametrical axis

Open Calculator

fx $$I_r = \frac{\pi \cdot d^4}{64}$$

ex $$981.0639\text{m}^4 = \frac{\pi \cdot (11.89\text{m})^4}{64}$$

34) Radius of gyration given moment of inertia and area

Open Calculator

fx $$k_G = \sqrt{\frac{I_r}{A}}$$

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

35) Resolution of Force with Angle along Horizontal Direction

Open Calculator

fx $$F_H = F_\theta \cdot \cos(\theta)$$

ex $$11.55437\text{N} = 12.02\text{N} \cdot \cos(16^\circ)$$

36) Resolution of Force with Angle along Vertical Direction

Open Calculator

fx $$F_v = F_\theta \cdot \sin(\theta)$$

ex $$3.313161\text{N} = 12.02\text{N} \cdot \sin(16^\circ)$$

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

Open Calculator

fx $R_{par} = F_1 + F_2$

ex $72\text{N} = 60\text{N} + 12\text{N}$

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

Open Calculator

fx $R = F_1 - F_2$

ex $48\text{N} = 60\text{N} - 12\text{N}$

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

Open Calculator

fx $R = \sqrt{F_1^2 + F_2^2}$

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

40) Resultant of Two Forces acting on Particle with Angle

Open Calculator

fx $R_{par} = \sqrt{F_1^2 + 2 \cdot F_1 \cdot F_2 \cdot \cos(\theta) + F_2^2}$

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

41) Resultant of Two like Parallel Forces

Open Calculator

fx $R_{par} = F_1 + F_2$

ex $72\text{N} = 60\text{N} + 12\text{N}$

42) Resultant of Two Unlike Parallel Forces Unequal in Magnitude

Open Calculator

fx $$R = F_1 - F_2$$

ex $$48\text{N} = 60\text{N} - 12\text{N}$$

Moment of Inertia in Solids

43) Moment of inertia of hollow circle about diametrical axis

Open Calculator

fx $$I_s = \left(\frac{\pi}{64}\right) \cdot \left(d_c^4 - d_i^4\right)$$

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

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

Open Calculator

fx $$J_{xx} = \frac{\left(B \cdot L_{rect}^3\right) - \left(B_i \cdot L_i^3\right)}{12}$$

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

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

Open Calculator

fx $$J_{xx} = B \cdot \left(\frac{L_{rect}^3}{12} \right)$$

ex $$1.346666\text{m}^4 = 1.99\text{m} \cdot \left(\frac{(2.01\text{m})^3}{12} \right)$$

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

Open Calculator

fx $$J_{yy} = L_{rect} \cdot \frac{B^3}{12}$$

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

Open Calculator

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

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

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

Open Calculator

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

ex $$2.576816\text{m}^4 = 0.11 \cdot (2.2\text{m})^4$$

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

Open Calculator

fx $$J_{xx} = \frac{b_{tri} \cdot H_{tri}^3}{36}$$

ex $$1.123998\text{m}^4 = \frac{2.82\text{m} \cdot (2.43\text{m})^3}{36}$$

Variables Used

- **A** Area of Cross-Section *(Square Meter)*
- **B** Breadth of Rectangular Section *(Meter)*
- B_i 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)*
- d_i 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_θ Force at Angle *(Newton)*
- **H** Height *(Meter)*
- H_c Height of Cone *(Meter)*
- H_{cyl} Cylinder Height *(Meter)*
- H_{tri} Height of Triangle *(Meter)*
- I_r Rotational Inertia *(Meter⁴)*
- I_s Moment of Inertia for Solids *(Meter⁴)*
- I_{xx} 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_{yy} Moment of Inertia about y-y axis *(Meter⁴)*
- k_G Radius of Gyration *(Meter)*
- L Length *(Meter)*
- L_i Inner Length of Hollow Rectangle *(Meter)*
- L_{rect} 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_{cyl} Cylinder Radius *(Meter)*
- $r_{F\text{-}F}$ Perpendicular Distance between Two Forces *(Meter)*
- r_{FP} Perpendicular Distance between Force and Point *(Meter)*

- R_{par} 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)*
- **ρ** 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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