3 marks $\begin{cases} 1\times1 \\ 1\times2 \end{cases}$

PANA ACADEMY

NEPAL ENGINEERING COUNCIL
LICENSE EXAM PREPARATION COURSE

FOR

CIVIL ENGINEERS

Er. Dilendra Raj Panta

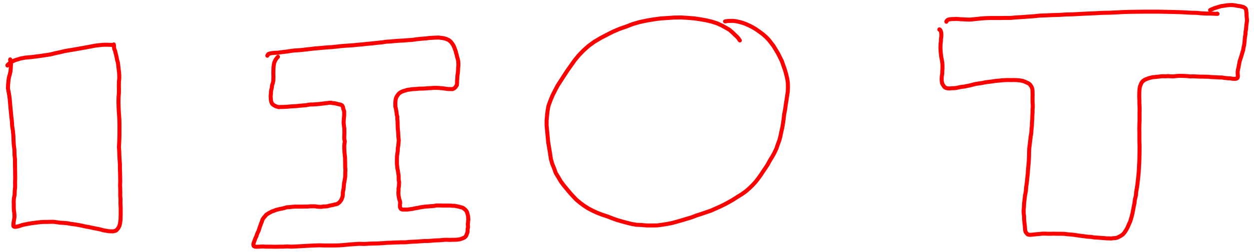
PANA ACADEMY

1. Basic Civil Engineering

1.4 Geometric properties of sections

Er. Dilendra Raj Panta

Sub topics



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- Axes of symmetry
- Centre of gravity of different sections
- Moment of inertia (I)   1D, 2D, 3D
- Radius of gyration

$$R = \sqrt{\frac{I}{A}}$$

Axes of symmetry

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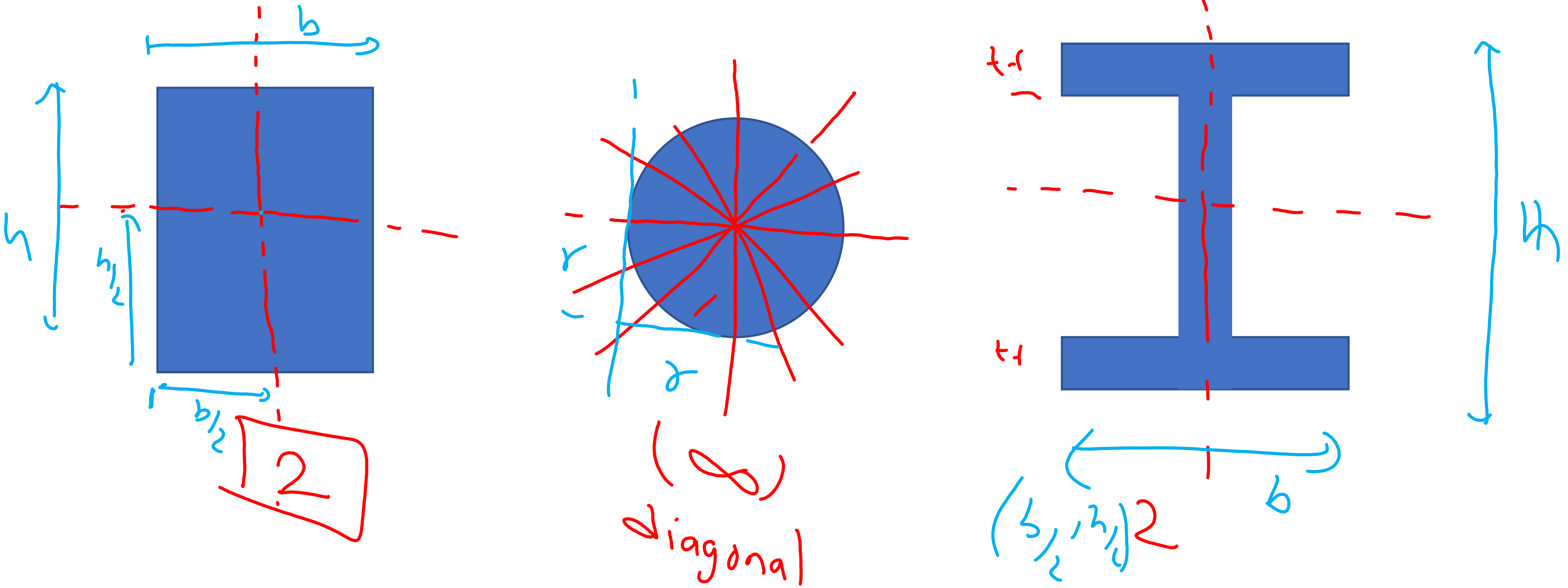
Axis of symmetry is a line that divides an object into two equal halves, two sides are mirror image to each other



Axes of symmetry

(centroind)
(Shear centre)

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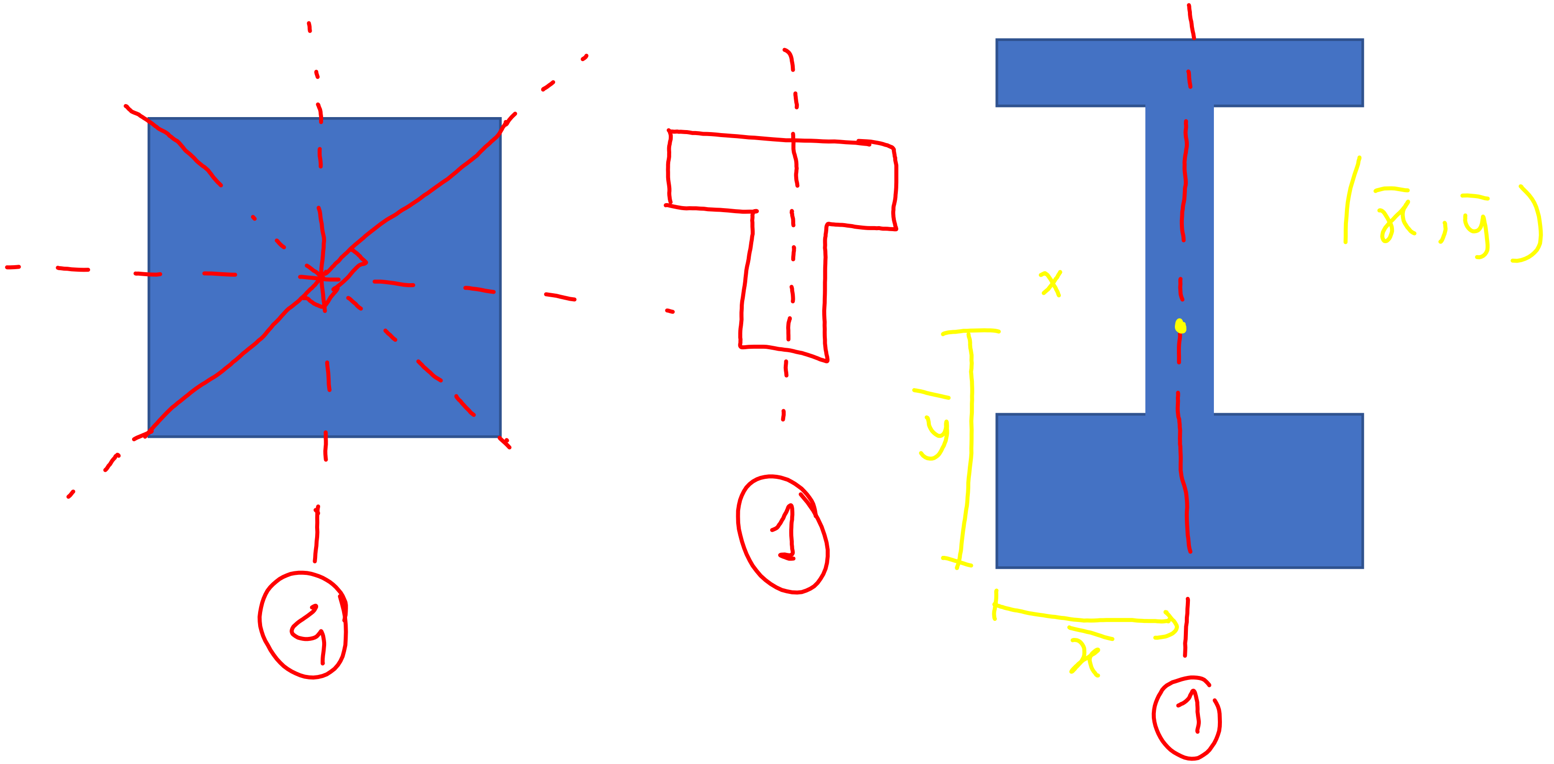
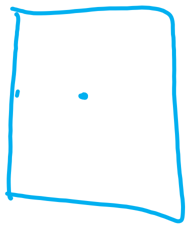
Axis of symmetry is a line that divides an object into two equal halves



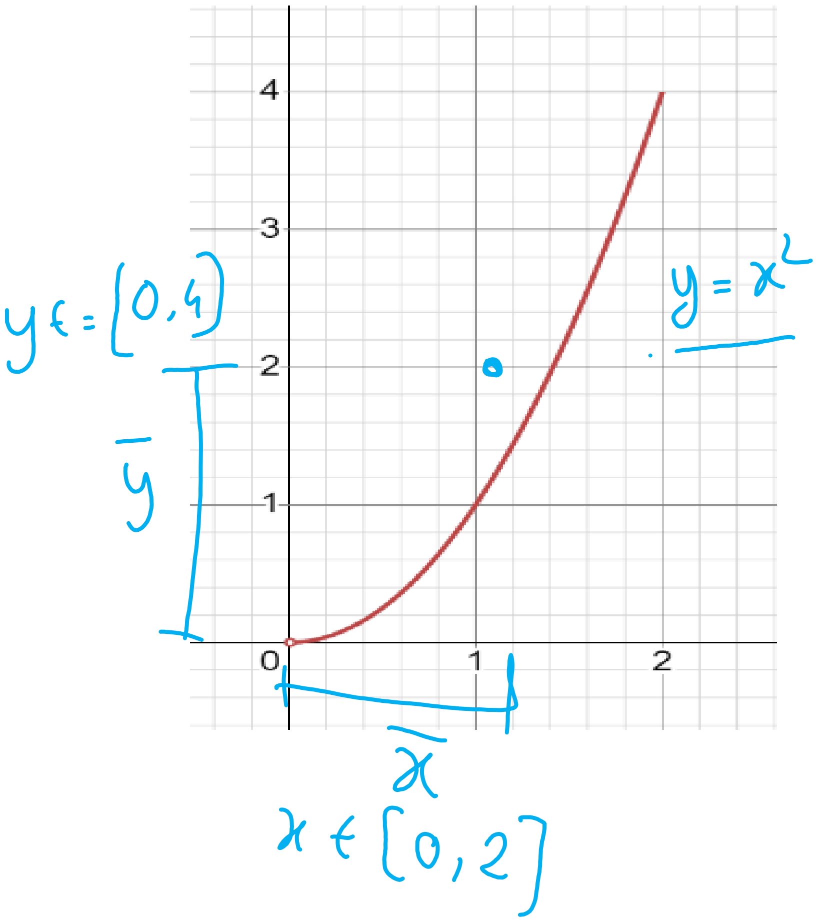
Centre of gravity of different sections

Centre of gravity:
Imaginary point where weight of body is thought to be concentrated.

Centroid: / C.A
Imaginary point where area is concentrated.
Also, the centre of mass of an object of uniform density , especially of a geometric figure



Centroid of lines (1D)



$$\bar{y} = \frac{\int y\,dL}{L} = \frac{\int y\,dL}{\int dL} = \frac{\int_0^2 x^2 \sqrt{1+4x^2}\,dx}{\int_0^2 \sqrt{1+4x^2}\,dx}$$

$$= 1.82$$

$$\bar{x} = \frac{\int x\,dL}{L}$$

$$\frac{dy}{dx} = \frac{dx^2}{dx} = 2x$$

$L = \int dL$

$dL = \sqrt{dy^2 + dx^2}$

$$dL = \left(\sqrt{1 + \left(\frac{dy}{dx}\right)^2}\right) dx = \sqrt{1 + 4x^2}\,dx$$

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Centroid of lines

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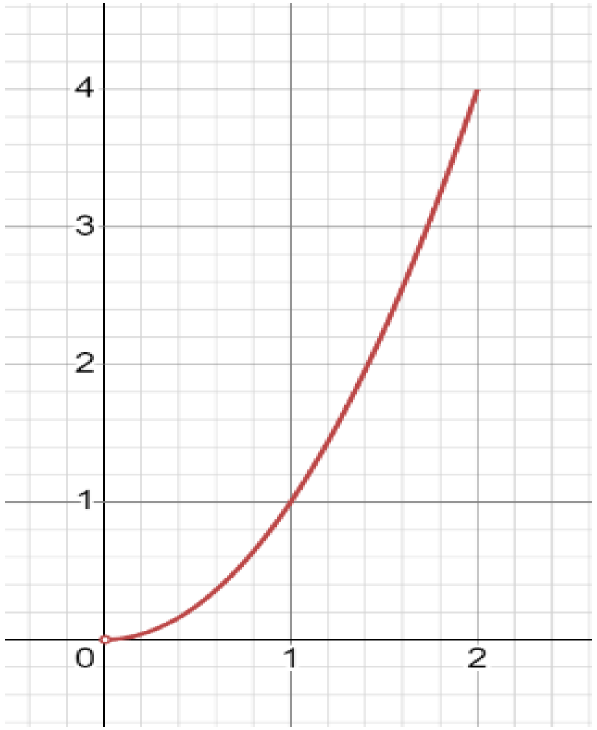

$$y = x^2$$

$$x \epsilon [0,2]$$

$$\frac{dy}{dx} = \frac{dx^2}{dx} = 2x$$

$$dL = \left(\sqrt{1 + \left(\frac{dy}{dx}\right)^2}\right) dx$$

$$= \sqrt{1 + (2x)^2}\, dx$$

$$= \sqrt{1 + 4x^2}\ \ dx$$

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Centroid of lines

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$$\bar{y} = \frac{\int y\sqrt{1+4x^2}\,dx}{\int \sqrt{1+4x^2}\,dx} = \frac{\int x^2\sqrt{1+4x^2}\,dx}{\int \sqrt{1+4x^2}\,dx}$$

$$\bar{x} = \frac{\int x\sqrt{1+4x^2}\,dx}{\int \sqrt{1+4x^2}\,dx}$$

$$\bar{y} = \frac{\int y\sqrt{1+4x^2}\ dx}{\int \sqrt{1+4x^2}\ dx} = \frac{\int_0^2 x^2\sqrt{1+4x^2}\ dx}{\int_0^2 \sqrt{1+4x^2}\ dx} = 1.82$$

$$\bar{x} = \frac{\int_0^2 x\sqrt{1+4x^2}\ dx}{\int_0^2 \sqrt{1+4x^2}\ dx} = 1.23$$

$$= \frac{\int x\,dL}{\int dl}$$

$\bar{x} = 1.23$

$\bar{y} = 1.82$

Centroid of lines

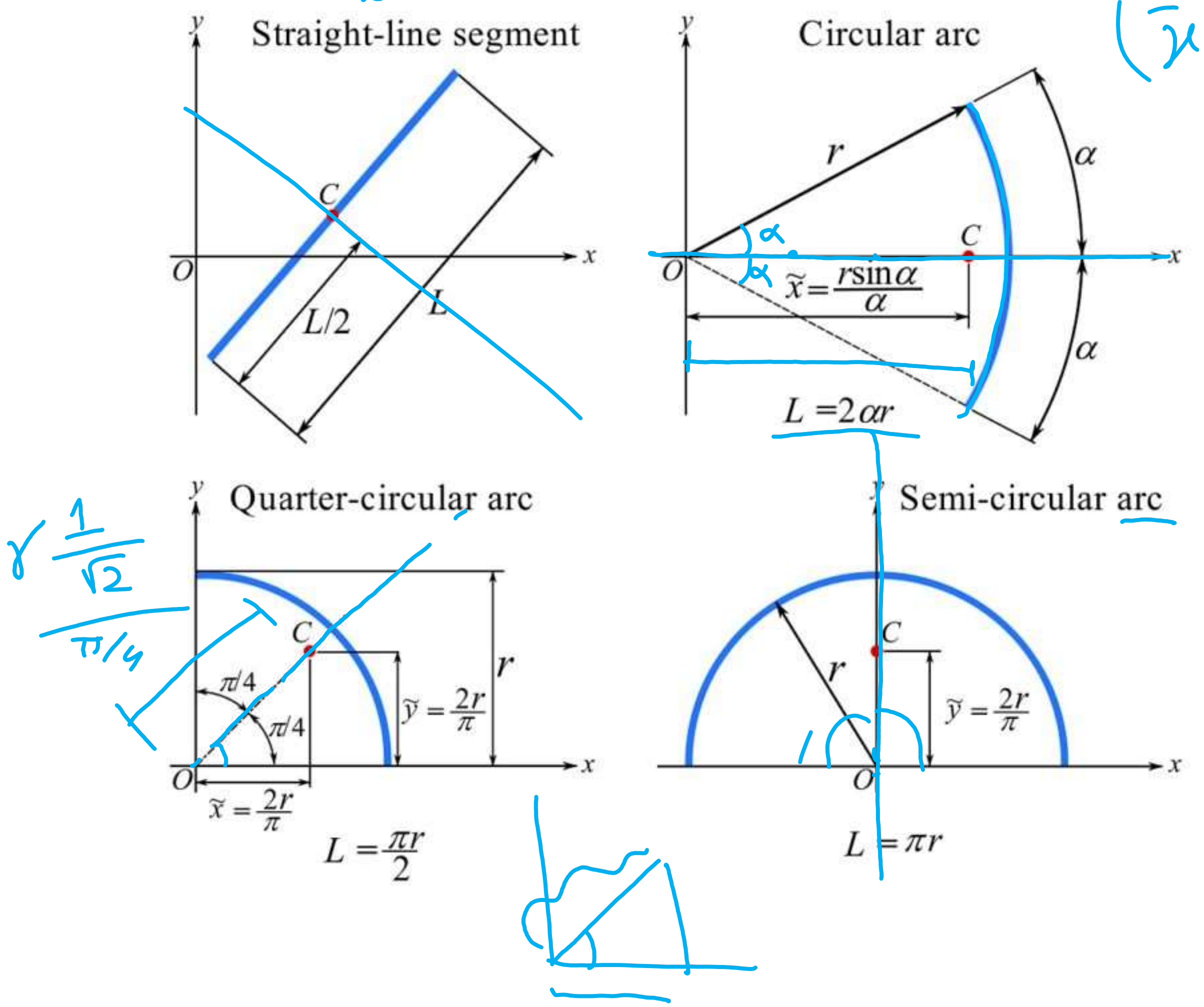
180 → π

1 → π/180

45 → π/180 × 45 = π/4

α → radian

$(\bar{x}, \bar{y}) = \left(\frac{r \sin\alpha}{\alpha}, 0 \right)$



$$\bar{y} = \frac{\bar{y}_1 L_1 + \bar{y}_2 L_2}{L_1 + L_2} = \frac{\sum \bar{y}_i L_i}{\sum L_i}$$

$$\bar{x} = \frac{\bar{x}_1 L_1 + \bar{x}_2 L_2}{L_1 + L_2}$$

MCQs

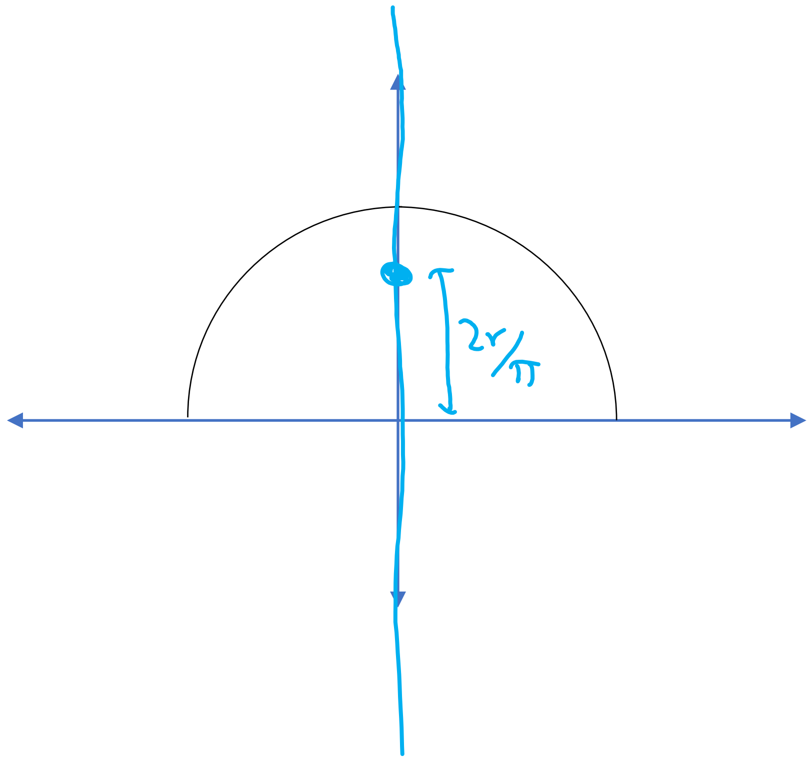
The centroid of semi circular arch with center in origin is

a) $x = 0; y = 2r/\pi$

b) $x = 2r/\pi; y = 2r/\pi$

c) $x = 2r/\pi; y = 0$

d) $x = 0; y = 0$



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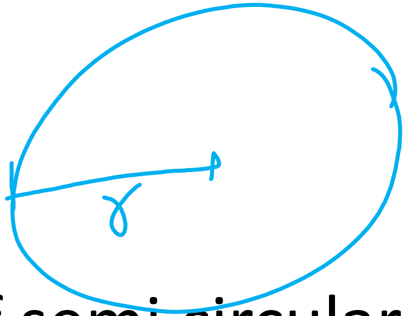
MCQs



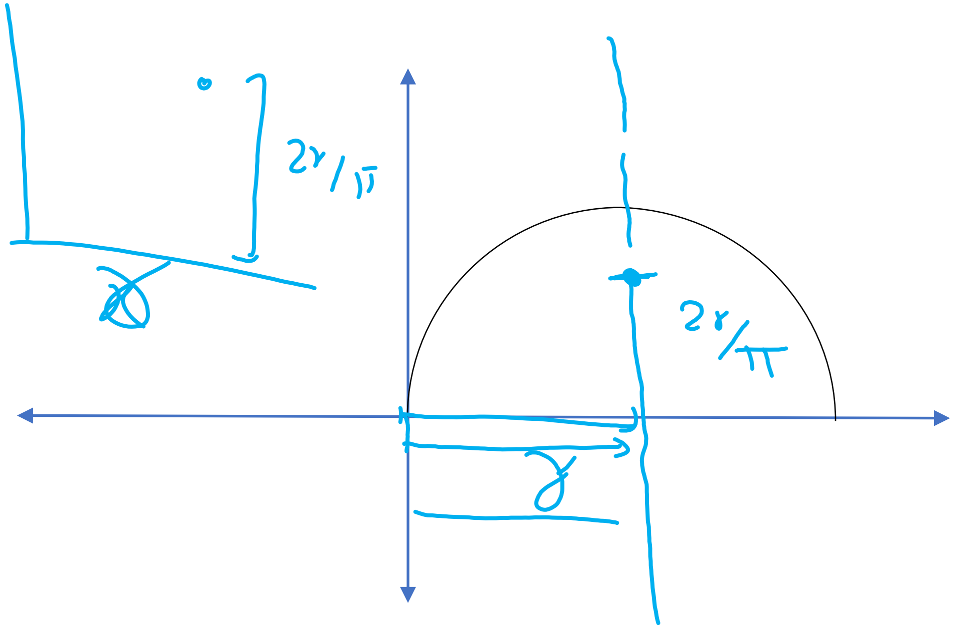
The centroid of semi circular arch with center in origin is

a) $x = r; y = 2r/\pi$

b) $x = 2r/\pi; y = 2r/\pi$

c) $x = 2r/\pi; y = 0$

d) $x = 2r/\pi; y = 0$



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MCQs

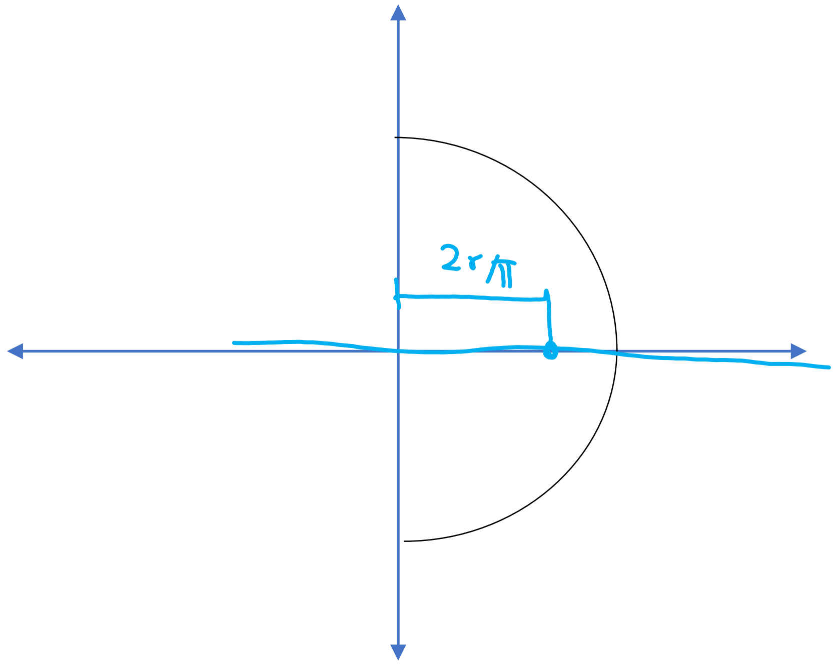
The centroid of semi circular arch with center in origin is

a) $x = 0; y = 2r/\pi$

b) $x = 2r/\pi; y = 2r/\pi$

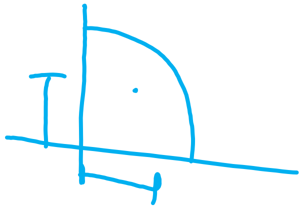
c) $x = 2r/\pi; y = 0$

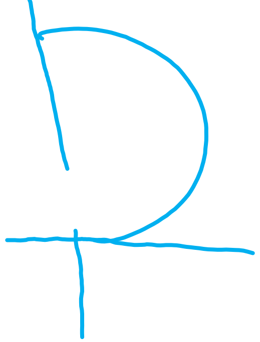
d) $x = 0; y = 0$



MCQs

The centroid of semi circular arch with center at (0, $2r/\pi$) is



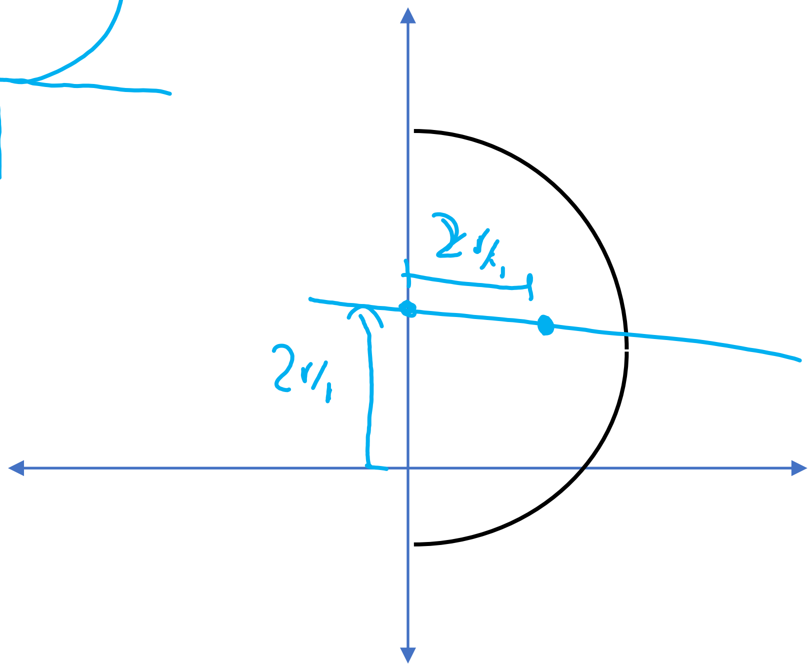


a) $x = 0; y = 2r/\pi$

b) $x = 2r/\pi; y = 2r/\pi.$

c) $x = 2r/\pi; y = 0$

d) $x = 0; y = 0$



Centroid of lines

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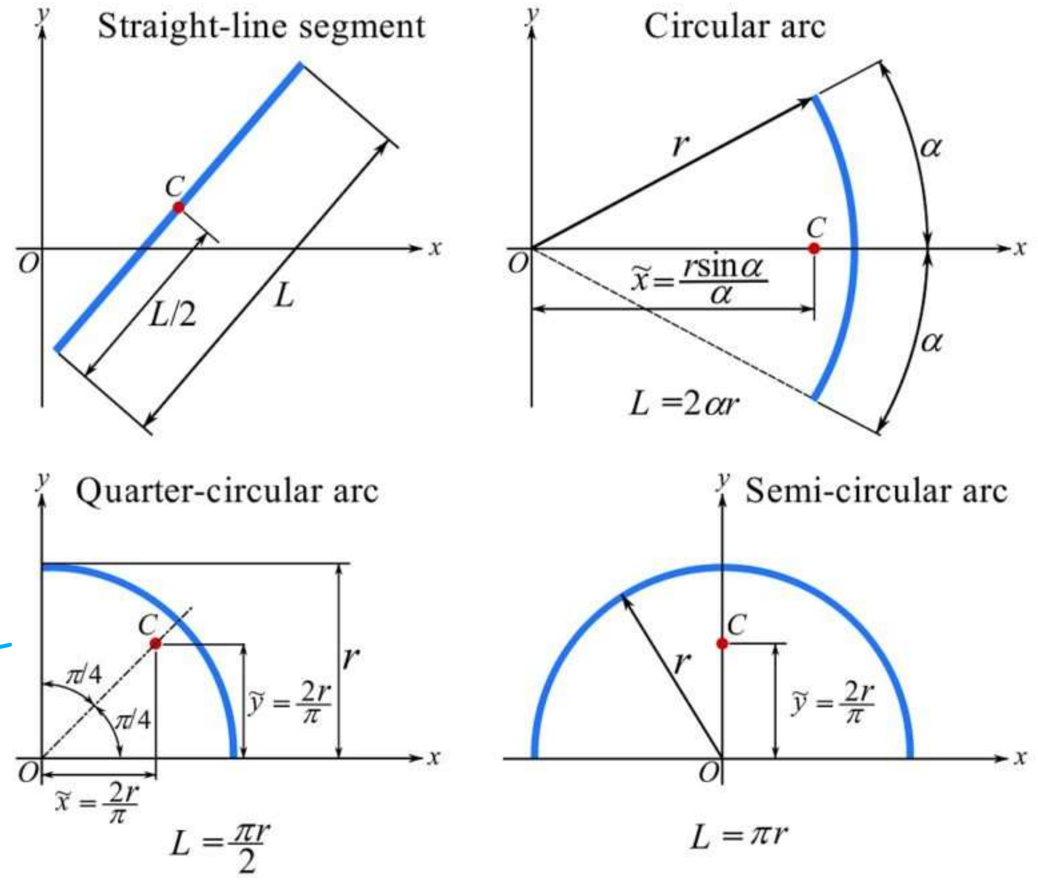

$$\bar{y} = \frac{\bar{y}_1 L_1 + \bar{y}_2 L_2}{L_1 + L_2}$$

$$\bar{x} = \frac{\bar{x}_1 L_1 + \bar{x}_2 L_2}{L_1 + L_2}$$

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MCQs

$$\bar{y} = \frac{y_1 L_1 + y_2 L_2}{L_1 + L_2} = \frac{0 \times 2r + \frac{2r}{\cancel{\pi}} \cancel{\pi} r}{2r + \pi r}$$

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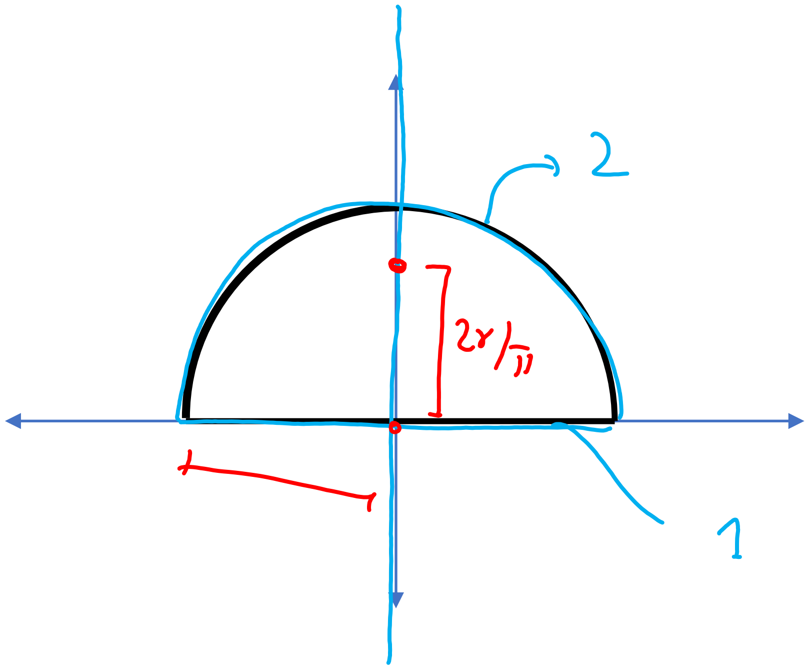
The centroid path formed by semi circular arch (r=5) with center at origin and its diameter is

a) $x = 0; y = \dfrac{2r}{\pi + 2}$.

b) $x = 0; y = 2r/\pi$

c) $x = 2r/\pi; y = 0$

d) $x = \dfrac{2r}{\pi + 2}; y = 0$



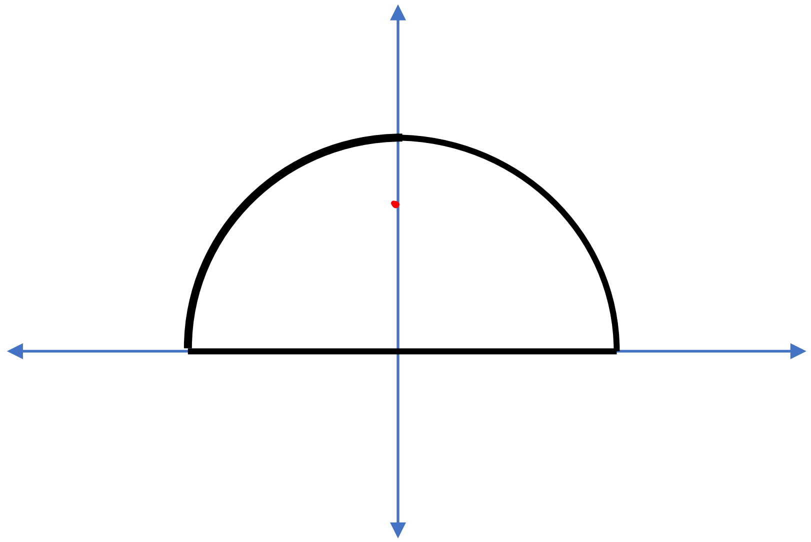
MCQs

PANA ACADEMY

The centroid path formed by semi circular arch with center in origin and its diameter is at

$$\bar{y} = \frac{\bar{y}_1 L_1 + \bar{y}_2 L_2}{L_1 + L_2}$$

$$\bar{x} = \frac{\bar{x}_1 L_1 + \bar{x}_2 L_2}{L_1 + L_2}$$



Centre of gravity of different sections

$$\bar{y} = \frac{\int \breve{y} dA}{A}$$

$$\bar{y} = \frac{\bar{y}_1 A_1 + \bar{y}_2 A_2}{A_1 + A_2}$$

$$\bar{x} = \frac{\int \breve{x} dA}{A}$$

$$\bar{x} = \frac{\bar{x}_1 A_1 + \bar{x}_2 A_2}{A_1 + A_2}$$

$$A = \int dA$$

$$dA = xdy = ydx$$

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Centre of gravity of different sections

$= \int_0^b \frac{y}{2}\, ydx \Big/ \int_0^b ydx$

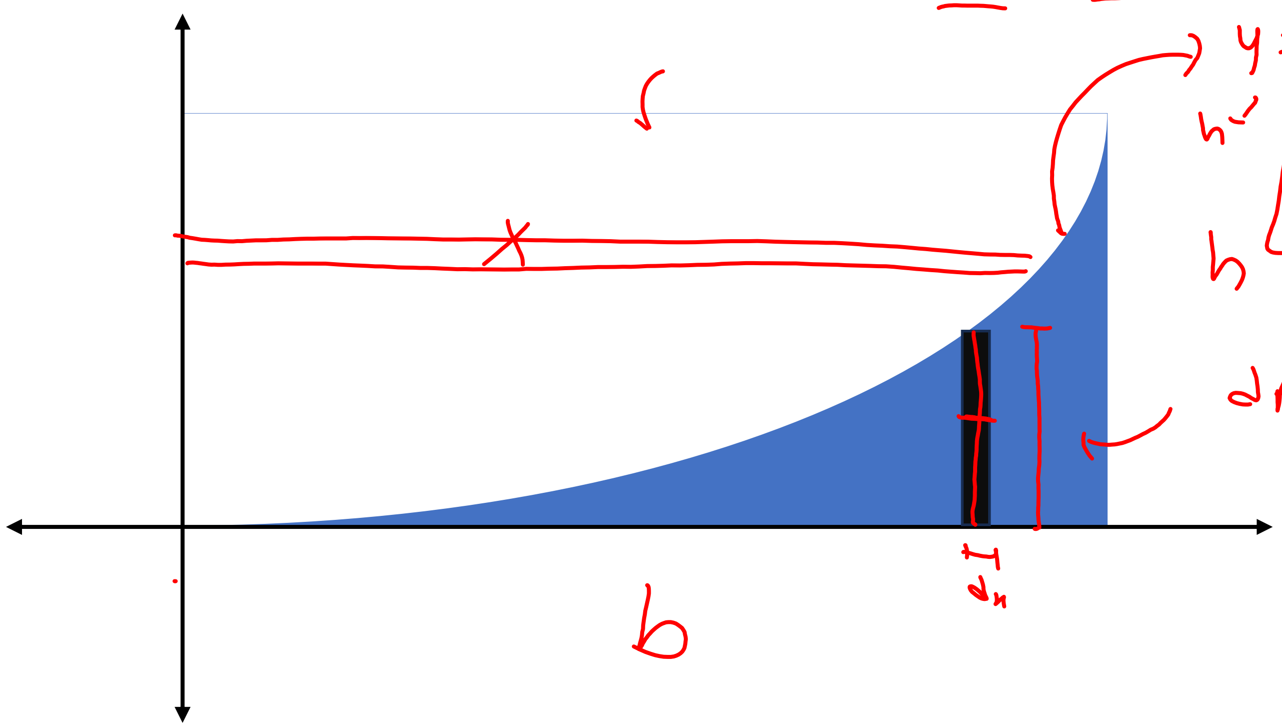
$$\bar{y} = \frac{\int \breve{y} dA}{A}, \bar{x} = \frac{\int \breve{x} dA}{A}$$

$$A = \int dA$$
$$dA = xdy = ydx$$

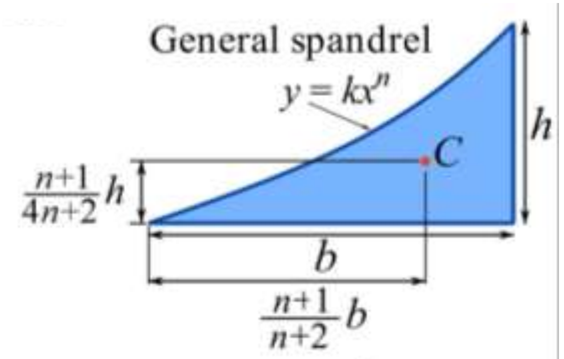
$y = kx^n$

$\boxed{h = kb^n}$

$dA = ydx$



$$A = \frac{bh}{n+1}$$



$$A = \frac{bh}{n+1}$$

$y = kx^n$
When x=b, y =h, so,
$h = kb^n$

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Centre of gravity of different sections

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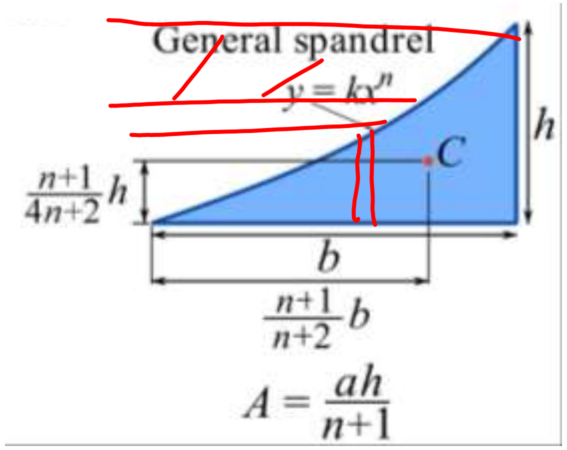
$$\bar{y} = \frac{\int \breve{y} dA}{A}, \bar{x} = \frac{\int \breve{x} dA}{A} \qquad A = \int dA$$
$$dA = xdy = ydx$$

$$dA = ydx$$
$$A = \int dA = \int_0^b kx^n dx = k\frac{b^{n+1}}{n+1} = \frac{bh}{n+1}$$

$$\int x^n dx = \frac{x^{n+1}}{n+1}$$

$$\int \breve{y} dA = \int \frac{y}{2} . ydx = \int \frac{y^2 dx}{2} = \int_0^b \frac{k^2 x^{2n} dx}{2}$$
$$= \frac{1}{2} k^2 \frac{b^{2n+1}}{2n+1} = \frac{k^2 b^{2n} . b}{4n+2} = \frac{h^2 b}{4n+2}$$



$$\bar{y} = \frac{\int \breve{y} dA}{A} = \frac{\frac{h^2 b}{4n+2}}{\frac{bh}{n+1}} = \frac{n+1}{4n+2} h$$

Centre of gravity of different sections

$$\bar{y} = \frac{\bar{y}_1 A_1 + \bar{y}_2 A_2}{A_1 + A_2}$$

$$\bar{x} = \frac{\bar{x}_1 A_1 + \bar{x}_2 A_2}{A_1 + A_2}$$

$\bar{x}$ x

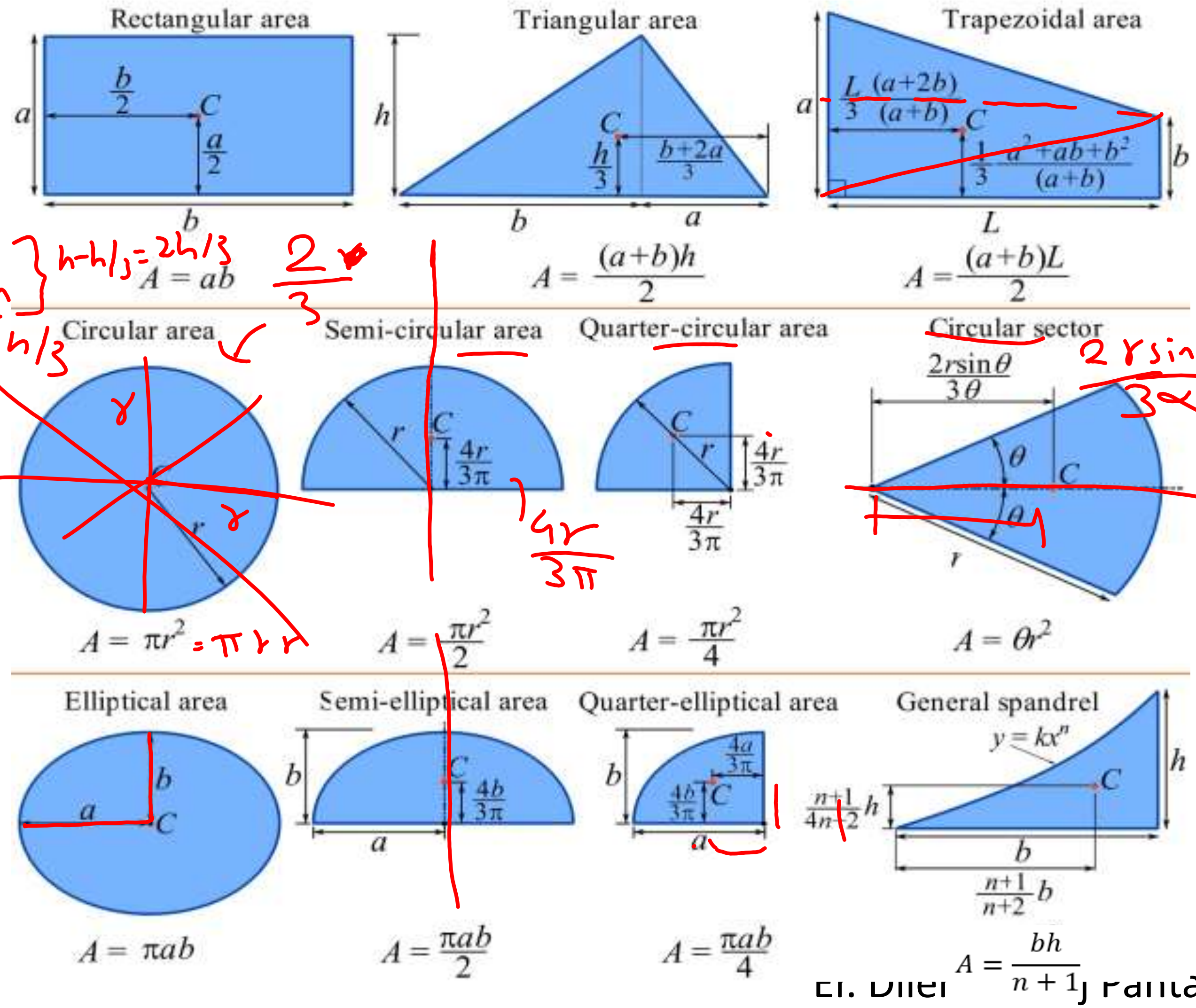
$y = 3x^3$

$h - h/3 = 2h/3$

h

$h/3$

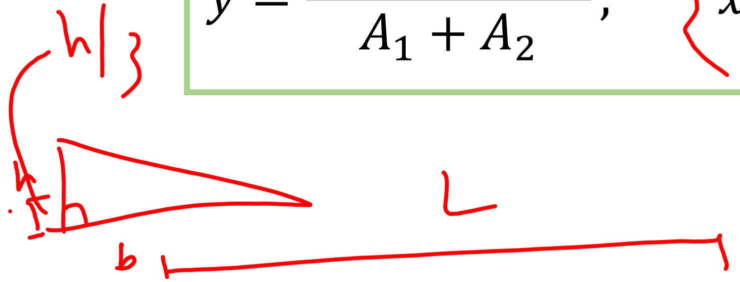
$\frac{2}{3}$

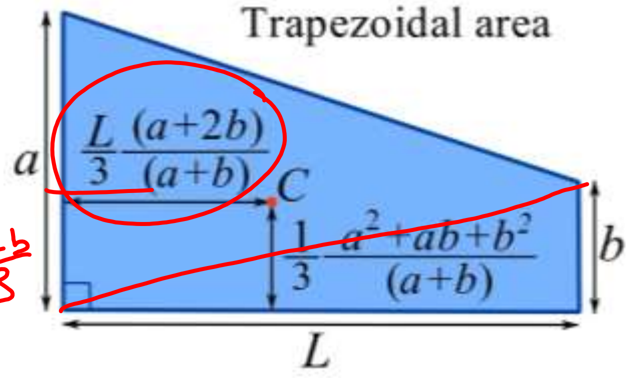


$4r/3\pi$

$2r\sin\alpha / 3\alpha$

$$\bar{y} = \frac{\bar{y}_1 A_1 + \bar{y}_2 A_2}{A_1 + A_2}, \quad \bar{x} = \frac{\bar{x}_1 A_1 + \bar{x}_2 A_2}{A_1 + A_2}$$





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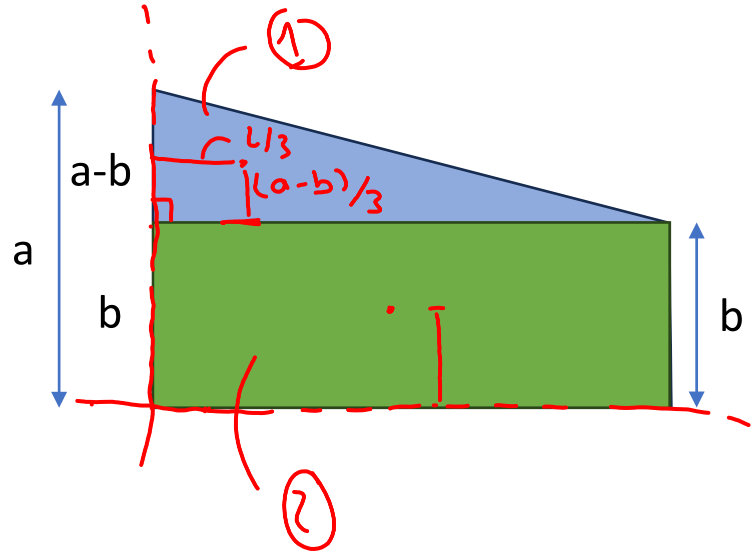
$\bar{y}_1 = b + \frac{a-b}{3}$



$$A_1 = \frac{1}{2}(a-b)L \,, \bar{x}_1 = \frac{L}{3}$$

$$A_2 = bL \,, \bar{x}_2 = \frac{L}{2}, \; \bar{y}_2 = b/2$$

$\frac{1}{2}(a-b)L \times L/3$

$\frac{L^2}{6}(a-b)$

$$A = A_1 + A_2 = \frac{1}{2}(a-b)L + bL = \frac{1}{2}(a+b)L$$

$$\bar{x}_1 A_1 + \bar{x}_2 A_2 = \frac{L^2(a-b)}{6} + \frac{L^2 b}{2} = \frac{L^2(a-b) + 3L^2 b}{6} = \frac{L^2(a+2b)}{6}$$

$$\bar{x} = \frac{\bar{x}_1 A_1 + \bar{x}_2 A_2}{A_1 + A_2} = \frac{\frac{L^2(a+2b)}{6}}{\frac{1}{2}(a+b)L} = \boxed{\frac{L}{3}\frac{(a+2b)}{(a+b)}}$$

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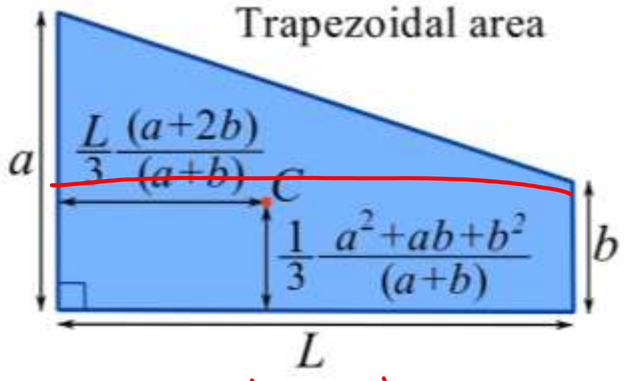
$$\bar{y} = \frac{\bar{y}_1 A_1 + \bar{y}_2 A_2}{A_1 + A_2}, \qquad \bar{x} = \frac{\bar{x}_1 A_1 + \bar{x}_2 A_2}{A_1 + A_2}$$



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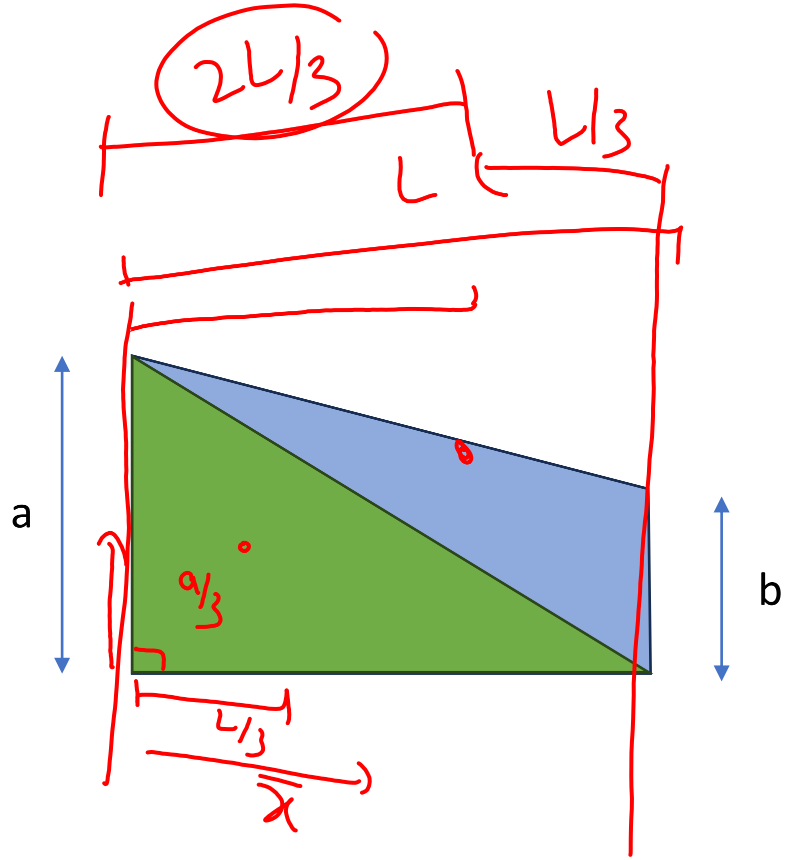
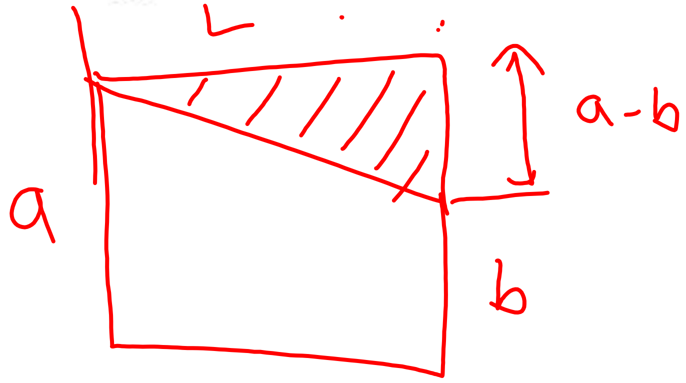


$$A_1 = \frac{1}{2} aL \,, \bar{x}_1 = \frac{L}{3}$$

$$A_2 = \frac{1}{2} bL \,, \bar{x}_2 = \frac{2L}{3}$$



$$A = A_1 + A_2 = \frac{1}{2} aL + \frac{1}{2} bL = \frac{1}{2}(a+b)L$$

$$\bar{x}_1 A_1 + \bar{x}_2 A_2 = \frac{L^2 a}{6} + \frac{2L^2 b}{6} = \frac{L^2(a+2b)}{6}$$

$$\bar{x} = \frac{\bar{x}_1 A_1 + \bar{x}_2 A_2}{A_1 + A_2} = \frac{\frac{L^2(a+2b)}{6}}{\frac{1}{2}(a+b)L} = \boxed{\frac{L}{3}\frac{(a+2b)}{(a+b)}}$$

$A_1 = L a, \bar{x}_1 = L/2$

$A_2 = \frac{1}{2}(a-b).L$

$\bar{x}_2 = 2L/3$

$$\bar{x} = \frac{\bar{x}_1 A_1 - \bar{x}_2 A_2}{A_1 - A_2}$$

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MCQs

PANA ACADEMY

The centroid of given shape $(\bar{y})$

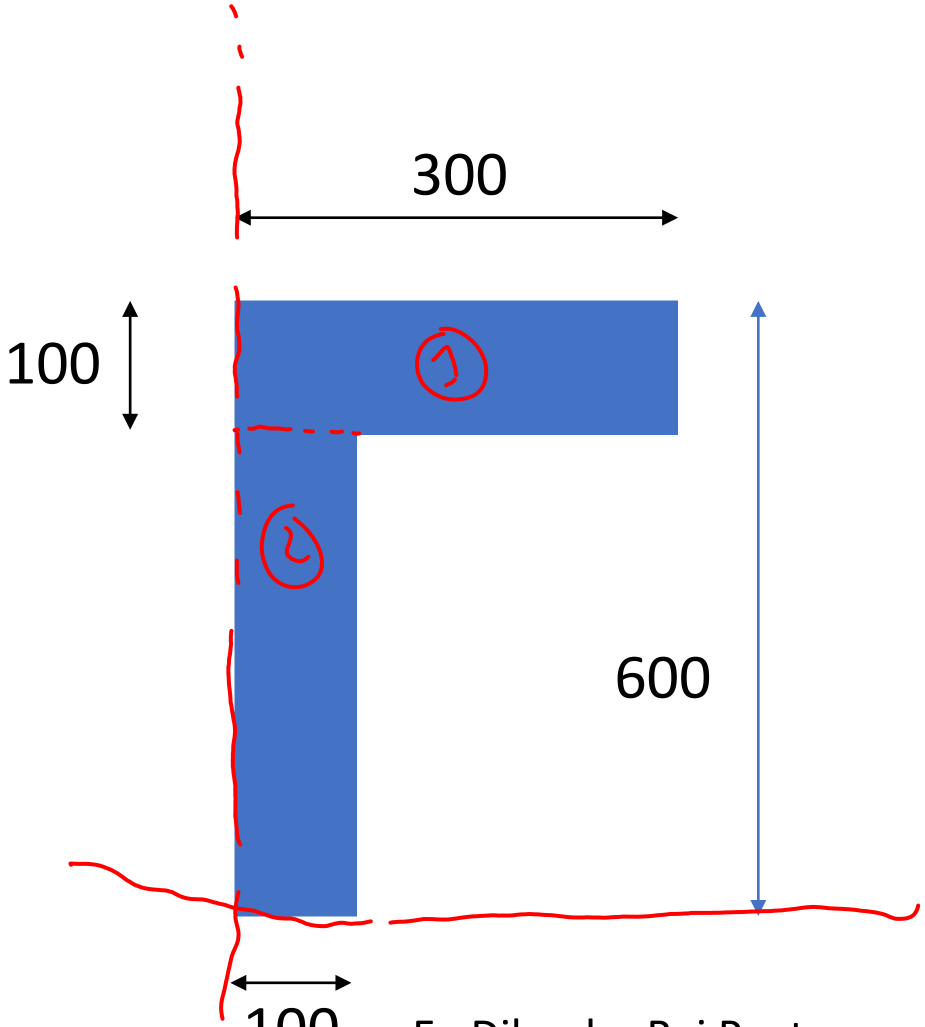
a) $362.5\ from\ top$

b) $362.5\ from\ bottom$

$= 237.5$ from top

c) $300\ from\ bottom$

d) $cannot\ be\ determined$



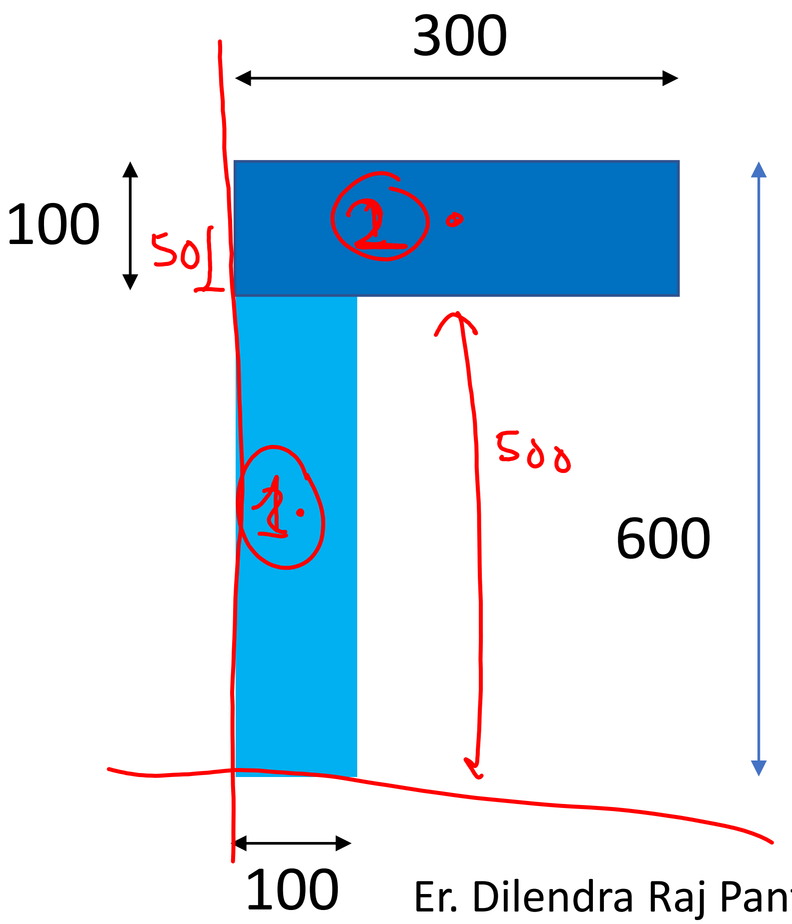
MCQs

The centroid of given shape

$$\bar{y} = \frac{\bar{y}_1 A_1 + \bar{y}_2 A_2}{A_1 + A_2} \Bigg\} = 362.5$$

$\bar{y}_1$=250, A_1=100*500
$\bar{y}_2$=500+50, A_2=300*100

$$362.5\ from\ bottom$$



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MCQs

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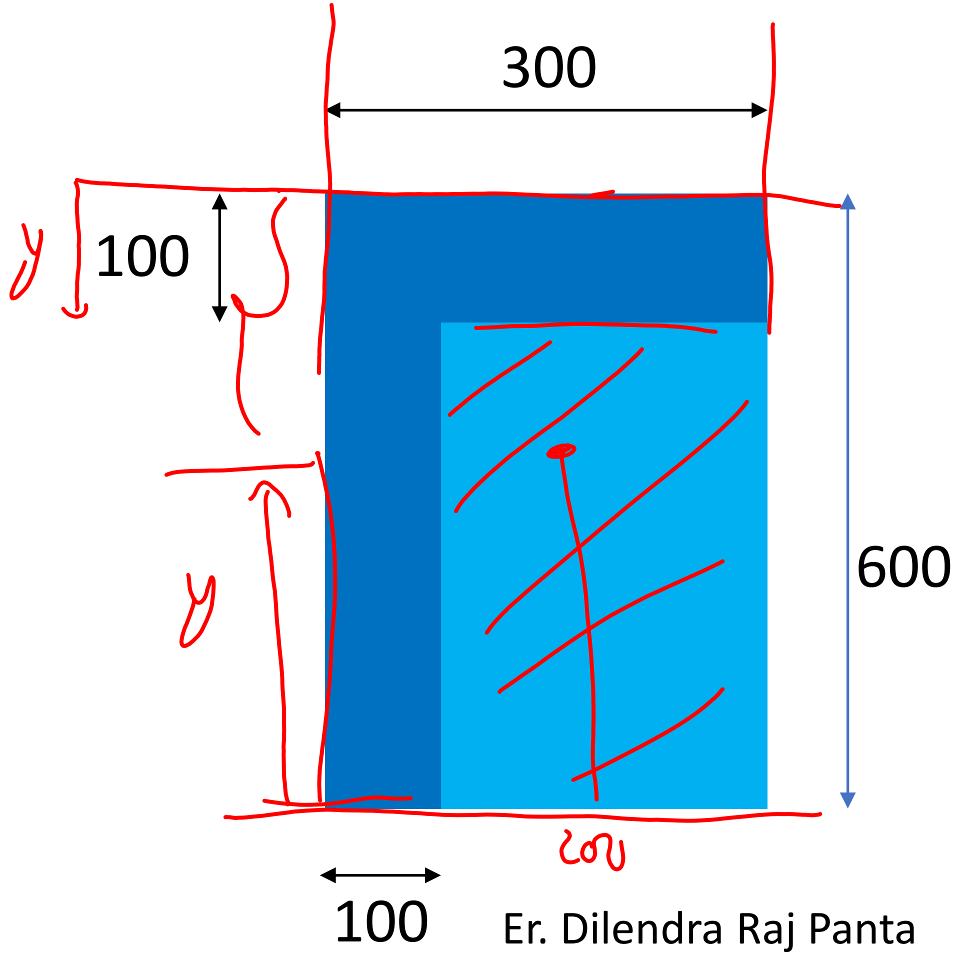
The centroid of given shape

$$\bar{y} = \frac{\bar{y}_1 A_1 - \bar{y}_2 A_2}{A_1 - A_2} = 362.5\,mm$$

$\bar{y}_1$=600/2, A_1=300*600
$\bar{y}_2$=500/2, A_2=200*500

$362.5\ from\ bottom$



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MCQs

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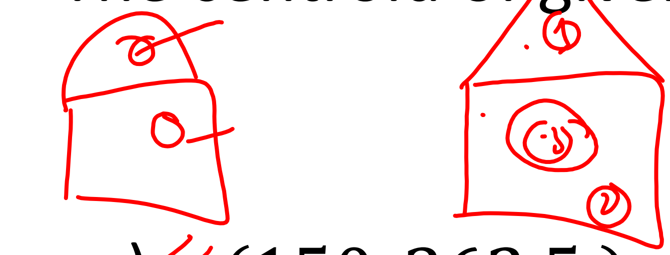
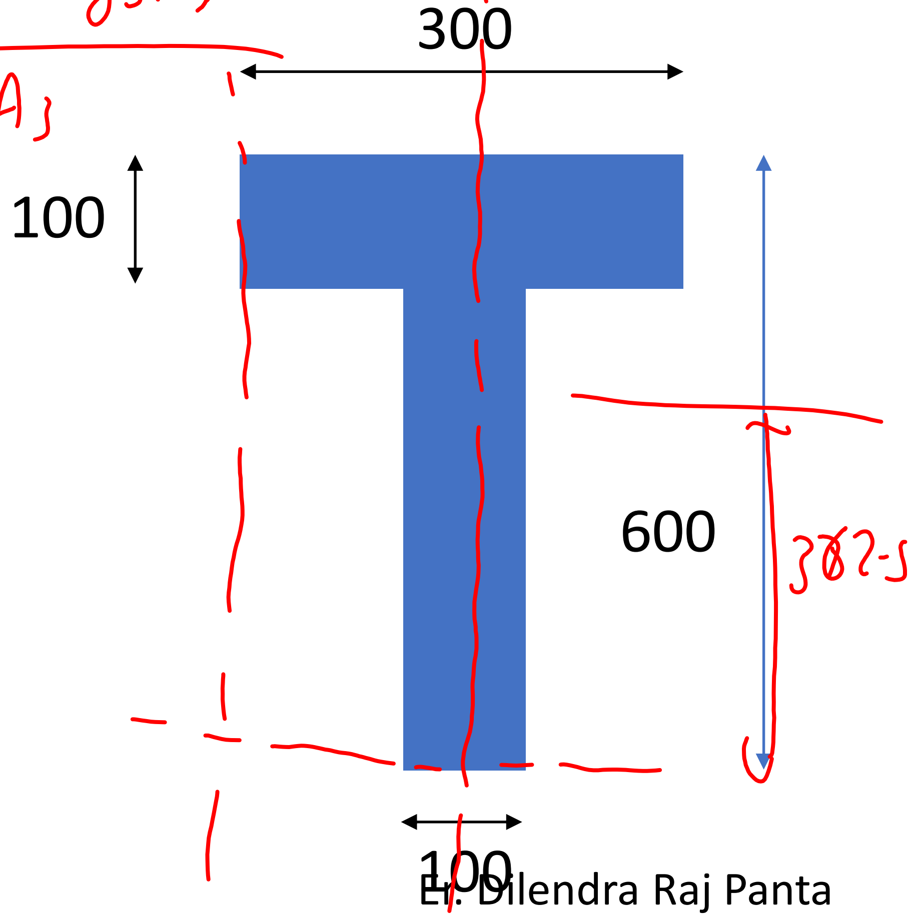
The centroid of given shape



$$\bar{y} = \frac{y_1 A_1 + y_2 A_2 - y_3 A_3}{A_1 + A_2 - A_3}$$



a) (150, 362.5)

b) (0, 362.5)

c) (362.5, 150)

d) (150, 237.5)

Centre of weight of different volumes

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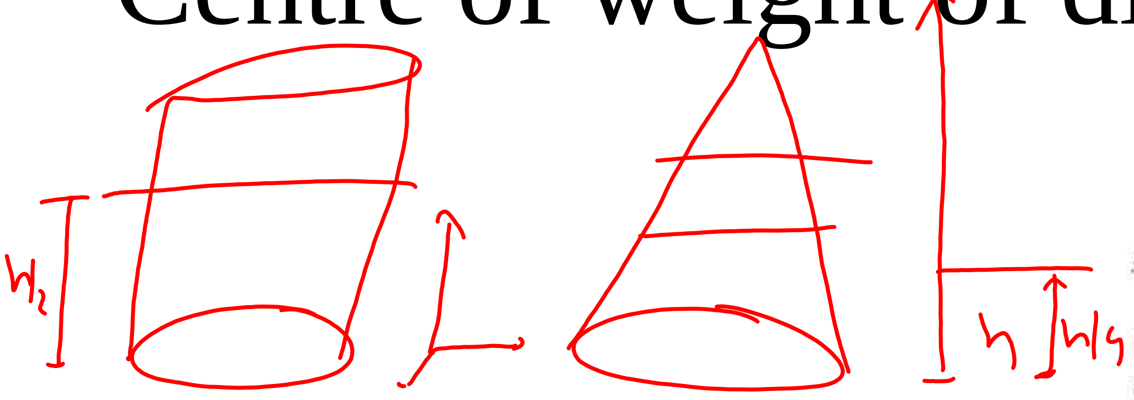
$$\bar{y} = \frac{\int y dV}{V}$$

$$\bar{x} = \frac{\int x dV}{V}$$

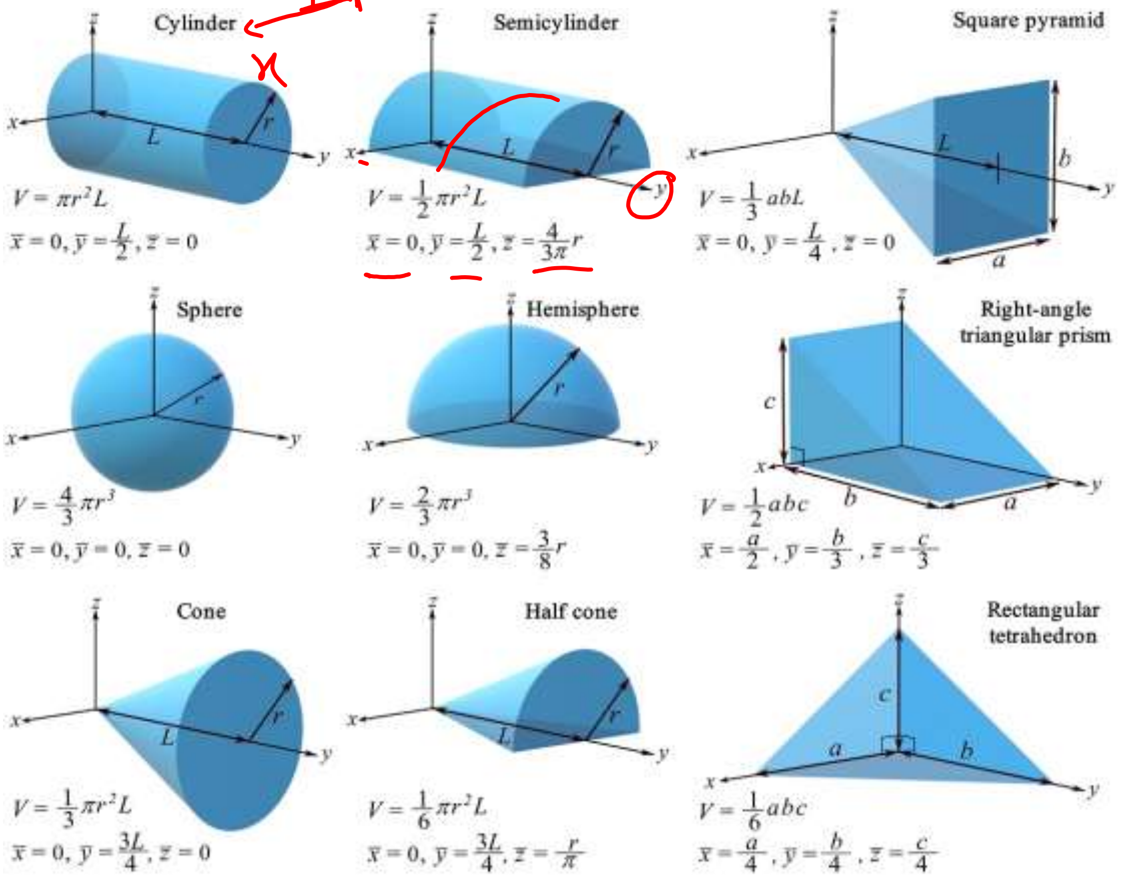
$$\bar{y} = \frac{\bar{y}_1 V_1 + \bar{y}_2 V_2}{V_1 + V_2}$$

$$\bar{x} = \frac{\bar{x}_1 V_1 + \bar{x}_2 V_2}{V_1 + V_2}$$

Centre of weight of different volumes



$\bar{y} = L/2$



Cylinder
Prism

$V = A \times h$
$= \pi r^2 h$
$\bar{z} = h/2$

Cone
Pyramid

$V = \frac{1}{3} A \times h$
$= \frac{1}{3} \pi r^2 h$
$\bar{z} = h/4$

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Centre of weight of different volumes

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height from base $h/4$

Solid and hollow Prism

$$\bar{z} = \frac{h}{2}, V = A * h$$

Solid Pyramid , cone

$$\bar{z} = \frac{h}{4}$$ $V = \frac{1}{3} A * h$

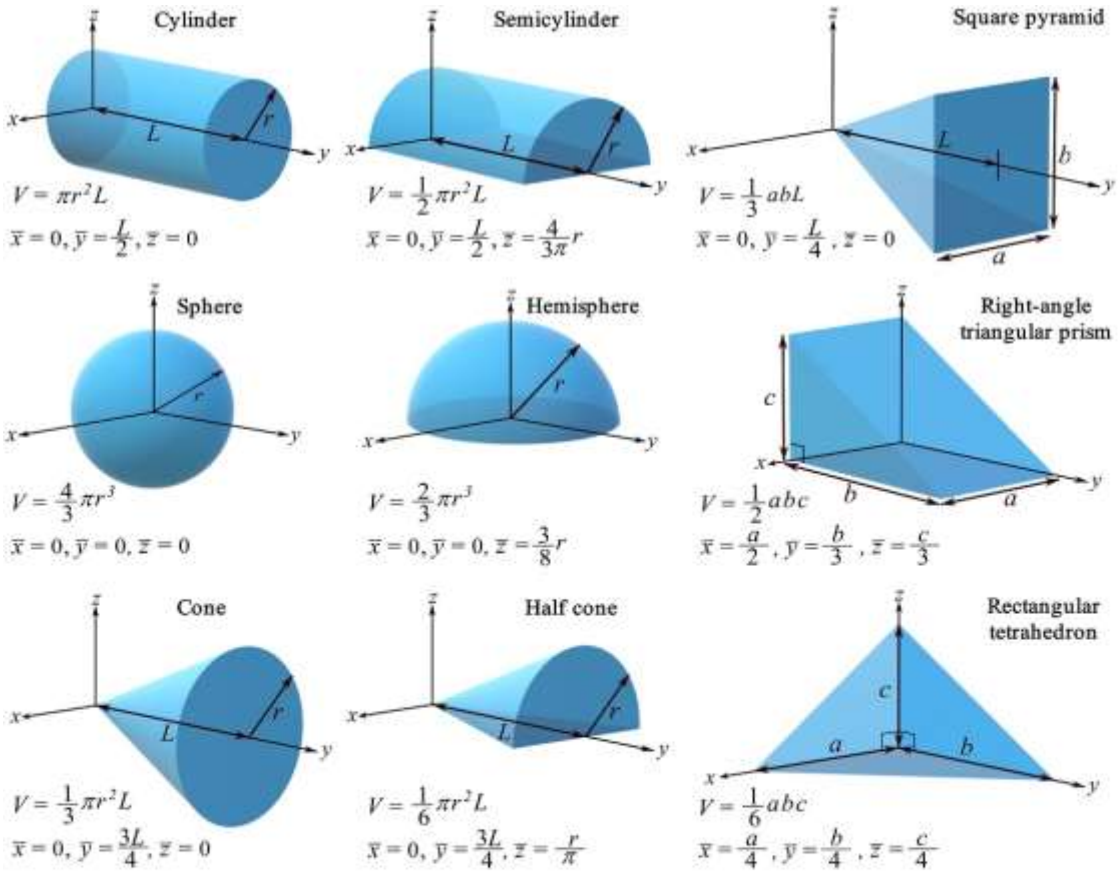
Hollow Pyramid , cone

$$\bar{z} = \frac{h}{3}, \cancel{V = \frac{1}{3} A * h}$$

Hemisphere

$$\bar{z} = \frac{3r}{8} = \frac{3d}{16}, V = \frac{2}{3}\pi r^3$$

r $3r/8$ $5r/8$



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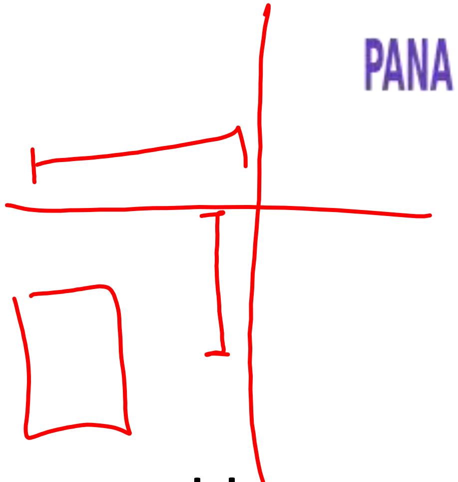
Moment of inertia

Second moment of area.

$$I_x = \int y^2 dA = \sum y^2 dA$$

$I_y = \int x^2 dA$



Moment of inertia is defined as the quantity expressed by the body resisting angular acceleration which is the sum of the product of the mass of every particle with its square of a distance from the axis of rotation.

CG about moi is minimum

Always positive

Moment of inertia

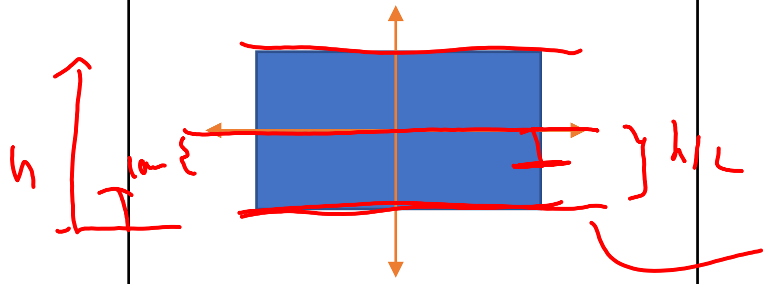
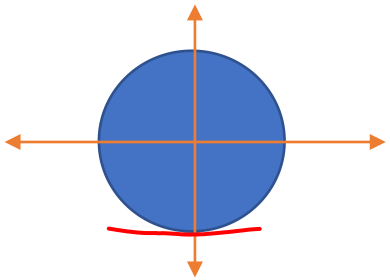
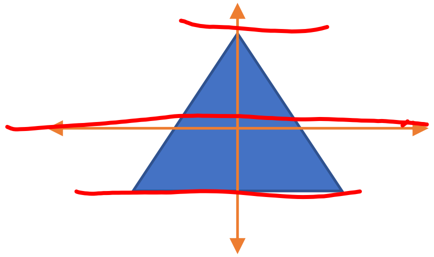
Product moment of area is

$$I_{xy} = \int xydA = \sum xydA$$

Principle axis – product moment of inertia is zero (I_{uv})

$F \times y^2$

PANA ACADEMY

Shape	Centroid	Moment of inertia
	$\bar{x} = b/2$ $\bar{y} = h/2$	$I_{\bar{x}\bar{x}} = \frac{bh^3}{12}$
	$\cancel{I_{xx} = I_b + Ad^2}$ At center	$I_{\bar{x}\bar{x}} = \frac{\pi D^4}{64}$
	$\bar{x} = b/2$ $\bar{y} = h/3$	$I_{\bar{x}\bar{x}} = \frac{bh^3}{36}$

$I_b = I_{\bar{x}\bar{x}} + A \times d^2$

$I_b = \frac{bh^3}{12} + bh\left(\frac{h}{2}\right)^2 = \frac{bh^3}{3}$

$\frac{I_{ca}}{I_b} = 1/4$

h/2

Plastic NA → Area half

Aos

Moment of inertia

Parallel axis theorem:

$$I_{xx} = I_{cg} + Ah^2$$

Perpendicular axis theorem:

$$I_{zz} = I_{xx} + I_{yy}$$

I_{zz} is also termed as polar moment of inertia

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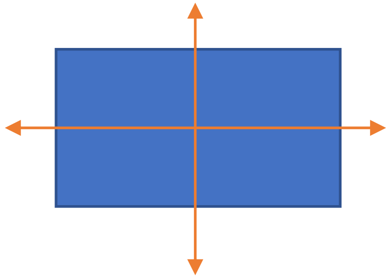
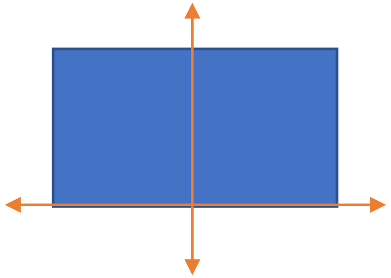
PANA ACADEMY

Shape	Centroid	Moment of inertia
	$\bar{x} = b/2$ $\bar{y} = h/2$	$I_{\bar{x}\bar{x}} = \frac{bh^3}{12}$
	$\bar{x} = b/2$ $\bar{y} = h/2$	$I_{xx} = \frac{bh^3}{12} + bh * \left(\frac{h}{2}\right)^2$ $= \frac{bh^3}{3}$

Ratio = ?

$\frac{I_{ca}}{I_b} = 1:4$

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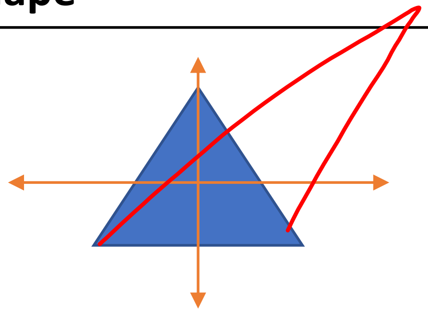
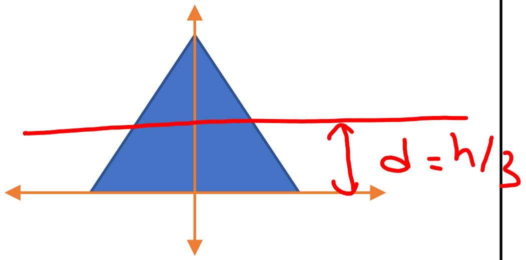
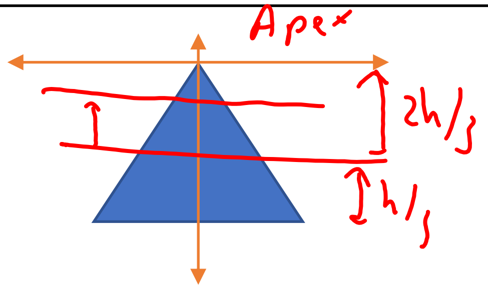
PANA ACADEMY

Shape	Centroid	Moment of inertia
	$\cancel{\bar{x} = b/2}$ $\bar{y} = h/3$	$I_{\bar{x}\bar{x}} = \frac{bh^3}{36}$
	$\bar{x} = b/2$ $\bar{y} = h/3$	$I_{xx} = \frac{bh^3}{36} + \frac{1}{2}bh * \left(\frac{h}{3}\right)^2$ $= \frac{bh^3}{12}$
	$\bar{x} = b/2$ $\bar{y} = h/3$	$I_{xx} = \frac{bh^3}{36} + \frac{1}{2}bh * \left(\frac{2h}{3}\right)^2$ $= \frac{bh^3}{4}$

Apex : base = 3:1

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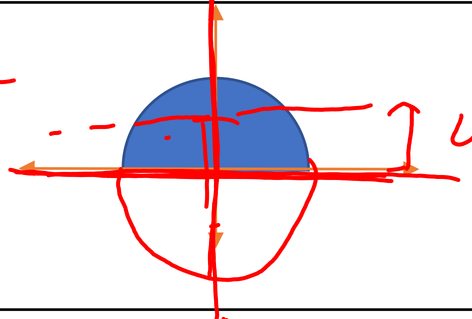
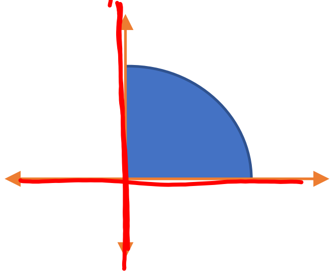
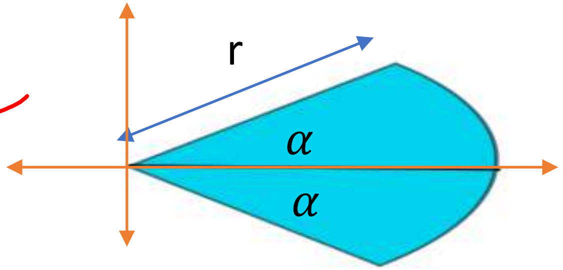
PANA ACADEMY

Shape	Centroid	Moment of inertia
$\frac{\pi D^4}{64} \times \frac{1}{2}$  $4r/3\pi$	$\bar{x} = 0$ $\bar{y} = 4r/3\pi$ $I_b = I_{\bar{x}\bar{x}} + Ad^2$ $I_{\bar{x}\bar{x}} = I_b - Ad^2$	$I_{xx} = \frac{\pi D^4}{128} = \frac{\pi r^4}{8}$(base) $I_{\bar{x}\bar{x}} = \left(\frac{\pi}{8} - \frac{8}{9\pi}\right) = 0.11r^4$ (about centroid)
	$\bar{x} = 4r/3\pi$ $\bar{y} = 4r/3\pi$	$I_{xx} = \frac{\pi D^4}{256} = \frac{\pi r^4}{\cancel{8}\ 16}$(base) $I_{\bar{x}\bar{x}} = \left(\frac{\pi}{16} - \frac{4}{9\pi}\right) = 0.055r^4$ (about centroid)
	$\bar{x} = \frac{2r\sin\alpha}{3\alpha}$ $\bar{y} = 0$	$I_{\bar{x}\bar{x}} = \frac{r^4}{4}(\alpha - \frac{1}{2}sin2\alpha)$

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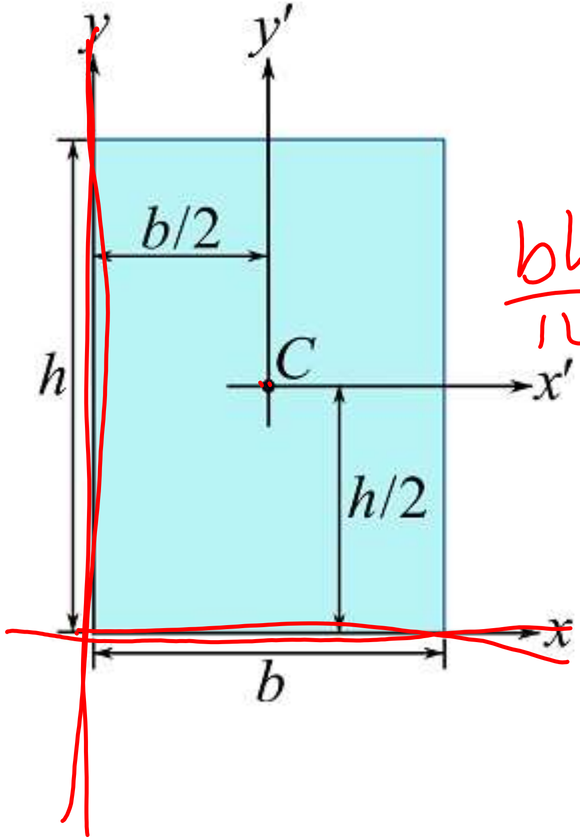
Moment of inertia



$\frac{bh}{12}(b^2 h^2)$

$$I_x = \bar{I}_{x'} + Ad^2 = \frac{1}{12}bh^3 + (bh)(\frac{h}{2})^2 = \frac{1}{3}bh^3$$

$$I_y = \bar{I}_{y'} + Ad^2 = \frac{1}{12}hb^3 + (bh)(\frac{b}{2})^2 = \frac{1}{3}hb^3$$

$\frac{bh^3}{3} + \frac{hb^3}{3}$

$\frac{bh}{3}(b^2+h^2)$

MCQs

$$= \frac{bh^3/36}{2h/3} = \frac{bh^2}{24}$$

PANA ACADEMY

Section modulus of hollow circular section

$$Z = \frac{I}{y_{max}}$$

a) $\pi \dfrac{D^4 - d^4}{64D}$

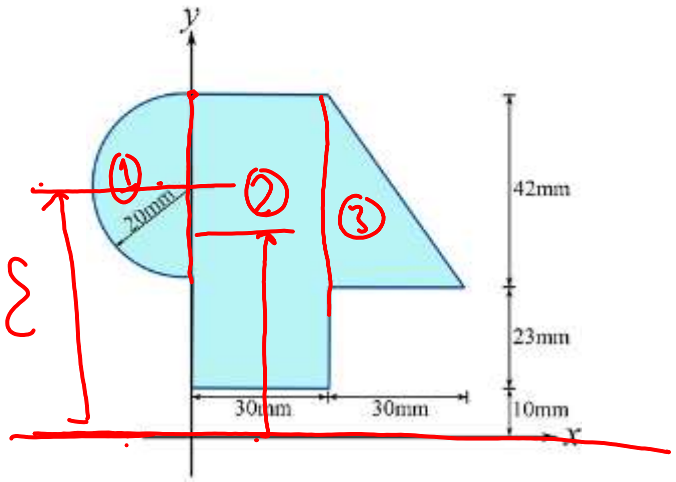
b) $\pi \dfrac{D^4 - d^4}{32D}$

c) $\pi \dfrac{D^4 - d^4}{64d}$

d) $\pi \dfrac{D^4 - d^4}{32d}$

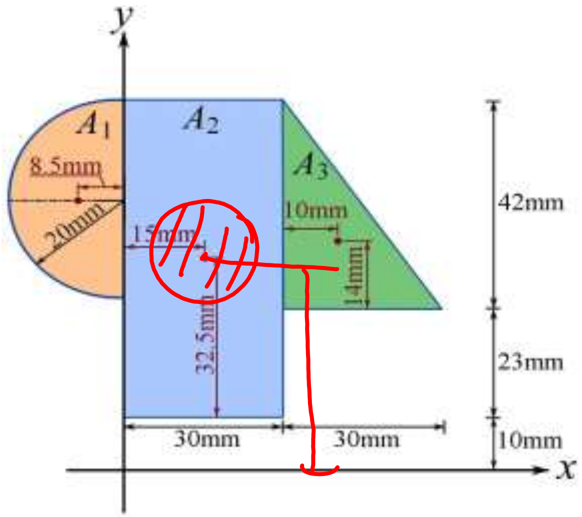
Moment of inertia

$I_{4x} = \frac{\pi r^4}{4} + \pi r^2 \times d^2$



$$I_{1x} = \bar{I}_{1x'} + Ad^2 = \frac{1}{8}\pi r^4 + (\frac{1}{2}\pi r^2)d^2$$
$$= \frac{1}{8}\pi 20^4 + (\frac{1}{2}\pi 20^2)(55)^2 = 1.964 \times 10^6 \text{ mm}^4$$

$$I_{2x} = \frac{1}{12}bh^3 + (bh)d^2$$
$$= \frac{1}{12}(30)(65)^3 + (30 \times 65)(42.5)^2 = 4.209 \times 10^6 \text{ mm}^4$$



$$I_{3x} = \frac{1}{36}bh^3 + (\frac{1}{2}bh)d^2$$
$$= \frac{1}{36}(30)(42)^3 + (\frac{1}{2}30 \times 42)(47)^2 = 1.453 \times 10^6 \text{ mm}^4$$

$$I_x = I_{1x} + I_{2x} + I_{3x} = 7.626 \times 10^6 \text{ mm}^4$$

$- I_{4x}$

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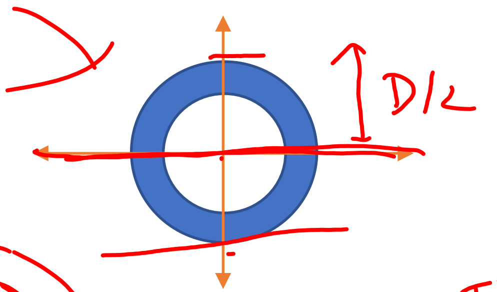
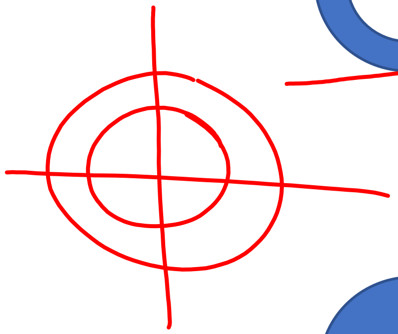
MOI of complex shape



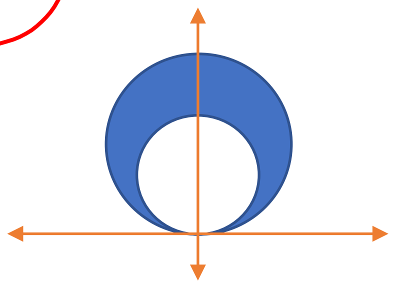
$$I_{\bar{x}\bar{x}} = \frac{\pi(D^4 - d^4)}{64}$$

$$/\ D/2$$

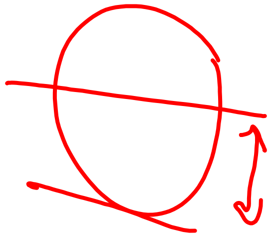


$$\frac{\pi D^4}{64} - \frac{\pi d^4}{64}$$

$$2\left\{\frac{\pi(D^4 - d^4)}{32D}\right.$$



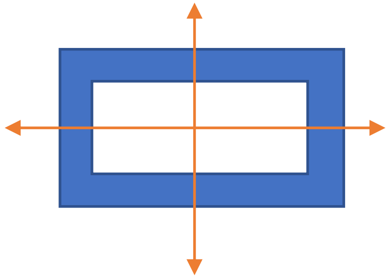
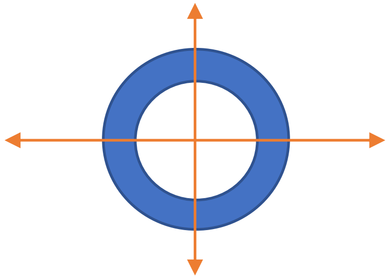
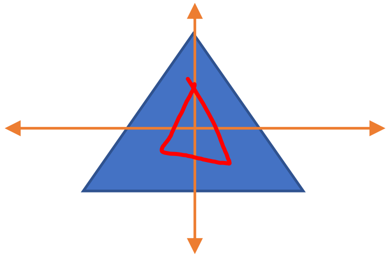
$$= \frac{5\pi}{64}(D^4 - d^4)$$



$$\frac{\pi D^4}{64}$$

$$I_b = \frac{\pi D^4}{64} + \frac{\pi D^2}{4} \times \frac{D^2}{4} = \frac{5}{64}\pi D^4$$

PANA ACADEMY

Shape	Centroid	Moment of inertia
	$\bar{x} = b/2$ $\bar{y} = h/2$	$I_{\bar{x}\bar{x}} = \dfrac{bh^3 - b'h'^3}{12}$
	At center	$I_{\bar{x}\bar{x}} = \dfrac{\pi(D^4 - d^4)}{64}$
	$\bar{x} = b/2$ $\bar{y} = h/3$	$I_{\bar{x}\bar{x}} = \dfrac{bh^3}{36}$

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Moment of inertia

About Base:

$$I_1 = I_{CG_1} + A_1 d_1^2$$

$$I_{CG_1} = \frac{100 \times 40^3}{12}$$

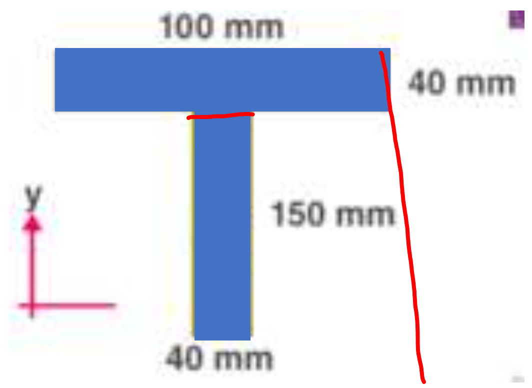
$$A_1 d_1^2 = 100 \times 40 \times \left(150 + \frac{40}{2}\right)^2$$

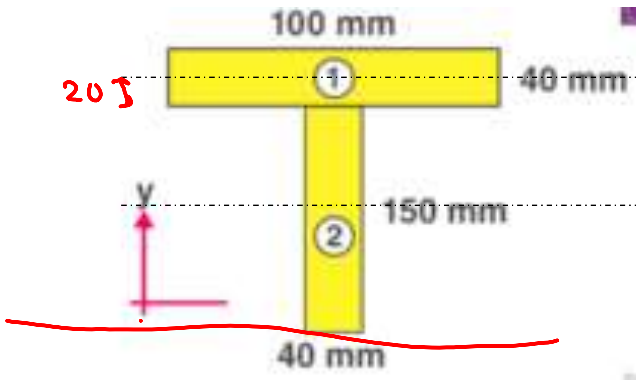
$$I_2 = I_{CG_2} + A_2 d_2^2$$

$$I_{CG_2} = \frac{40 \times 150^3}{12}$$

$$A_1 d_1^2 = 40 \times 1500 \times \left(\frac{150}{2}\right)^2$$

$$I = I_1 + I_2 =$$





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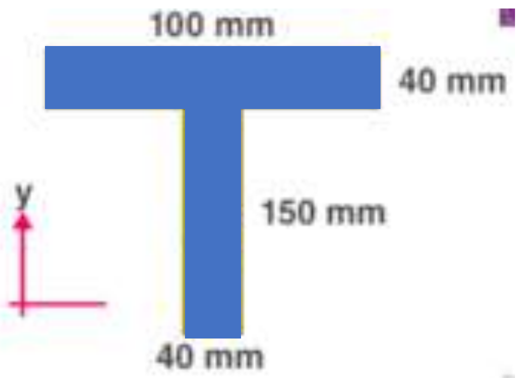
Moment of inertia

PANA ACADEMY

$$\bar{y} = \frac{\bar{y}_1 A_1 + \bar{y}_2 A_2}{A_1 + A_2}$$
$$= \frac{\left(150 + \frac{40}{2}\right)(100 \times 40) + \left(\frac{150}{2}\right)(40 \times 150)}{100 \times 40 + 40 \times 150} = 113\ mm$$



$$I_1 = I_{CG_1} + A_1 d_1^2$$

$$I_{CG_1} = \frac{100 \times 40^3}{12}$$

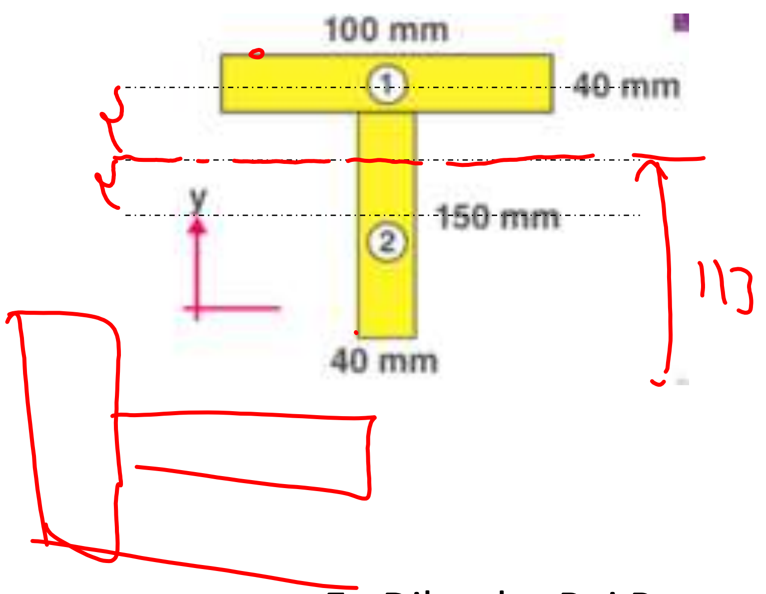
$$A_1 d_1^2 = 100 \times 40 \times \left(150 + \frac{40}{2} - 113\right)^2$$

$$I_2 = I_{CG_2} + A_2 d_2^2$$

$$I_{CG_2} = \frac{40 \times 150^3}{12}$$

$$A_1 d_1^2 = 40 \times 1500 \times \left(113 - \frac{150}{2}\right)^2$$

$$I = I_1 + I_2$$



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Radius of gyration

PANA ACADEMY

Radius where entire mass is thought to be concentrated such that ,moment of inertia is same.

$M^0 L^4 T^0$

$mm^4 \quad m^2$

MLT

$$I = AR^2$$

$m \quad L$

$$R = \sqrt{\frac{I}{A}}$$

As, $I_z = I_x + I_y$,

$AR_z^2 = AR_x^2 + AR_y^2$

$R_z = \sqrt{R_x^2 + R_y^2}$

$$R_z^2 = R_x^2 + R_y^2$$

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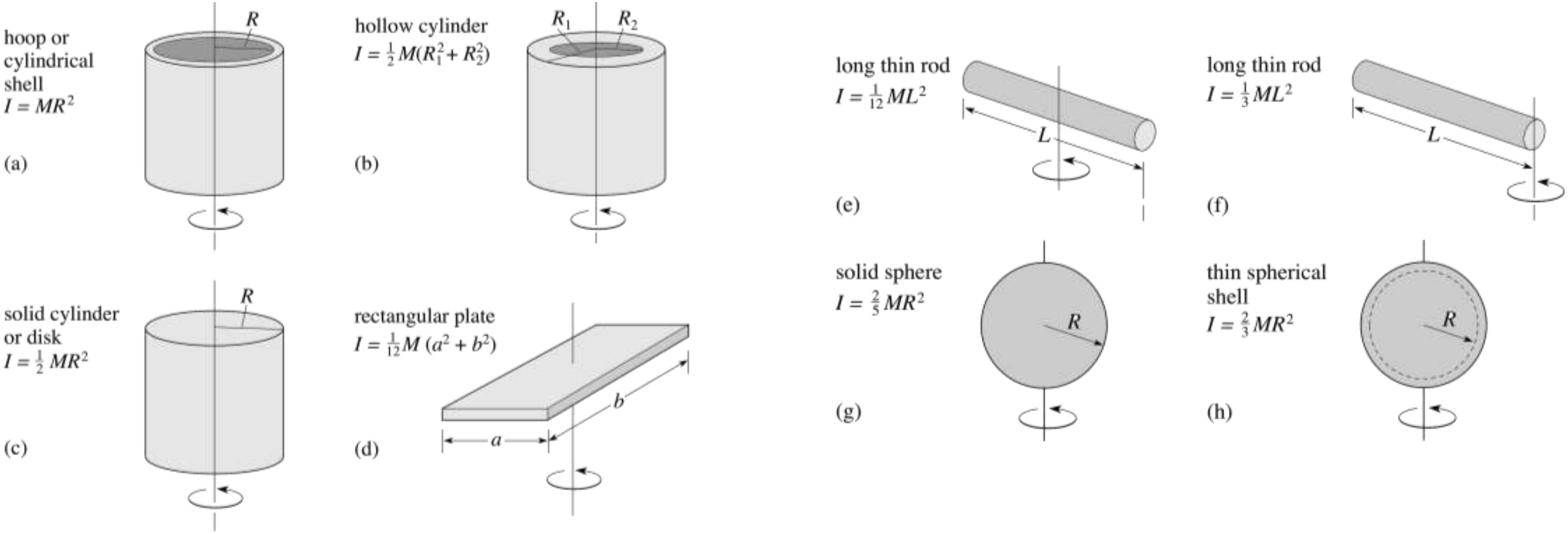
Mass moment of inertia



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MCQs

PANA ACADEMY

A circular section consists of

a) No line of symmetry

b) One line of symmetry

c) Two line of symmetry

d) Infinite line of symmetry

MCQs

The center of gravity of a circle of radius 20 cm will be

a. At the center of the radius
b. At its center of the diameter
c. Anywhere on the circumference
d. Anywhere in its area

MCQs

PANA ACADEMY

In case of an area, the figure is assumed to be a lamina of negligible thickness so that its centre of gravity will be practically on the surface. As the area has no weight , this point is also called the.

a. moment of inertia of areas .
b. neutral axis
c. centroid
d. None

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MCQs

PANA ACADEMY

The point through which the whole weight of the body acts is called

a. inertial point
b. center of gravity
c. central point
d. centroid

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MCQs

PANA ACADEMY

The centre of _____________ is the ratio of the product of centroid and volume to the total volume.

$$\bar{y} = \frac{\int \bar{y}\, dV}{\int dv}$$

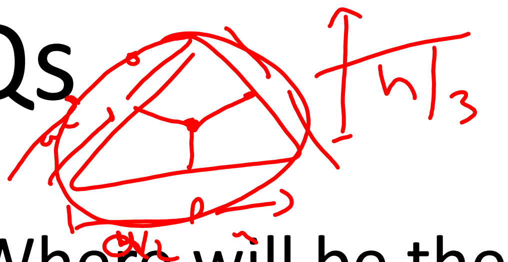
a) Centroid axis

b) Density

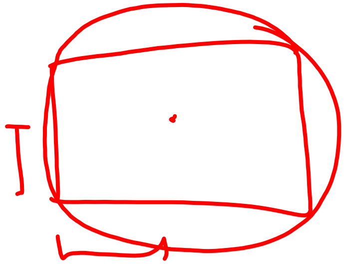
c) Mass

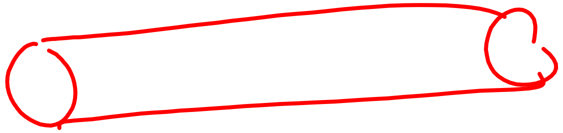
d) Volume

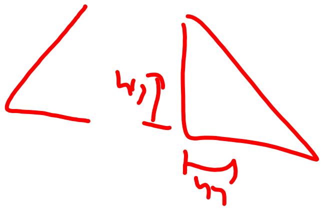
MCQs



Where will be the centre of gravity of a uniform rod lies?







a. At its end

b. At its middle point

c. At its centre of its cross sectional area

d. Depends upon its material

Which of the follow section donot have C.G coinciding with Geometric Centre

Rectangle

Circle

equilateral triangle

Rt triangle

MCQs

PANA ACADEMY

Point, where the total volume of the body assumed to be concentrated is.

a. center of area
b. centroid of volume
c. centroid of mass
d. all of the mentioned

MCQs

PANA ACADEMY

The Moment of inertia of a circular section having diameter 10 mm is

$\frac{\pi D^4}{64}$

a. 490.6 mm^4

b. 480.6 mm^4

c. 981.2 mm^4

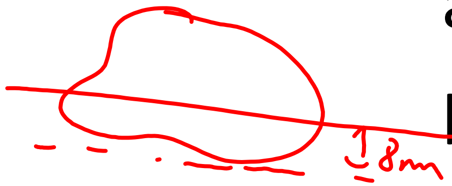
d 961.2 mm^4

MCQs

PANA ACADEMY

The composite section of area 250 mm^2 has centroidal axis 8mm from the bottom. The moment of inertia about centroidal x-axis is 6250 mm^4. The moment of inertia about the base is

min → centroidal axis



a. 9750 mm^4

b. 22250 mm^4 ✓

c. 8250 mm^4

d. 16000 mm^4

$I_{GG} =$

$I_b = \quad + Ad^2$

MCQs

PANA ACADEMY

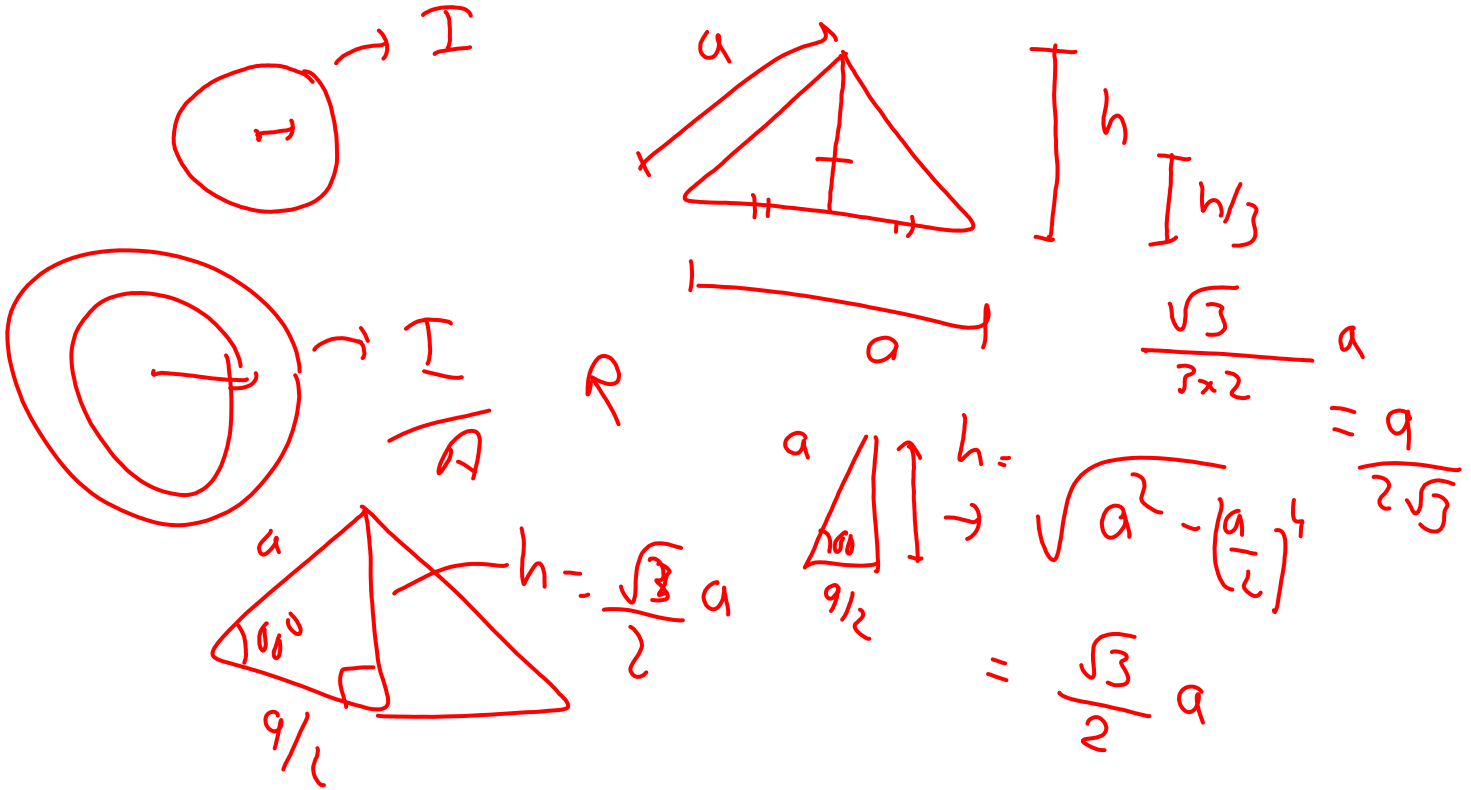
The radius of gyration along x and y axis are 30 mm and 40 mm respectively, the radius of gyration along the axis perpendicular to given axis is

a. 70 mm

b. 60 mm

c. 50 mm

d. 10 mm



Thank YOU !!!

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