Govt. Polytechnic Vaishali

Unit 4 Engg. mechanics

Seme II Mech + Electrical

Centre of gravity of a body is defined as the point through which the whole weight of the body acts. A body can have only one centre of gravity for all positions of the body.
It is represented by C.G or G.

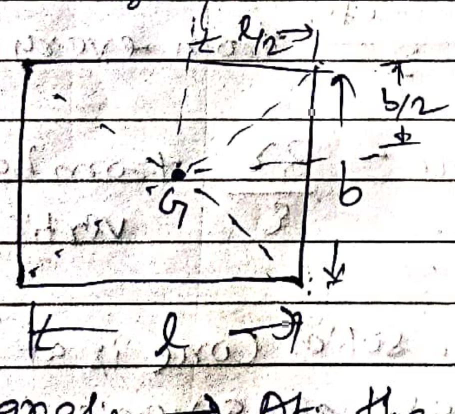
Centroid –
The point at which the total area of a plane is assumed to be concentrated, is called the centroid of that area. It is also represented as G or C.G.

→ The centroid and centre of gravity are at the same point.

* Methods for centre of gravity
(1) By geometrical considerations
(2) by moments
(3) By graphical method.

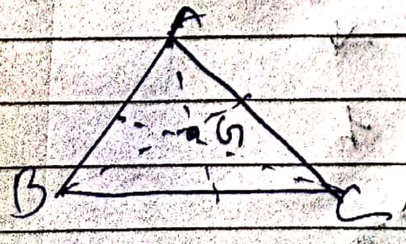
Centre of gravity or centroid of some plane fig

Rectangle / parallelogram




$G \equiv (l/2, b/2)$ at the intersection of diagonals

Triangle → At the Intersection of medians.

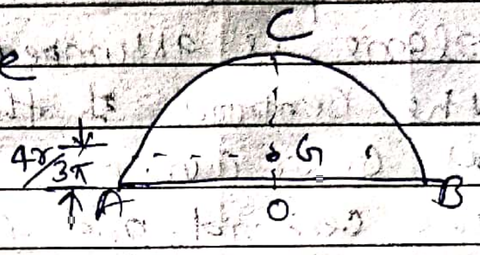


**Trapezium:**

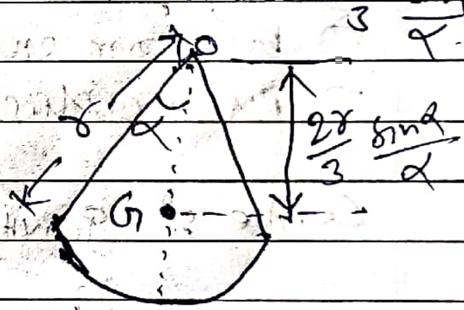
$G = \frac{h}{3}\left(\frac{b+2a}{b+a}\right)$ from side b.


**Semi-circle.**

$CG = \frac{4r}{3\pi}$ from base measured along vertical radius.




**Circular sector:-** C.G of semi circular sector of semi-vertical angle '$\alpha$' is at a distance $\frac{2r}{3}\frac{\sin\alpha}{\alpha}$

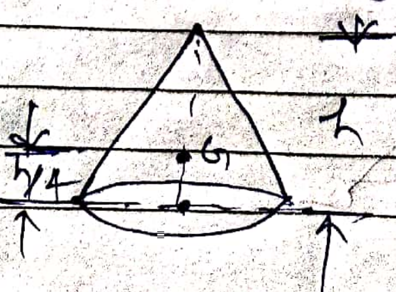



→ C.G of cube = $\frac{\text{side}}{2}$ from every face.

→ C.G of sphere = $\frac{\text{diameter}}{2}$ from every point.

→ C.G of Hemisphere = $\frac{3r}{8}$ from base along vertical radius.

→ C.G of right circular solid cone is at distance of $\frac{h}{4}$ from its base along vertical axis.



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## Centre of gravity by moments

$$M\bar{x} = m_1x_1 + m_2x_2 + m_3x_3 + \cdots$$

$$\therefore \bar{x} = \frac{\Sigma m \cdot x}{M}$$

$$\bar{y} = \frac{\Sigma m \cdot y}{M}$$

M = total moments
$M = m_1 + m_2 + \cdots$

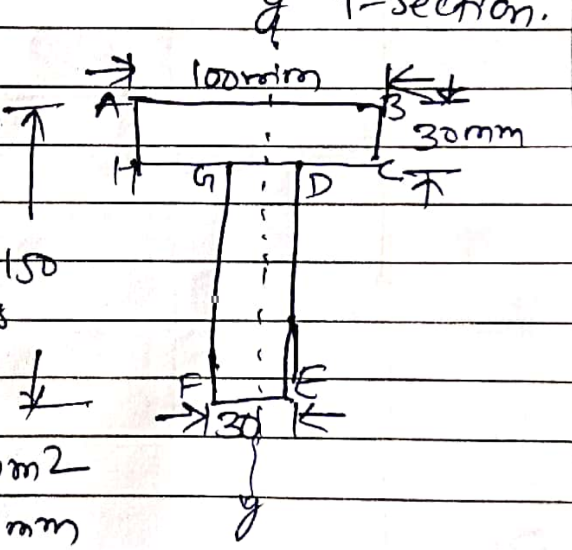
For plane figures it has only Area not mass.

$$\bar{x} = \frac{a_1x_1 + a_2x_2 + \cdots}{a_1 + a_2 + a_3 \cdots}$$

$$\bar{y} = \frac{a_1y_1 + a_2y_2 + \cdots}{a_1 + a_2 + a_3 \cdots}$$

**Example →** Find centre of gravity of a 100mm×150mm×30mm T-section.

⇒ Section is symmetrical about y-y axis. Therefore its C.G lies on this axis.




Let FE be the reference axis

Rectangle ABCD

$a_1 = 100 \times 30 = 3000\ mm^2$
$y_1 = \left(150 - \frac{30}{2}\right) = 135\ mm$

Rectangle DEFG

$a_2 = 120 \times 30 = 3600\ mm^2$, $y_2 = \frac{120}{2} = 60\ mm$

$$\bar{y} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2} = \frac{3000 \times 135 + 3600 \times 60}{3000 + 3600}\ mm$$

$\bar{y} = 94.1$ mm from FE on the y-y axis.

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