

Centre of Mass (CM)

CM shall be understood with the help of following points

(i) A system consists of many particles with different masses and different position from the reference point.

(ii) The mass of the system is equal to the sum of the mass of each particle in the system.

If the mass of the entire particles of the system is connected at a particular point, then that point is called the Centre of mass of the system.

CM in a One Dimensional System

Let us consider a fulcrum placed along the x-axis which is not at equilibrium position.



Let $m_1, m_2, m_3, \dots, m_n$ be mass of particles

$x_1, x_2, x_3, \dots, x_n$ position of particles from the supporting point

The tendency of a mass to rotate with respect to supporting point is called moment of mass

The moment of mass for an element mass m_n with respect to the fulcrum can be written as $m_n x_n$.

For the equilibrium system, the total moments is given by

$$m_1 x_1 + m_2 x_2 + \dots + m_n x_n = \sum_{i=1}^n m_i x_i = 0 \quad \text{--- (1)}$$

If the total moment is equal to zero, the CM will lie at the supporting point.

But from the figure, the system is not equilibrium, therefore the supporting point is adjusted to a distance 'x' to get balanced system.



Under equilibrium

$$\text{Eqn (1)} \Rightarrow \sum_{i=1}^n m_i x_i - \sum_{i=1}^n m_i x = 0$$

$$\sum_{i=1}^n m_i x = \sum_{i=1}^n m_i x_i$$

$$x = \frac{\sum_{i=1}^n m_i x_i}{\sum_{i=1}^n m_i}$$

$$(ii) x = \frac{m_1 x_1 + m_2 x_2 + \dots + m_n x_n}{m_1 + m_2 + m_3 + \dots + m_n}$$

The system should be moved to a distance of x in order to attain the balanced position.

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H Kauffman



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