

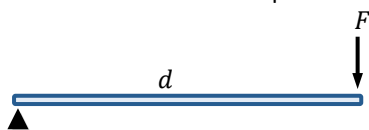
TURNING EFFECTS OF FORCES (MOMENTS)

Moment of a Force

The **Moment of a Force** (or torque) is the product of the force F and the perpendicular distance d from the line of action of force to pivot.

$$M = F \times d$$

M : Moment (Nm)
 F : Force (N)
 d : Perpendicular distance (m)



Moment can be affected by varying the force or perpendicular distance to the pivot.

Moment is a vector quantity. Its direction can either be clockwise (CW) or anticlockwise (ACW).

Principle of Moments

The **Principle of Moments** states that when a body is in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anticlockwise moments about the same pivot.

$$\text{Sum of CW Moments} = \text{Sum of ACW Moments}$$

Steps to Solve Moment Questions:

- 1) Identify and label **all** forces on object.
- 2) Identify point (pivot) to take moments.
- 3) Determine direction of moments for each force (CW or ACW).
- 4) Apply principle of moment equation.

Conditions for Static Equilibrium

- 1) The resultant force on object is zero.
- 2) The resultant moment on the object is zero.

Centre of Gravity (C.G.)

The **Centre of Gravity (C.G.)** of any object is the point through which its entire weight *appears* to act.

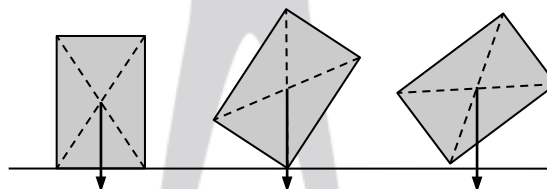
The CG of a regular shape and uniform density, the CG is at its geometrical centre.



For the case of a **uniform** metre rule, the c.g. is at the centre of rule (50 cm mark)

Tipping Point of an object

An object will topple when the line of action of its weight lies outside the base area of the object.



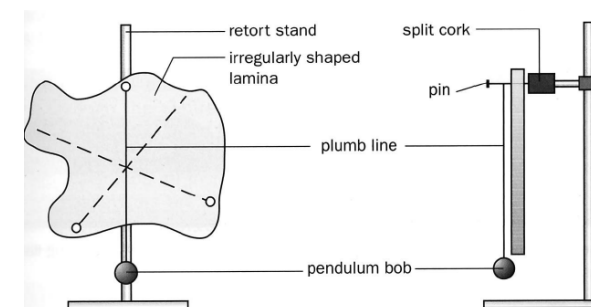
Types of Equilibrium

Stable Equilibrium	Unstable Equilibrium	Neutral Equilibrium
If cone is slightly tilted		
<ul style="list-style-type: none"> • The centre of gravity rises before returning to its original height. • The weight of object generates a moment to return object to its original position. 	<ul style="list-style-type: none"> • The centre of gravity is lowered. • The weight of object generates a moment to increase the displacement further. 	<ul style="list-style-type: none"> • The centre of gravity remains at the same height. • The weight of object generates no moment. • Object remains at the new displaced position.

Finding C.G. of Laminar

Procedure to find c.g. of an irregular shaped plane lamina:

- 1) Make three small holes near the edge of the lamina. The holes should be as far apart as possible.
- 2) Suspend the lamina freely from a pin.
- 3) Hang a plumb line is steady, trace the line on the lamina.
- 4) Repeat steps 2 to 4 for the other two holes.
- 5) The point of intersection of the three lines is the position of the centre of gravity.



Stability

The **Stability** of an object is a measure of its ability to *return* to its original position after it is slightly displaced.

To increase the stability of an object:

- 1) The centre of gravity can be **lowered** by adding mass to the base.
- 2) The base area should be kept as **large** as possible.