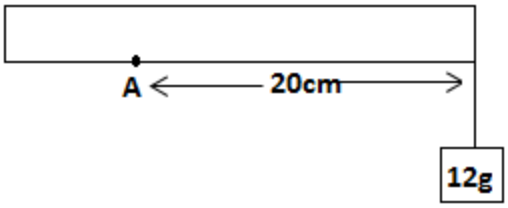
CHAPTER TWO

TURNING FORCES:

Moment:

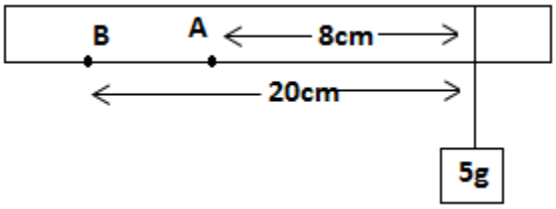
- The moment of a force about a point is the product of the force, and its perpendicular distance away from that given point.
- For this reason, moment = force x perpendicular distance between the force and the point.

Example (1):



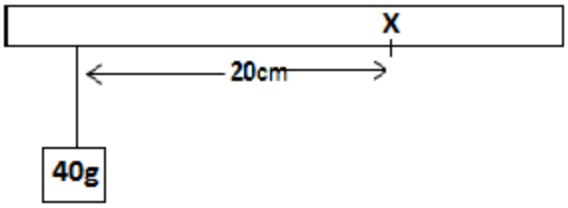
- The amount of the 12g mass about the point A = 12 x 20 = 240.

Example (2):



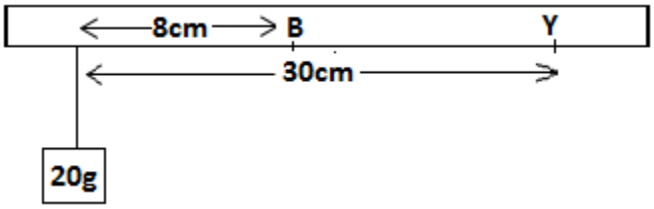
- The moment of the 5g mass about the point A = 5 x 8 = 40.
- Also the moment of the same 5g mass about the point B = 5 x 20 = 100.

Example (3):



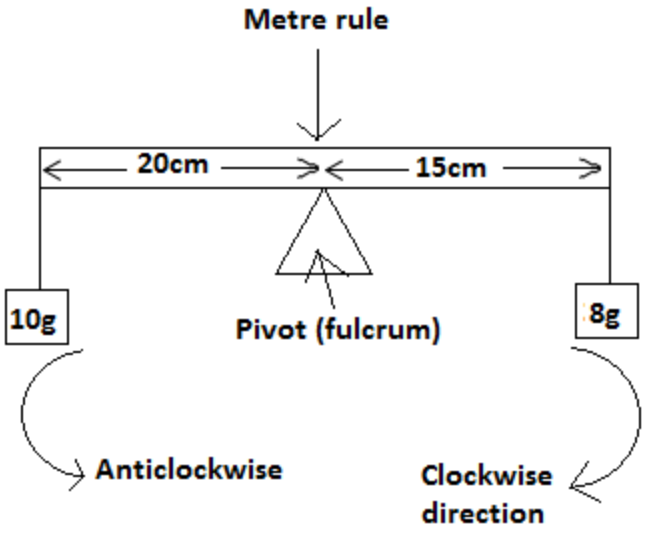
- The moment of the 40g mass about the point x = 40 x 20 = 800.

Example (4):



- The moment of the 20g weight about the point B = 20 x 8 = 160.
- Also the moment of the same 20g weight about the point Y = 20 x 30 = 600.

The clockwise moment and the anticlockwise moment:

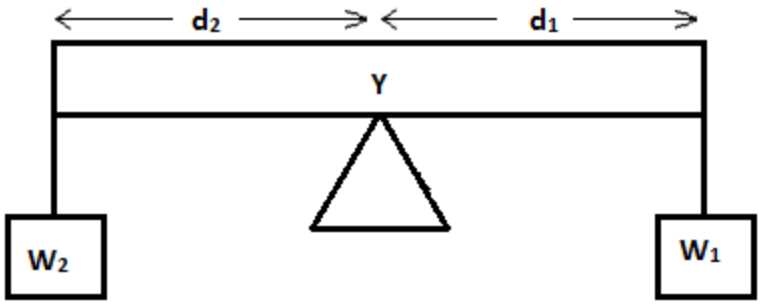


- A metre rule is a ruler which is 100cm long and a half metre rule is 50cm long.
- The given diagram shows a rule or a ruler which is pivoted about the point A.
- The point A even though not indicated in the diagram, is located at the point where the ruler and the pivot are in contact, (i.e the point where the ruler is resting on the sharp or the pointed edge of the pivot).
- In the absence of the 10g mass, the 8g mass will cause clockwise direction.

- Also in the absence of the 8g mass, he 10g mass will cause the rule to move in the anticlockwise direction.
- Now the moment of the 8g mass about the point A = 8 x 15 = 120.
- Since the 8g mass can cause the movement of the rule in the clockwise direction, this moment (i.e. the 120), is referred to as the clockwise moment.
- The moment of the 10g mass about the point A = 10 x 20 = 200.
- Since the 10g mass can cause the movement of the rule in the anticlockwise direction, this moment (i.e. the 200) is referred to as the anticlockwise moment.

The principle of moment:

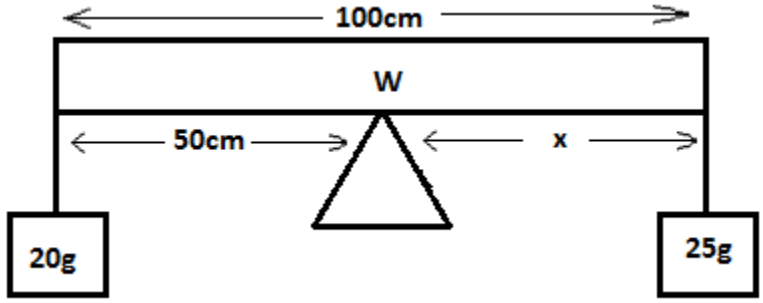
- This state that when a body is in equilibrium, the sum of the clockwise moment about a given point, is equal to the sum of the anticlockwise moment about the same point.



Taking moment about the point Y, then
(1) the Clockwise moment = $W_1 \times d_1 = W_1d_1$.
(2) the anticlockwise moment = $W_2 \times d_2 = W_2d_2$.
Since when a body is in equilibrium, the sum of the clockwise moment = the sum of the anticlockwise moment, then $W_1d_1 = W_2d_2$.

(Q1) A metre rule is pivoted at the 50cm mark, with a mass of 20g hanging from one of its ends. At what distance away from the pivot, must a 25g mass be suspended, in order to keep the rule in equilibrium.

Soln:



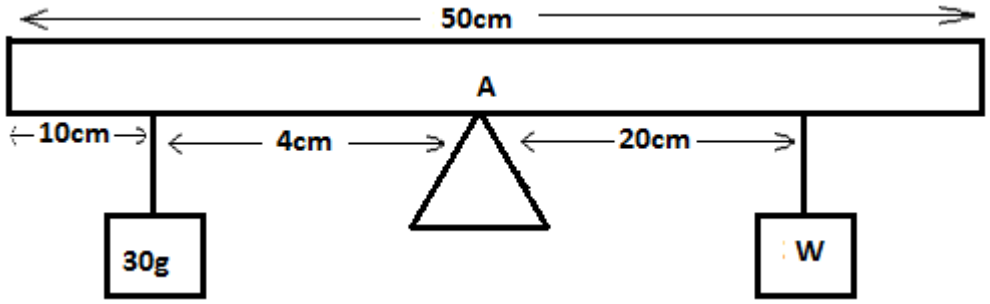
- Since the rule is pivoted at the 50cm mark, or at it mid-point, then the distance from the pivot to any of the two ends of the rule is 50cm.
- Let x = the distance between the 25g mass and the pivot.
- Taking moment about the point W, => the clockwise moment = 25 x x = 25x, and the anticlockwise moment = 20 x 50 = 1000.
-Since at equilibrium, the sum of the clockwise moment = the sum of the anticlockwise moment, =>25x = 1000,

=> x = $\frac{1000}{25} = 40$.

=>The 25g mass must be suspended at a distance of 40cm away from the pivot.

(Q2)A half metre rule or a 50cm long rule, has a 30g weight suspended 10cm away from one end (i.e. the zero centimetre mark), and the pivot is located 4cm away from this 30g weight. Determine the weight which must be suspended 20cm away from the pivot, in order to keep the rule in equilibrium.

Soln:



- Let W = the weight which must be suspended 20cm away from the pivot, in order to keep the rule in equilibrium.

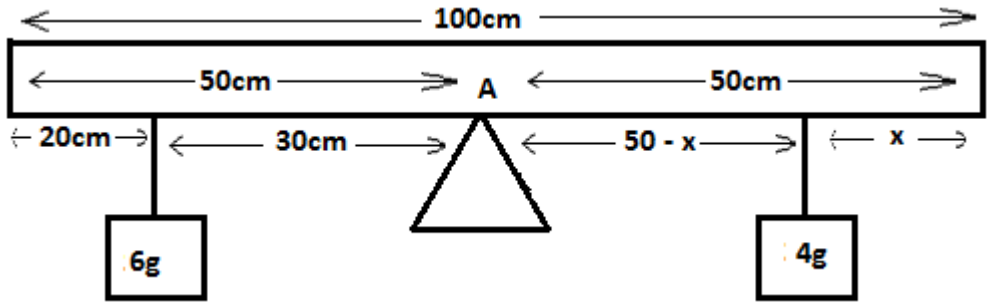
- Taking moment about the point A, the clockwise moment = 20 x W = 20W, and the anticlockwise moment = 30 x 4 = 120.
- At equilibrium, the sum of the clockwise moment= the sum of anticlockwise moment.

=>20W = 120 => W = $\frac{120}{20} = 6$.

=> Required weight = 6g.

(Q3) A metre rule was taken and a 6g mass was suspended at the 20cm mark. The fulcrum or the pivot is positioned 30cm away from the 6g mass. At what point or position away from the other end, must a 4g mass be suspended in order to keep the rule in equilibrium.

Soln

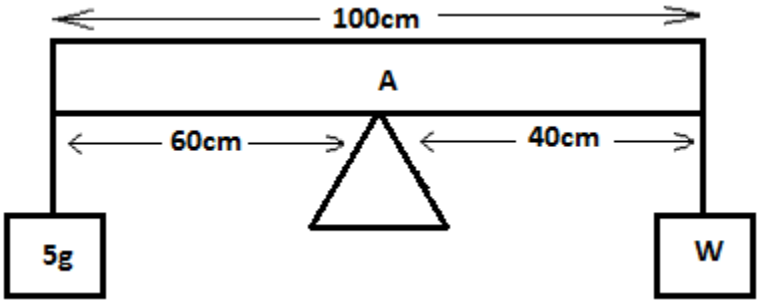


- Let x = the distance from the other end, the 4g mass must be suspended in order to obtain equilibrium.
- Taking moment about the point A, the clockwise moment = 40 x (5 – x) = 4(50 - x) = 200 – 4x.
- The anticlockwise moment = 6 x 30 = 180.
- Since at equilibrium, the sum of the clockwise and the anticlockwise moments are equal, then 200 – 4x = 180,
  =>200 – 180 = 4x, => 20 = 4x
  =>x = $\frac{20}{4}$ = 5cm.
  =>The 4g must be hanged 5cm away from the other end, or 50 – x = 50 – 5 = 45cm away from the pivot in order to obtain the equilibrium of the rule.

  (Q4) A meter rule is pivoted at the 60cm mark. A 5g weight is hanged at the 0cm mark (zero centimeter mark), or the end. Find the weight which must be hanged at

the 100cm mark (or the other end) in order to keep the rule in balance or equilibrium.

Soln:



- Let W = the weight which must be suspended at the other end, in order to obtain equilibrium.
- Taking moment about the point A, the clockwise moment = 40 x W = 40W.
- The anticlockwise moment = 5 x 60 = 300.
- Since at equilibrium the sum of the clockwise moment = the sum of the anticlockwise moment, then 40W = 300 => W = $\frac{300}{40}$ = 7.5.

=>The required weight = 7.5g.