Single Mechanics – Moments 2

If an object is in equilibrium, then

1. the forces must balance in any given direction, and
2. the moments must balance about *any* point.

If the object is *on the point of tilting*, then one of the reactions must go to zero.

Questions

1. A uniform ladder of length 10 m has mass 20 kg. It is rested on two supports at A and B. A is 1 m from one end of the ladder and B is 2 m from the other end. A sumo wrestler of mass 120 kg stands on the ladder.

   (a) If he stands at the centre, find the reactions at A and B. $\boxed{R_A = 60g, R_B = 80g}$

   (b) How far can he move beyond the support at A before the ladder tilts? $\boxed{\frac{2}{3}\text{ m}}$

   (c) How far can he move beyond the support at B before the ladder tilts? $\boxed{\frac{1}{2}\text{ m}}$

2. A uniform ladder of length 10 m has mass 20 kg. It is rested on two supports at A and B. A is 2 m from one end of the ladder and B is 3 m from the other end. Mr Stone of mass 110 kg stands on the ladder.

   (a) How far beyond B before before the ladder tilts? $\boxed{\frac{4}{11}\text{ m beyond}}$

   (b) How far beyond A before before the ladder tilts? $\boxed{\frac{6}{11}\text{ m beyond}}$

3. A uniform ladder of length l m has mass 15 kg. It is supported on two supports 1 m from each end. Mr Stone (of mass 110 kg) cannot sit further than 30 cm beyond either support. Find l.

   $\boxed{l = 6.4\text{ m}}$

4. A uniform ladder of length l m has mass 16 kg. It is supported on two supports A and B. A is 1 m from one end and B is 2 m from the other. A Constable (of mass 75 kg) cannot sit further than 50 cm beyond B. Find l. $\boxed{l = 8.6875\text{ m}}$

5. A uniform ladder of length 10 m has mass m kg. It is rested on two supports at A and B. A is 2 m from one end of the ladder and B is 2 m from the other end. Mr Stone has mass 110 kg. When he sits 60 cm beyond A the ladder is on the point of tilting. Find m. $\boxed{22\text{ kg}}$

6. A uniform ladder of length 10 m has mass 20 kg. It is rested on two supports at A and B. A is 1 m from one end of the ladder and B is x m from the other end. When a gentleman of mass 90 kg sits 50 cm beyond B, the ladder is on the point of tilting. Find x. $\boxed{x = 2.75\text{ m}}$

7. A non-uniform ladder of length 10 m has mass 20 kg. It is rested on two supports at A and B. A is 1 m from one end of the ladder and B is 2 m from the other end.

   (a) Given that the reactions at A and B are equal, find how far the centre of mass is from A.

   $\boxed{3.5\text{ m}}$

   (b) How far can a gymnast of mass 50 kg move beyond B before the ladder tilts? $\boxed{1.4\text{ m}}$

8. A non-uniform ladder has length 12 m and mass 16 kg. It is rested on supports at A and B. Both A and B are 1 m from each end. The reaction at A is three times the reaction at B.

   (a) Find the reaction at A and at B. $\boxed{R_A = 12g, R_B = 4g}$

   (b) How far is the centre of mass of the ladder from B? $\boxed{7.5 \text{ m}}$

   (c) How far can a 200 kg mass be placed beyond A before the ladder tilts? $\boxed{20 \text{ cm}}$

9. A non-uniform ladder has length 10 m and mass 14 kg. It is rested on supports at A and B. A is 1 m from one end and B is 2 m from the other. The reaction at A is five times the reaction at B.

   (a) How far is the centre of mass of the ladder from A? $\boxed{\frac{7}{6} \text{ m}}$

   (b) How far can a 140 kg mass be placed beyond A before the ladder tilts? $\boxed{\frac{7}{60} \text{ m}}$