

M1 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*.

$$R_A = 60g, R_B = 80g$$

(b) How far can he move beyond the support at *A* before the ladder tilts?

$$\frac{2}{3} \text{ m}$$

(c) How far can he move beyond the support at *B* before the ladder tilts?

$$\frac{1}{2} \text{ m}$$

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?

$$\frac{4}{11} \text{ m beyond}$$

(b) How far beyond *A* before before the ladder tilts?

$$\frac{6}{11} \text{ m beyond}$$

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 .

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

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 .

$$l = 8.75 \text{ m}$$

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 .

$$22 \text{ kg}$$

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 .

$$x = 2.75 \text{ m}$$

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*.

$$3.5 \text{ m}$$

(b) How far can a gymnast of mass 50 kg move beyond *B* before the ladder tilts?

$$1.4 \text{ m}$$

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 .

$$R_A = 12g, R_B = 4g$$

(b) How far is the centre of mass of the ladder from B ?

$$7.5 \text{ m}$$

(c) How far can a 200 kg mass be placed beyond A before the ladder tilts?

$$20 \text{ cm}$$

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 ?

$$\frac{7}{6} \text{ m}$$

(b) How far can a 140 kg mass be placed beyond A before the ladder tilts?

$$\frac{7}{60} \text{ m}$$