



Name: _____ Date: _____ Score: _____ / 84

- 1** A uniform beam AB has length 4 m and mass 12 kg. The beam rests horizontally on two supports, one at C and one at D , where $AC = 0.5$ m and $DB = 1$ m, as shown in the diagram. Find the magnitude of the reaction on the beam at C and the magnitude of the reaction on the beam at D .



(4 marks)

Answer _____

- 2** A uniform plank PQ has length 6 m and mass 20 kg. The plank is held in a horizontal position by two light vertical ropes, one attached at P and one attached at the point R on the plank, where $PR = 5$ m. A bucket of mass 5 kg hangs from the end Q . The bucket is modelled as a particle.

Find the tension in each rope.

(4 marks)

Answer _____

3

A non-uniform plank AB has length 3.6 m and mass 15 kg. The plank hangs in a horizontal position from two light vertical strings, one at A and one at B . The tension in the string at B is one and a half times the tension in the string at A .

- a. Find the tension in each string.
- b. Find the distance of the centre of mass of the plank from A .

(5 marks)

Answer _____

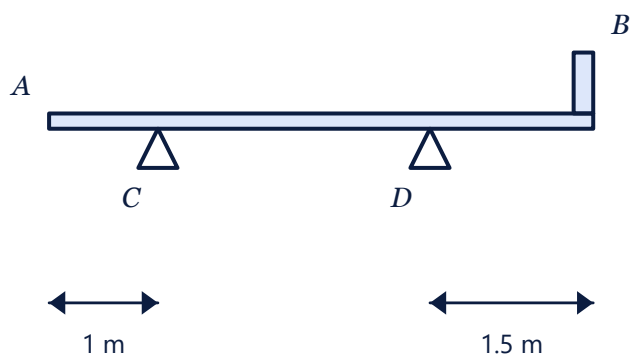
4

A uniform plank AB has length 5 m and mass 30 kg. It rests horizontally on two supports at C and D , where $AC = 1$ m and $DB = 1.5$ m, as shown in the diagram. A child of mass 12 kg stands on the plank at B . The child is modelled as a particle.

- a. Find the magnitude of the reaction on the plank at C and the magnitude of the reaction on the plank at D .

The child gets off and an adult of mass M kg stands at B . The plank is now on the point of tilting about D .

- b. Find the value of M .
- c. State how you have used the modelling assumption that the plank is uniform.



(8 marks)

Answer _____

5

A uniform rod AB has length 4 m and mass 10 kg. The rod rests horizontally on two supports at C and D , where $AC = 1$ m and $AD = 2.5$ m. A particle of mass 15 kg is placed on the rod at the point P , where $AP = x$ metres.

Given that the rod remains in equilibrium, find the range of possible values of x .

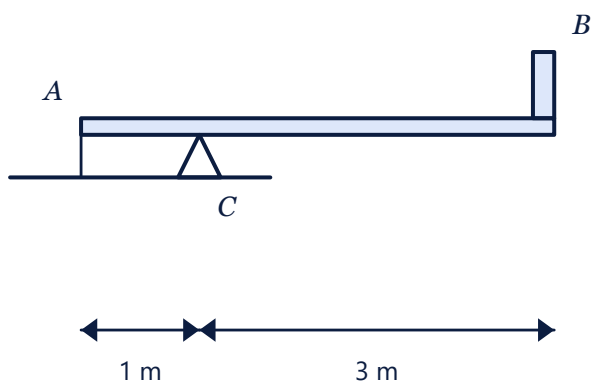
(7 marks)

Answer _____

6

A diving board AB is modelled as a uniform rod of length 4 m and mass 40 kg. The end A is bolted to the ground and the board rests horizontally on a support at C , where $AC = 1$ m, as shown in the diagram. A diver of mass 60 kg stands at the end B . The diver is modelled as a particle.

- Find the magnitude of the force exerted on the board by the support at C .
- Find the magnitude of the force exerted on the board by the bolt at A , and state its direction.



(6 marks)

Answer _____

7 A uniform rod AB has length $2a$ and weight W . The rod rests horizontally on two supports, one at A and one at C , where $AC = \frac{3}{2}a$. A particle of weight kW is attached to the rod at B , where k is a constant.

- Show that the magnitude of the reaction on the rod at A is $\frac{1}{3}W(1 - k)$.
- Hence write down the greatest possible value of k .
- Given that the reaction at C is five times the reaction at A , find the value of k .

(7 marks)

Answer _____

8 A non-uniform rod AB has length 3 m. When the rod rests on a single support at the point C , where $AC = 1.2$ m, it balances in a horizontal position. A particle of mass 2 kg is now attached to the rod at B , and the rod now balances horizontally when the support is moved to the point D , where $AD = 1.5$ m.

- Find the mass of the rod.
- The particle is removed from B and attached to the rod at A instead. Find the distance from A of the point at which the rod now balances.

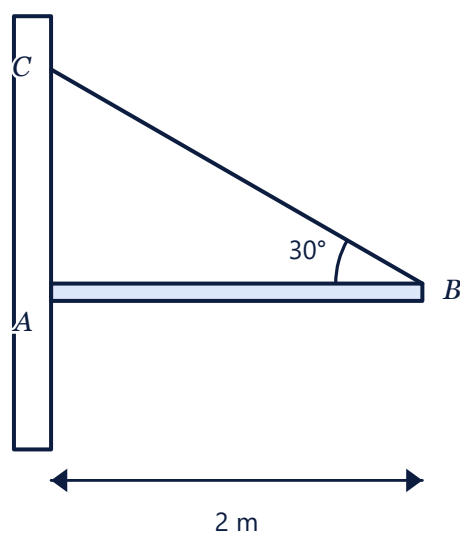
(6 marks)

Answer _____

9

A uniform rod AB has length 2 m and mass 5 kg. The end A is freely hinged to a vertical wall. The rod is held in a horizontal position by a light inextensible string. One end of the string is attached to the rod at B and the other end is attached to the wall at the point C , vertically above A . The string makes an angle of 30° with the rod, as shown in the diagram.

- Find the tension in the string.
- Find the magnitude of the force exerted on the rod by the hinge, and the angle this force makes with the rod.



(8 marks)

Answer _____

10

A non-uniform beam AB has length 6 m and mass 50 kg. The beam rests horizontally on two supports at C and D , where $AC = 1$ m and $DB = 2$ m. When a woman of mass 30 kg stands on the beam at B , the beam is on the point of tilting about D . The woman is modelled as a particle.

a. Find the distance of the centre of mass of the beam from A .

The woman now walks along the beam and stands at A .

b. Show that the beam does not tilt.

c. Find the magnitude of the reaction on the beam at each support when the woman stands at A .

d. Explain what is meant by modelling the woman as a particle.

(9 marks)

Answer _____

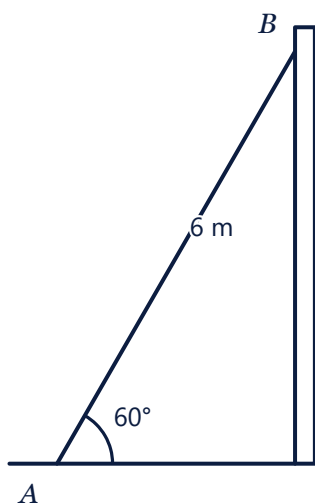
11

A uniform ladder AB has length 6 m and mass 20 kg. The ladder rests with its end A on rough horizontal ground and its end B against a smooth vertical wall. The ladder makes an angle of 60° with the ground and lies in a vertical plane perpendicular to the wall, as shown in the diagram. The ladder is modelled as a uniform rod.

- a. Show that the coefficient of friction between the ladder and the ground must be at least $\frac{1}{2\sqrt{3}}$.

The coefficient of friction between the ladder and the ground is in fact 0.35. A man of mass 75 kg climbs slowly up the ladder. The man is modelled as a particle.

- b. Find the greatest distance up the ladder, measured from A , that the man can climb before the ladder slips.



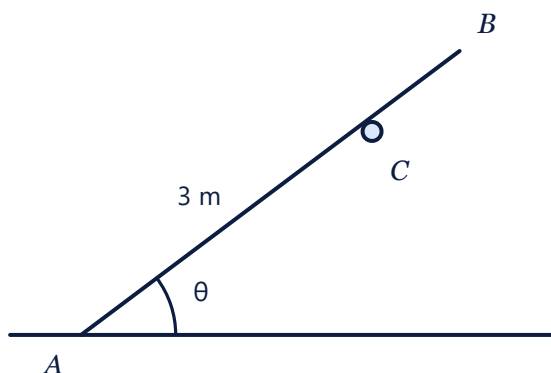
(10 marks)

Answer _____

12

A uniform rod AB has length 4 m and weight W . The rod rests with its end A on rough horizontal ground and rests against a small smooth peg at the point C on the rod, where $AC = 3$ m. The rod is in a vertical plane perpendicular to the peg and makes an angle θ with the ground, where $\tan \theta = \frac{3}{4}$, as shown in the diagram. The rod is in limiting equilibrium.

- Show that the magnitude of the reaction of the peg on the rod is $\frac{8}{15}W$.
- Find the exact value of the coefficient of friction between the rod and the ground.
- State the direction of the friction on the rod at A , giving a reason.



(10 marks)

Answer _____

End of questions | Total 84 marks