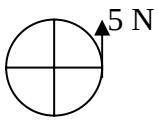
EdExcel Mechanics 2

Statics of rigid bodies

Section 1: Moments of forces at an angle

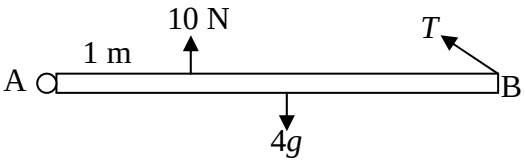
Exercise

1. The diagram shows a driver steers his car by pulling upwards on the steering wheel with a force of 5 N. The steering wheel has a radius of 25 cm.

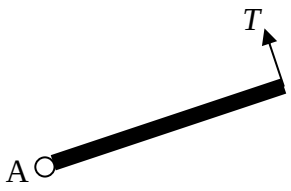


   (i) Calculate the moment of the force about the centre of the wheel.
   (ii) Describe the condition that needs to be fulfilled if the moment is to remain constant as the wheel turns, assuming that the force remains constant.

2. The diagram shows a uniform beam, mass 4 kg and length 3.5 m, freely hinged at A and resting in equilibrium. Given that the force T acts at 30° to the horizontal, find the magnitude of T and the magnitude of the reaction at the hinge.



3. The diagram shows a uniform beam of mass 4 kg and length 4 m freely hinged at A. It is held at an angle of 30° to the horizontal by a light inextensible string attached at the end. Find the magnitude of the tension T in the string given that it acts at right angles to the beam. Find also the magnitude and direction of the reaction at the hinge.



4. A light flag hangs from a pole AB. The pole is freely hinged at A to a vertical wall and supported in a horizontal position by means of a chain attached to B and a point C on the wall directly above A. The pole has a mass of 5 kg and the tension in the chain is 40 N. Find the angle that the chain makes with the pole.

5. A uniform ladder of length 6.5 m rests with one end against a smooth wall and the other on rough horizontal ground at a distance 2.5 m from the wall. If the foot of the ladder is on the point of slipping, find the coefficient of friction between the ladder and the ground.

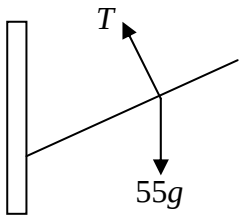
6. A uniform ladder of weight W and length $2l$ rests with one end against a smooth vertical wall and the other on rough horizontal ground. The coefficient of friction is ½. The ladder is in limiting equilibrium.

   (i) Draw a diagram showing all of the forces acting on the ladder.
   (ii) Find the angle that the ladder makes with the horizontal.
   (iii) Find the reaction at the wall.

   A man of weight W climbs the ladder.

   (iv) How far up the ladder does he get before the ladder starts to slip?
   (v) If a sack of weight W is placed on the bottom of the ladder, how far can the man now climb before the ladder starts to slip?

7. The diagram represents a climber of mass 55 kg with her feet resting against a vertical wall and has a rope attached to her as support. Her body is inclined at an angle of 120° to the downwards vertical at the wall. The rope is attached to her at the point through which her weight acts and is at right angles to the line of her body. Find the tension in the rope and the magnitude and direction of the reaction at the wall.



8. The square hatch on a boat is uniform with a mass of 17 kg. It is held open at an angle of 60° to the horizontal by a rope attached to a point A on the edge. The hatch is hinged at O immediately opposite A. Find the tension in the rope and the magnitude of the reaction at the hinge if the rope makes an angle of
   (i) 90° to OA
   (ii) 120° to OA