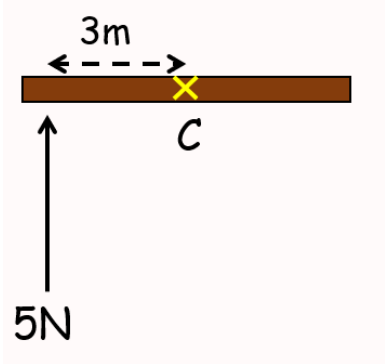
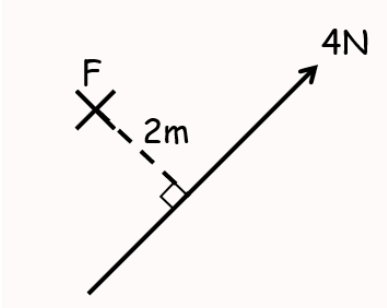
4A Moments Introduction

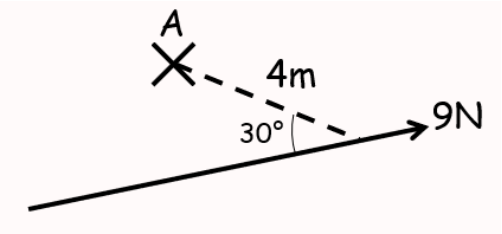
1. Find the Moment about C

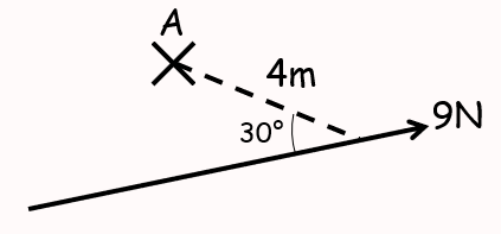


2. Calculate the moment of the force about point F



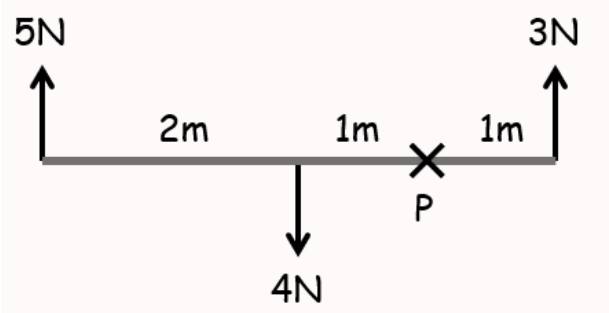
3. Calculate the moment of the force about point A



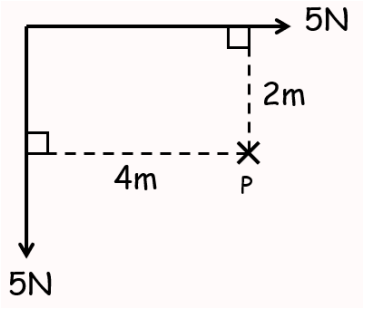


4B Multiple Moments

1. Calculate the sum of the moments acting about the point P



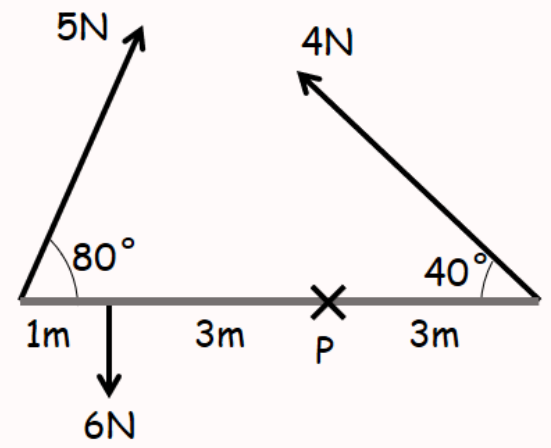
2. Calculate the sum of the moments acting about the point P



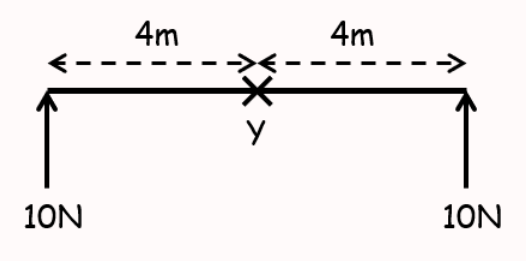
3. The diagram to the right shows 3 forces acting on a light rod.

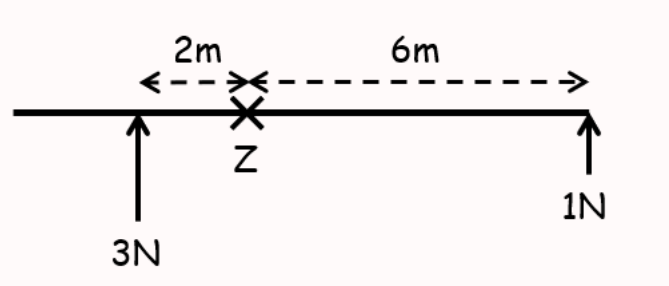
   Find the resultant moment about point P

   (ie – if the rod were fixed at point P, how would it rotate?)

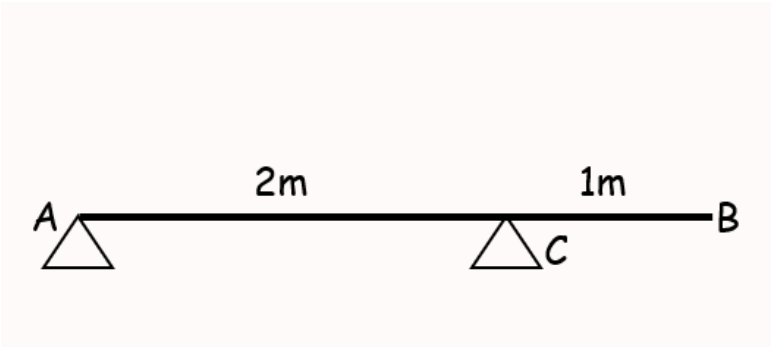


4C Uniform Rods





1. The diagram shows a uniform rod of length 3m and weight 20N resting horizontally on supports at A and C, where AC = 2m.
   Calculate the magnitude of the normal reaction at both of the supports

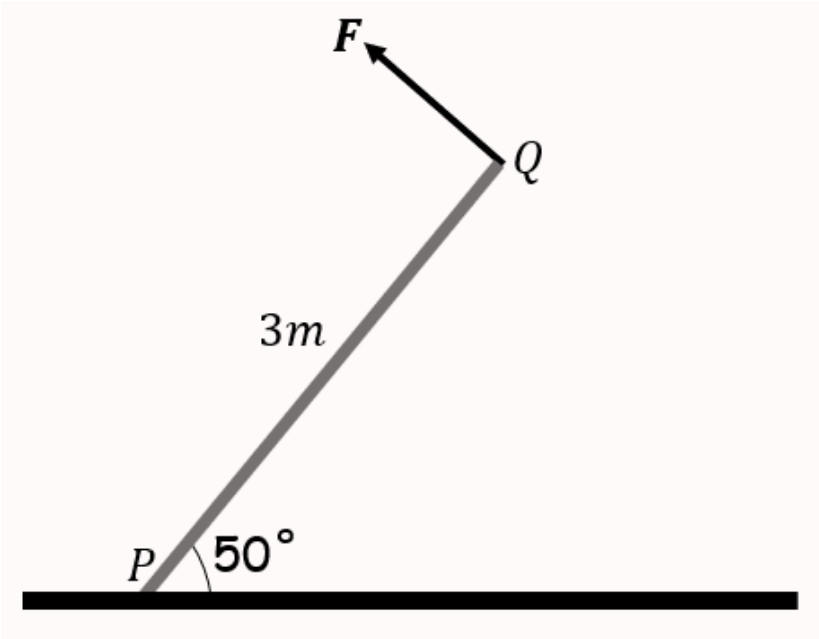


2. A uniform beam, AB, of mass 40kg and length 5m, rests horizontally on supports at C and D where AC = DB = 1m.

   When a man of mass 80kg stands on the beam at E, the magnitude of the reaction at D is double the reaction at C.

   By modelling the beam as a rod and the man as a particle, find the distance AE

3. A uniform rod PQ is hinged at the point P, and is held in equilibrium at an angle of 50˚ to the horizontal by a force of magnitude F acting perpendicular to the rod at Q. Given that the rod has a length of 3m and a mass of 8kg, find the value of $\boldsymbol{F}$.



4D Non-Uniform Rods

1. Sam and Tamsin are sitting on a non-uniform plank AB of mass 25kg and length 4m.

   The plank is pivoted at M, the midpoint of AB, and the centre of mass is at C where AC = 1.8m.

   Tamsin has mass 25kg and sits at A. Sam has mass 35kg. How far should Sam sit from A to balance the plank?

2. A rod AB is 3m long and has weight 20N. It is in a horizontal position resting on supports at points C and D, where AC = 1m and AD = 2.5m.

   The magnitude of the reaction at C is three times the magnitude of the reaction at D.

   Find the distance of the centre of mass of the rod from A.

4E Tipping Point

1. A uniform rod of length 4m and mass 12kg is resting in a horizontal position on supports at C and D, with AC = DB = 0.5m

   When a particle of mass mkg is placed on the rod at point B, the rod is on the point of turning about D.

   Find the value of m.

2. A non-uniform rod AB, of length 10m and weight 40N, is suspended from a pair of light cables attached to C and D where $AC = 3m$ and $BD = 2m$.

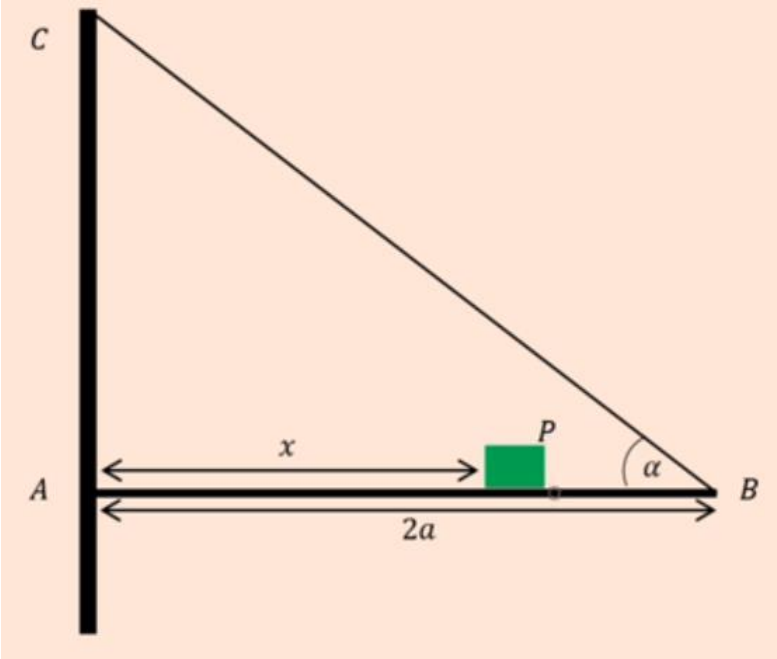
   When a weight of 25N is hung from point A the rod is on the point of rotation.

   Find the distance of the centre of mass of the rod from point A.

7D Hinges

1. A Plank AB of mass M and length 2a, rests with its end A against a rough vertical wall. The plank is held in a horizontal position by a rope. One end of the rope is attached to the plank and the other end is attached to the wall at the point C, which is vertically above A.

   A small block of mass 3M is placed on the plank at the point P, where AP = x. The plank is in equilibrium in a vertical plane which is perpendicular to the wall. The angle between the rope and the plank is α, where $\tan(\alpha) = \frac{3}{4}$, as shown.



   The plank is modelled as a uniform rod, the block is modelled at a particle and the rope is modelled as a light inextensible string.

   a) Using the model, show that the tension in the rope is

$$\frac{5Mg(3x+a)}{6a}$$

The magnitude of the horizontal component of the force exerted on the plane AB by the wall is 2Mg.

b) Find x in terms of a

The forces exerted on the plank by the wall acts in a direction which makes an angle β with the horizontal.

c) Find the value of tan β

The rope will break if the tension in it exceeds 5Mg.

d) Explain how this will restrict the possible values of P

5B (old Spec) Hinges

1. A uniform rod AB, of mass 6kg and length 4m, is smoothly hinged at A. A light inextensible string is attached to the rod at a point C where AC = 3m, and the point D, which is vertically above point A. If the string is keeping the rod in equilibrium in a horizontal position and the angle between the string and the rod is 40°, calculate:

a) The tension in the string

b) The magnitude and direction of the reaction at the hinge.

7D Ladders

2. A uniform rod AB of mass 40kg and length 10m rests with the end A on rough horizontal ground. The rod rests against a smooth peg C where AC = 8m. The rod is in limiting equilibrium at an angle of 15° to the horizontal. Find:

a) The magnitude of the reaction at C

b) The coefficient of friction between the rod and the ground

3. A ladder, AB, of mass m and length 3a, has one end A resting on rough horizontal ground. The other end, B, rests against a smooth vertical wall. A load of mass 2m is fixed on the ladder at point C, where AC = a. The ladder is modelled as a uniform rod and the load is modelled as a particle. The ladder rests in limiting equilibrium at an angle of 60° with the ground.
   Find the coefficient of friction between the ladder and the ground.