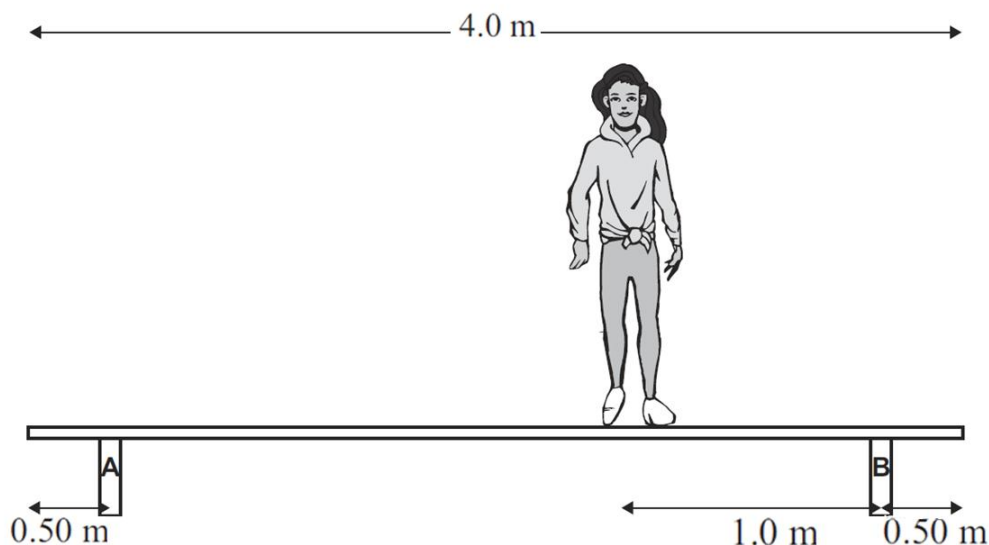


MECHANICS: EQUILIBRIUM QUESTIONS

THE SPECTATORS (2010;5)

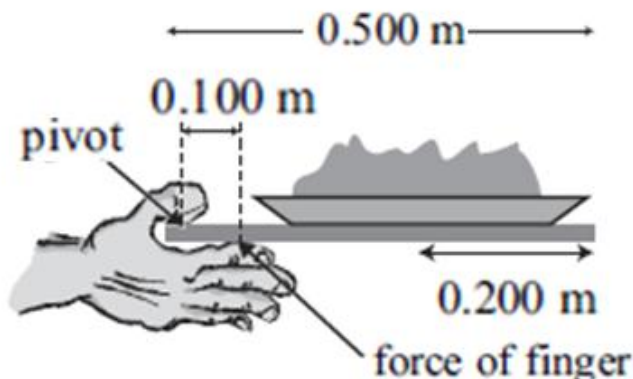
Aroha has a mass of 55 kg. She steps onto a bench to get a better view. The bench is 4.0 m long. Aroha walks towards one end so that she is 1.0 m away from support B.



- (c) The bench is in equilibrium. Explain what this means.
 (d) Support B exerts a force of 420 N on the bench. Assuming the bench is uniform, calculate the mass of the bench.

EQUILIBRIUM, MOMENTUM AND SPRINGS (2009;3)

Harry carries his tray of food to his cafeteria table for lunch. The uniform tray is 0.500 m long and has a mass of 0.20 kg. It holds a 0.40 kg plate of food where the centre of the plate is 0.200 m from the right hand edge. Harry holds the tray on the left-hand side with one hand, using his thumb as the pivot (fulcrum), and pushes up 0.100 m from the pivot (fulcrum) with his fingertips.

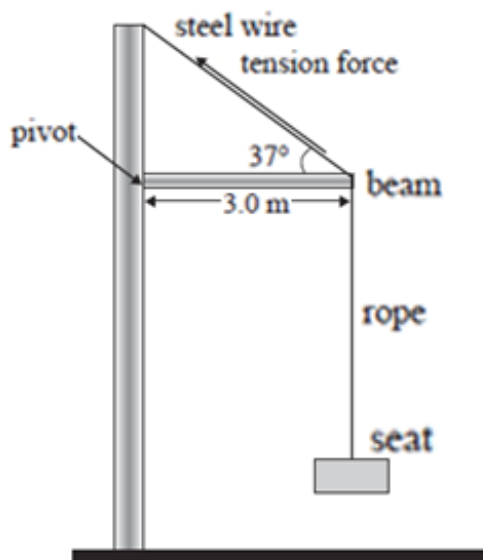


- (a) State the conditions necessary for the tray to be in equilibrium.
 (b) Calculate the weight (force of gravity) on:
 (i) the plate of food
 (ii) the tray.
 (c) Calculate the size of the upward force that Harry's fingertips must exert to keep the tray level.

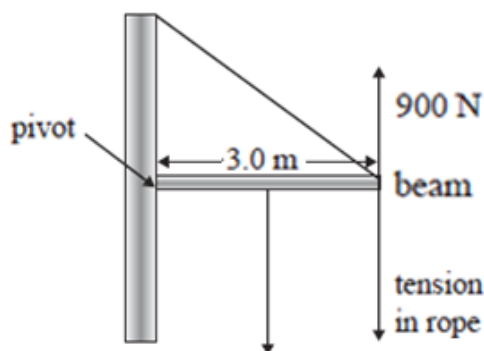
GOING TO THE PLAYGROUND (2008;2)

Rua goes across to the pole swing. The swing hangs on a rope attached to a uniform beam, as shown in the diagram.

The beam is 3.0 m long and has a mass of 35 kg.
 The angle between the steel wire and the beam is 37° .
 The tension force in the steel wire is 1500 N.

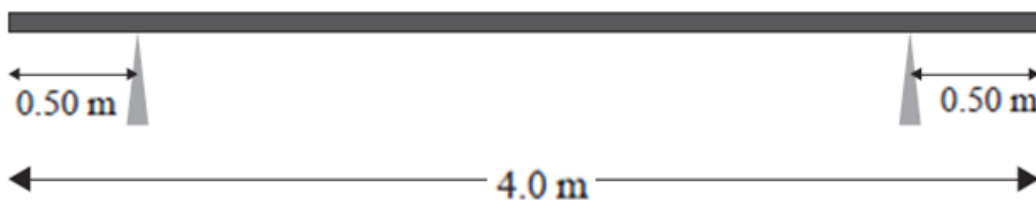


- The force exerted on the beam by the steel wire can be split into two components. Show that the vertical component of the force exerted on the beam by the steel wire is 900 N.
- By calculating the torques on the beam about the pivot, calculate the tension force in the rope.



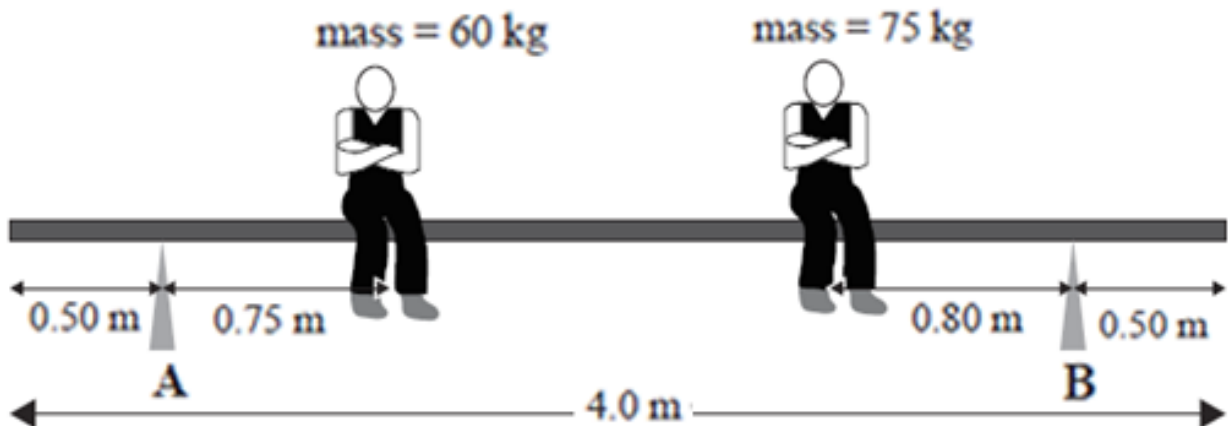
AT THE AIRPORT (2007;2)

Some painters are working at the airport. They have a uniform plank resting on two supports. The plank is 4.0 m long. It has a mass of 22 kg. The two legs that support the plank are 0.50 m from either end, as shown in the figure below.



- The plank is in equilibrium. Draw labelled arrows of appropriate sizes in the correct position showing the forces acting on the plank on the diagram above.

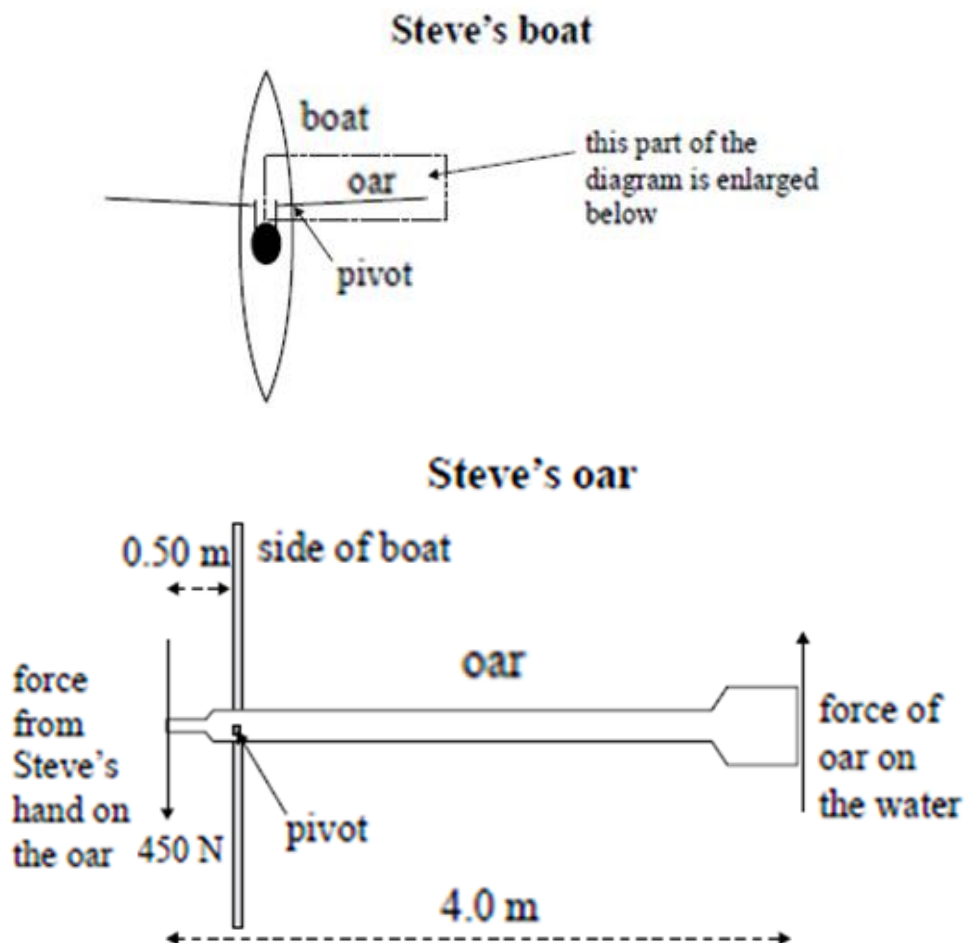
- (b) Calculate the support force on the plank at A if a painter of mass 60 kg sits 0.75 m from A, and another painter of mass 75 kg sits at a distance of 0.80 m from B. Use $g = 10 \text{ ms}^{-2}$.



ROWING (2006;1)

Steve is in a rowing race. The diagram below shows part of the side of the boat and one of Steve's oars as seen from above. The oar pivots on the side of the boat.

The oar is 4.0 m long. Steve's hand is 0.50 m from the pivot.
During a warm-up, Steve exerts a force of 450 N on the oar as shown in the diagram below.



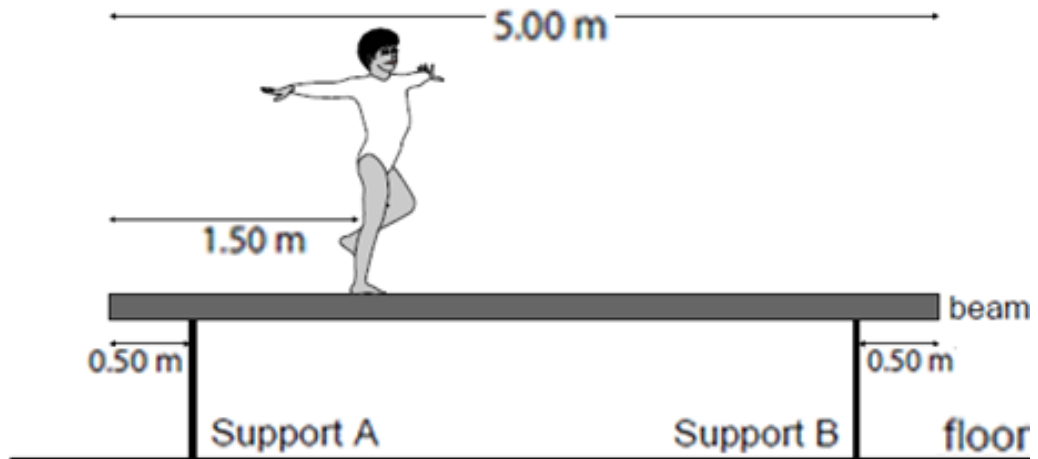
- (a) Calculate the size of the force that the oar exerts on the water.

SCHOOL GYM (2004;3)

Where needed, use $g = 10.0 \text{ ms}^{-2}$.

The Balance Beam

Nadia is performing an exercise on the balance beam. The beam is 5.00 m long and has two supports, A and B, each 0.50 m from either end. The beam is uniform and rigid and has a mass of 90 kg. Nadia's mass is 55 kg and she is standing 1.50 m from the left hand end as shown below.



- (i) On the diagram, draw four labelled arrows in the correct positions and pointing in the correct directions to show each of the following forces: Nadia's weight, the weight of the beam, the support force provided by support A, the support force provided by support B
- (ii) State the value of Nadia's weight and the weight of the beam
- (iii) Calculate the value of the support force at A when Nadia is in the position shown.
- (iv) Explain the physics involved in finding the answer to (iii).