Section 1: The moment of a force

Exercise level 2

1. A pole vaulter uses a uniform pole of length 4 m and mass 5 kg. He holds the pole horizontally by placing one hand at the end of the pole and the other 75 cm from that end. Find the vertical forces exerted by his hands.

2. A uniform plank AB of length 120 cm and weight 50 N rests on a fulcrum at its midpoint M. A force of 20 N acts downwards at B and a force of 30 N acts downwards at the point C situated 30 cm from A. A force of magnitude P is placed at A in order to keep the plank in equilibrium. Find P and the reaction at the fulcrum.

3. A uniform bar AB of length 80 cm and weight 20 N is supported in a horizontal position by two vertical strings, one at point C such that AC = 20 cm, and one at B. The bar carries loads of 5 N suspended at A and 10 N suspended at D where DB = 30 cm. Find the tensions in the strings.

4. A horizontal beam AB 4.5 m in length is supported by two vertical cables attached at the ends. The tensions in the cables at A and B are 160 N and 200 N respectively. Find the weight of the beam and the distance of its centre of mass from A.

5. A uniform plank ABC of weight 400 N is held in a horizontal position by a smooth support at B and a vertical rope at C. AB = 1 m and BC = 4 m. The rope is likely to break if the tension exceeds 750 N.
    (i)   Find the maximum weight that can be placed at the mid point of BC
    (ii) Find the maximum distance that a man of weight 800 N can safely walk from B towards C.

6. A see-saw consists of a uniform beam of length 4 m supported at its midpoint. Abi of mass 27 kg sits on one end of the see-saw. Where must her brother Benjy of mass 42 kg sit if the see-saw is to balance horizontally?

7. The plank of a pirate ship is 4 m long, uniform and of weight $25g$ N. It is held horizontally by a cable at one end and is balanced on the side of the ship at a distance of 1.5 m from that end. The cable can sustain a maximum tension of $100g$ N downwards before snapping.
    (i)   Find the maximum weight that a miscreant can have if he is to successfully reach the seaward end of the plank without being tipped into the water.
    (ii) How far from the side of the ship can a man of mass 75 kg walk before the plank starts to tip?

8. A non-uniform beam PQ of length 4 m and weight 400 N is held horizontally by smooth supports at R and S where PR = SQ = 1 m. A boy of weight 500 N can just stand at end P without the beam overturning.
    (i)   Find the position of the centre of mass of the beam.
    (ii) The boy walks towards Q. Find his distance from Q when the beam is about to tip.