Exercise 4E

1 A uniform rod AB has length 4 m and mass 8 kg. It is resting in a horizontal position on supports at points C and D where $AC = 1$ m and $AD = 2.5$ m. A particle of mass m kg is placed at point E where $AE = 3.3$ m. Given that the rod is about to tilt about D, calculate the value of m.

2 A uniform bar AB, of length 6 m and weight 40 N, is resting in a horizontal position on supports at points C and D where $AC = 2$ m and $AD = 5$ m. When a particle of weight 30 N is attached to the bar at point E the bar is on the point of tilting about C. Calculate the distance AE.

3 A plank AB, of mass 12 kg and length 3 m, is in equilibrium in a horizontal position resting on supports at C and D where $AC = 0.7$ m and $DB = 1.1$ m. A boy of mass 32 kg stands on the plank at point E. The plank is about to tilt about D. By modelling the plank as a uniform rod and the boy as a particle, calculate the distance AE.

(P) **4** A uniform rod AB has length 5 m and weight 20 N. The rod is resting on supports at points C and D where $AC = 2$ m and $BD = 1$ m.

a Find the magnitudes of the reactions at C and D.

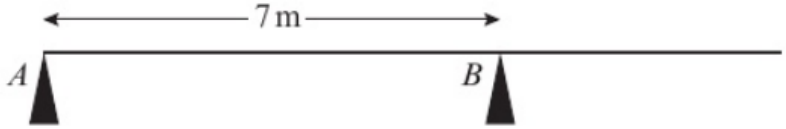
A particle of weight 12 N is placed on the rod at point A.

b Show that this causes the rod to tilt about C.

A second particle of weight 100 N is placed on the rod at E to hold it in equilibrium.

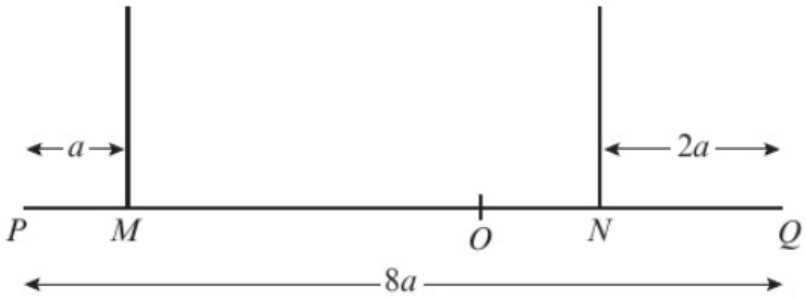
c Find the minimum and maximum possible distances of E from A.

E **5** A uniform plank of mass 100 kg and length 10 m rests horizontally on two smooth supports, A and B, as shown in the diagram. A man of mass 80 kg starts walking from one end of the plank, A, to the other end.



Find the distance he can walk past B before the plank starts to tip. **(4 marks)**

E/P **6** A non-uniform beam PQ, of mass m kg and length $8a$, hangs horizontally in equilibrium from two wires at M and N, where $PM = a$ and $QN = 2a$, as shown in the diagram. The centre of mass of the beam is at the point O. A particle of mass $\frac{3}{4}m$ kg is placed on the beam at Q and the beam is on the point of tipping about N.

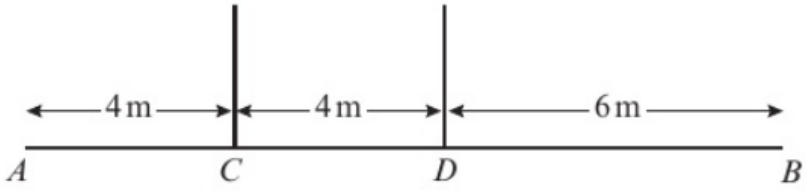


a Show that $ON = \frac{3}{2}a$. **(3 marks)**

The particle is removed and replaced at the midpoint of the beam and the beam remains in equilibrium.

b Find the magnitude of the tension in the wire attached at point N in terms of m. **(5 marks)**

E/P **7** A uniform beam AB, of weight W and length 14 m, hangs in equilibrium in a horizontal position from two vertical cables attached at points C and D where $AC = 4$ m and $BD = 6$ m.



Exercise 4E

1 5

2 $\frac{2}{3}$m

3 2.05 m

4 **a** $C = 15\,\text{N}, D = 5\,\text{N}$ **b** $2 \times 12 \neq 20 \times 0.5$

c $2.14 \leqslant x \leqslant 4.78\,\text{m}$

5 2.5 m

6 **a** Taking moments about N:
$mg \times ON = \frac{3}{4}mg \times 2a$ so $ON = \frac{3}{2}a$

b $\frac{23}{20}mg\,\text{N}$

7 40 N