Question 1 (**)
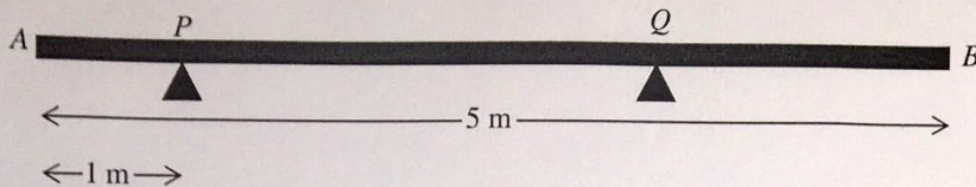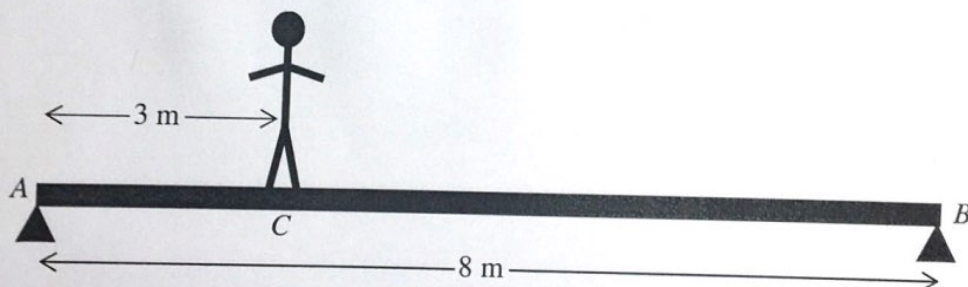

A uniform rod AB has length 5 m and weight 100 N.

The rod rests in a horizontal position on two smooth supports at P and Q, where $AP = 1$ m, as shown in the figure above.

The magnitude of the reaction force on the rod at P is 40 N.

    a) Determine magnitude of the reaction force on the rod at Q.

    b) Calculate the distance AQ.

Question 2 (**)

A non uniform plank of wood AB has length 8 m and mass 100 kg.

The plank is smoothly supported at its two ends A and B. A boy of mass 60 kg stands on the plank at the point C, where $AC = 3$ m, as shown in the figure above.

The plank with the boy standing on the plank, remains in equilibrium with AB horizontal. The plank is modelled as a non uniform rod and the boy as a particle.

    Given that the reactions at the two supports are equal, determine the distance of the centre of mass of the plank from A.

Question 3 (**)
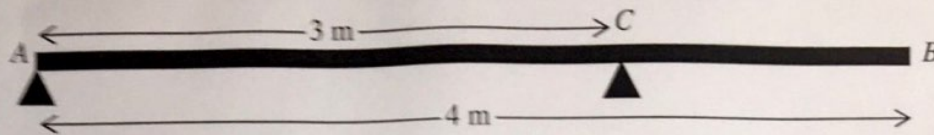
A plank of wood AB has length 4 m and mass 40 kg. The plank is smoothly supported at A and at C, where $AC = 3$ m, as shown in the figure above.
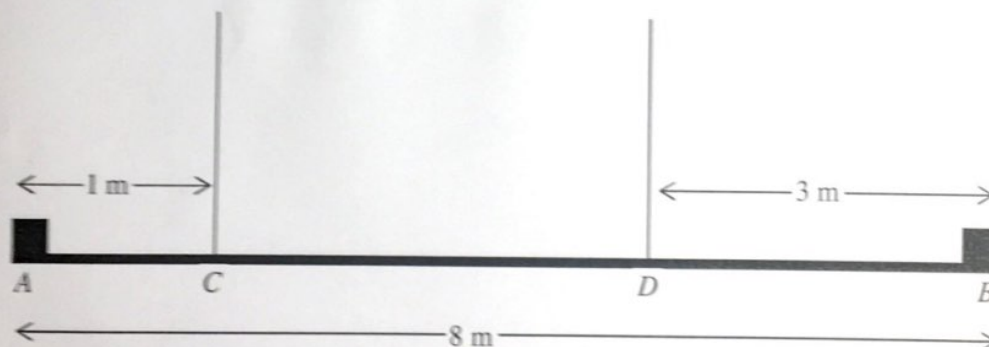
A man of mass 80 kg stands on the plank at a distance d m from A.

The plank with the man standing on it remains in equilibrium with AB horizontal, and the reactions on the rod at A and at C equal.

The plank is modelled as a uniform rod and the man as a particle.

Determine the value of d.

Question 4 (**)

A uniform iron girder AB has length 8 m and weight W N. A load of 250 N is attached to the girder at A and a load of 400 N is attached to the girder at B.

The loaded girder is suspended by two light vertical cables attached to the girder at points C and D, where $AC = 1$ m and $DB = 3$ m. When the loaded girder rests undisturbed in a horizontal position, the tension in the cable at D is four times the tension at the cable at C.

The girder is modelled as a uniform rod and the two loads as particles.

a) Determine magnitude of the tension on the girder at C.

b) Find the value of W.
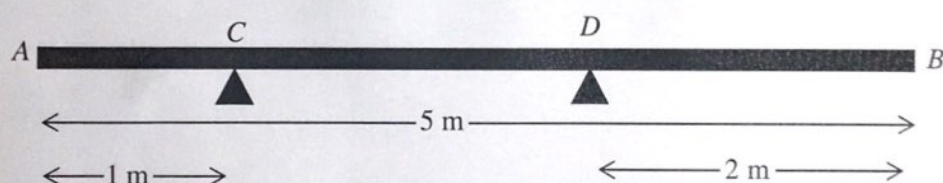
Question 5 (**+)
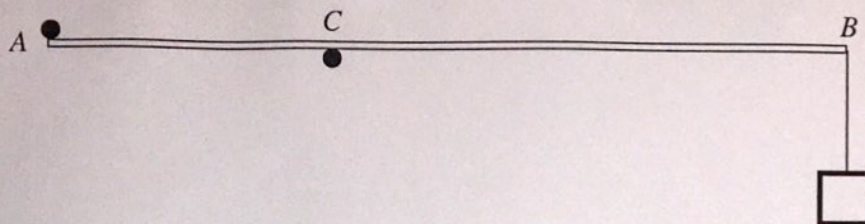
A box of mass 76 kg is attached by a string to one end B of a uniform rod AB of length 5 m and mass 24 kg.

The rod is held horizontally in equilibrium by two smooth cylindrical pegs, one at A and one at C, where $|AC| = 2$ m, as shown in the figure above.

Calculate the magnitude of the forces exerted by each of the pegs onto the rod.

$(R_A$ first, R_B second)

Question 6 (***+)

A uniform rod AB has length 5 m and weight 300 N. The rod rests in a horizontal position on two smooth supports at C and D, where $AC = 1$ m and $DB = 2$ m, as shown in the figure above. A particle of weight W N is placed on the rod at the point E, where $AE = x$ m.

The magnitude of the reaction on the rod at C is twice the magnitude of the reaction on the rod at D.
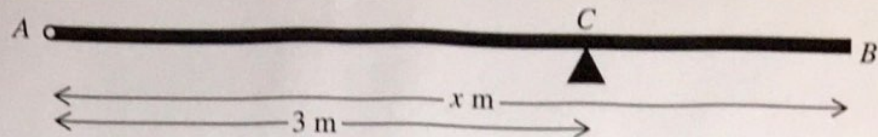
a) Show clearly that

$$W = \frac{a}{5 - 3x}.$$

State a

b) Determine the range of possible values of x.

$0 < x < b$ State b

Question 7 (***)

The figure above shows a uniform wooden beam AB, of length x m and weight 80 N. The beam is smoothly hinged at A and rests in a horizontal position on a smooth support at C, where $AC = 3$ m.

When a rock of weight 70 N is placed on the beam at B the magnitude of the reaction force on the beam at C is 165 N.

The beam is modelled as a uniform rod and the rock as a particle.

    a) Calculate the value of x.

The rock is next moved to a new position D on the beam, so that the beam with the rock at D remains in equilibrium in a horizontal position. The magnitude of reaction force at the support at C is now twenty times as large as the reaction force at the hinge at A.

    b) Calculate the distance AD.

Question 8 (***)

A mechanical lever consists of a uniform steel rigid rod AB, of length 2 m and weight 100 N, placed over a smooth pivot at C.

A box of weight 2400 N is suspended by a light inextensible string at B. When a vertical force is applied at A, as shown in the figure above, the lever remains in equilibrium, with AB horizontal.

    a) Given that $CB = 0.3$ m, determine the magnitude of the force applied at A.

The position of the pivot is changed so that lever remains in equilibrium when the vertical force applied at A has magnitude 200 N.

    b) Calculate the new distance of the pivot from B.
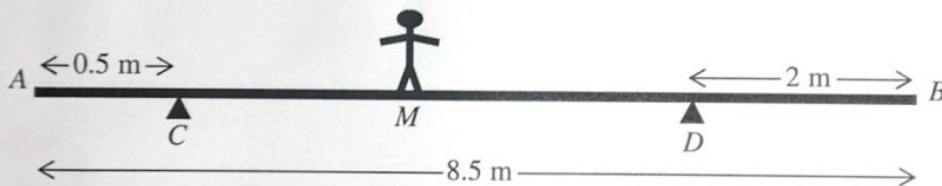
Question 9 (***)
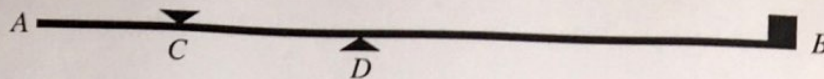
The figure above shows a uniform rod AB of length 1.8 m and mass 3 kg, held in a horizontal position by two small smooth pegs C and D.

A particle of mass 12 kg, is placed at B.

Given that $|AC| = 0.3$ m and $|CD| = 0.4$ m, determine the magnitude of each of the forces exerted on the rod by the pegs. R_c first, then R_D

Question 10 (***)

A non uniform plank of wood AB has length 8.5 m and mass 20 kg. The centre of mass of the plank is 3.75 m from B. The plank is smoothly supported at C and D, where $AC = 0.5$ m and $DB = 2$ m, as shown in the figure above.

A boy of mass 40 kg stands on the plank at the point M, where M is the midpoint of CD. The plank with the boy standing on the plank, remains in equilibrium with AB horizontal.

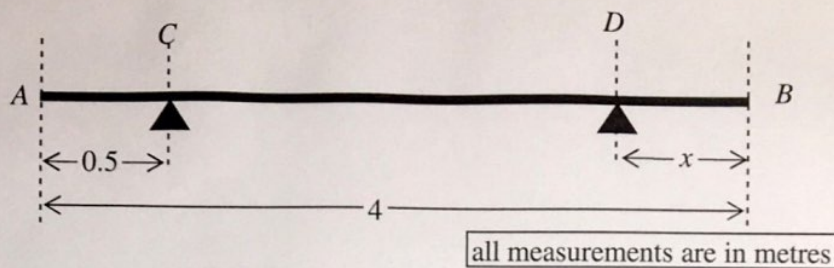The plank is modelled as a non uniform rod and the boy as a particle.

a) Calculate the magnitude of each of the reaction forces acting on the rod at C and D. R_c first, then R_D

The boy next moves and stands at the point E on the plank, so that the plank is at the point of tilting about D.

b) Determine the distance DE.

Question 11 (***)

all measurements are in metres

The figure above shoes a uniform rod AB of length 4 m and mass 100 kg. The rod rests in equilibrium in a horizontal position, on two supports at C and D, where $AC = 0.5$ m and $DB = x$ m.

a) Given that the reaction force at the support at D is three times as large as the reaction force at the support at C, determine the value of x.

The support at D is next moved to a new position E, where $EB = 0.75$ m and an additional mass of m kg is placed at B. The rod remains in equilibrium in a horizontal position and the reaction force at the support at E is now twice as large as the reaction force at the support at C.

b) Calculate the value of m.

Question 12 (***+)
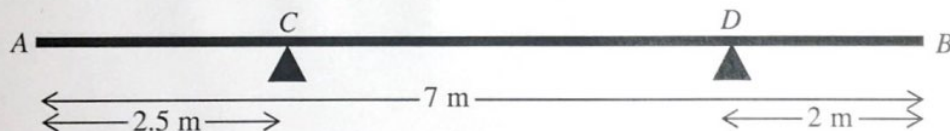
A non uniform rod AB has length 7 m and weight 300 N. The centre of mass of the rod is x m from A.

The rod is placed on two smooth supports at C and D, where $AC = 2.5$ m and $DB = 2$ m. The supports at C and D are at the same horizontal level, as shown in the figure above.

When a particle of weight W N is placed on the rod at A the reaction force on the rod at C is 200 N. The rod and the particle rest in equilibrium, with AB in a horizontal position.

a) Show clearly that $a = 60x - W$.   state a

The particle is then removed from A and placed on the rod at B. The rod and the particle remain in equilibrium, with AB in a horizontal position and the reaction force on the rod at C is now 80 N.

b) Calculate the value of W and the value of x.

$$R = 4.5$$
$$AC = 1.25$$
$$S = 3.55$$
$$B = 200$$
$$F = 60$$
$$K_1 = 600$$
$$L = 338.1$$
$$O = 0.185$$
$$EQU = 4.6$$
$$A = 1.5$$
$$N = 2350$$
$$IV = 3.5$$
$$Y = 334.83$$
$$PH = 750$$
$$\omega = 0.875$$
$$X = 20$$
$$G = 1176$$
$$Y = 5/3$$
$$J = 382$$
$$T = 485.1$$
$$D = 4.05$$
$$ZE = 2156$$
$$M = 253.16$$
$$E = 42.86$$

① $R_Q = 60$ N, $|AQ| = 3.5$ m   F   IV ✓

② $|AC| = 4.6$ m   E QU ✓

③ $d = 1.25$ m   AC ✓

④ $T_C = 600$ N, $W = 2350$ N   KI ✓   N ✓

⑤ $R_A = 1176$ N, $R_B = 2156$ N   G ✓   ZE ✓

750

PH ✓
Y ✓

⑥ $0 < x < \frac{5}{3}$

⑦ $x = 4.5$ m, $|AD| \approx 3.55$ m   R ✓   S ✓

⑧ $F = \frac{6500}{17} \approx 382$ N, $d = \frac{5}{27} \approx 0.185$ m   J ✓   O ✓

⑨ $R_C = 338.1$ N, $R_D = 485.1$ N   L ✓   T ✓

⑩ $|R_C| \approx 253.16...$ N, $|R_D| \approx 334.83...$ N, $|DE| = 0.875$ m   M ✓✓   Y ✓   E ✓

A ✓   X ✓

⑪ $x = 1.5$, $m = 20$

200

⑫ $W = \frac{300}{7} \approx 42.86$, $x = \frac{85}{21} \approx 4.05$ B ✓   E ✓   D ✓