M1 MOMENTS PPQ's

M1 – JUNE 10

4. A beam AB has length 6 m and weight 200 N. The beam rests in a horizontal position on two supports at the points C and D, where $AC = 1$ m and $DB = 1$ m. Two children, Sophie and Tom, each of weight 500 N, stand on the beam with Sophie standing twice as far from the end B as Tom. The beam remains horizontal and in equilibrium and the magnitude of the reaction at D is three times the magnitude of the reaction at C. By modelling the beam as a uniform rod and the two children as particles, find how far Tom is standing from the end B.

(7)

M1 – JAN 10

4.

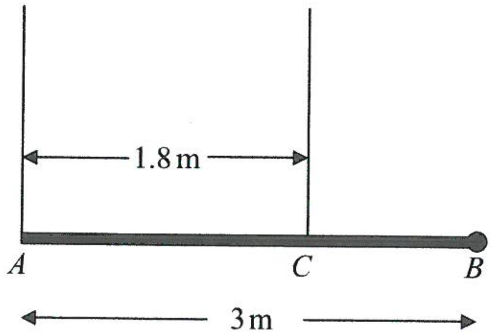


Figure 2

A pole AB has length 3 m and weight W newtons. The pole is held in a horizontal position in equilibrium by two vertical ropes attached to the pole at the points A and C where $AC = 1.8$ m, as shown in Figure 2. A load of weight 20 N is attached to the rod at B. The pole is modelled as a uniform rod, the ropes as light inextensible strings and the load as a particle.

(a) Show that the tension in the rope attached to the pole at C is $\left(\frac{5}{6}W + \frac{100}{3}\right)$ N.

(4)

(b) Find, in terms of W, the tension in the rope attached to the pole at A.

(3)

Given that the tension in the rope attached to the pole at C is eight times the tension in the rope attached to the pole at A,

(c) find the value of W.

(3)

M1 – JAN 09

4.

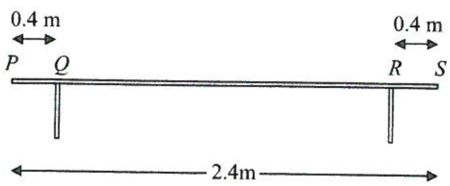


Figure 1

A bench consists of a plank which is resting in a horizontal position on two thin vertical legs. The plank is modelled as a uniform rod PS of length 2.4 m and mass 20 kg. The legs at Q and R are 0.4 m from each end of the plank, as shown in Figure 1.

Two pupils, Arthur and Beatrice, sit on the plank. Arthur has mass 60 kg and sits at the middle of the plank and Beatrice has mass 40 kg and sits at the end P. The plank remains horizontal and in equilibrium. By modelling the pupils as particles, find

(a) the magnitude of the normal reaction between the plank and the leg at Q and the magnitude of the normal reaction between the plank and the leg at R.

(7)

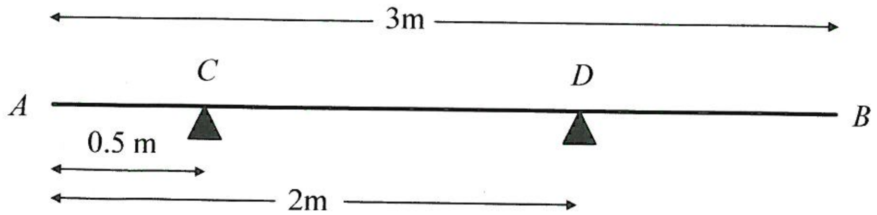
Beatrice stays sitting at P but Arthur now moves and sits on the plank at the point X. Given that the plank remains horizontal and in equilibrium, and that the magnitude of the normal reaction between the plank and the leg at Q is now twice the magnitude of the normal reaction between the plank and the leg at R,

(b) find the distance QX.

(6)

6.

Figure 3



M1 – Jan 03

A uniform rod AB has length 3 m and weight 120 N. The rod rests in equilibrium in a horizontal position, smoothly supported at points C and D, where $AC = 0.5$ m and $AD = 2$ m, as shown in Fig. 3. A particle of weight W newtons is attached to the rod at a point E where $AE = x$ metres. The rod remains in equilibrium and the magnitude of the reaction at C is now twice the magnitude of the reaction at D.

(*a*) Show that $W = \dfrac{60}{1-x}$.

(8)

(*b*) Hence deduce the range of possible values of x.

(2)

M1 June 04

7.

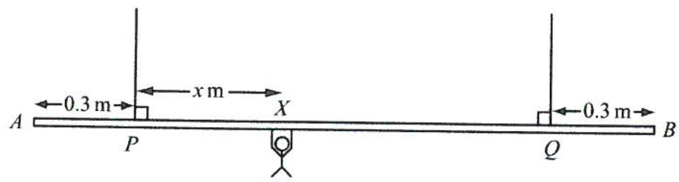


Figure 2

A beam AB is supported by two vertical ropes, which are attached to the beam at points P and Q, where $AP = 0.3$ m and $BQ = 0.3$ m. The beam is modelled as a uniform rod, of length 2 m and mass 20 kg. The ropes are modelled as light inextensible strings. A gymnast of mass 50 kg hangs on the beam between P and Q. The gymnast is modelled as a particle attached to the beam at the point X, where $PX = x$ m, $0 < x < 1.4$ as shown in Figure 2. The beam rests in equilibrium in a horizontal position.

(a) Show that the tension in the rope attached to the beam at P is $(588 - 350x)$ N.

(3)

(b) Find, in terms of x, the tension in the rope attached to the beam at Q.

(3)

(c) Hence find, justifying your answer carefully, the range of values of the tension which could occur in each rope.

(3)

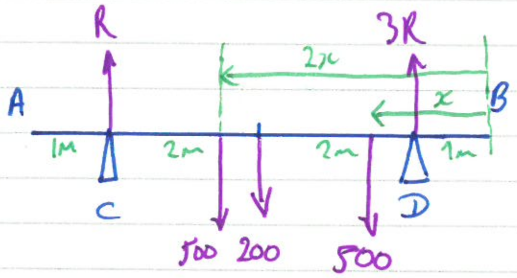
Given that the tension in the rope attached at Q is three times the tension in the rope attached at P,

(d) find the value of x.

(3)

M1 – June 10

Q4)



System in equilibrium ∴ $\sum F_y = 0$ $4R = 1200$

$R = 300N$ M1 A1

$\sum C_B$: $(3R \times 1) + (-500 \times x) + (-200 \times 3) + (-500 \times 2x) + (R \times 5) = 0$

M1 A1 A1

$900 - 500x - 600 - 1000x + 1500 = 0$

$1500x = 1800$

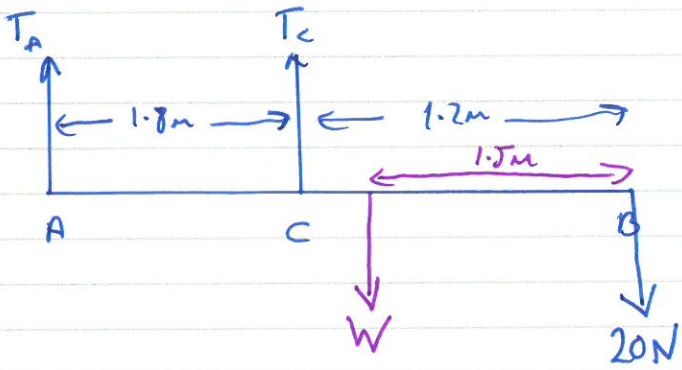
$x = 1.2$ M1 A1.

∴ Tom is standing 1.2 meters from B.

(M/7).

M1 – Jan 10

Q4



(a) $\sum \circlearrowright_A$: $(-T_c \times 1.8) + (W \times 1.5) + (20 \times 3) = 0$ M1 A1 A1

$1.8 T_c = 1.5W + 60$

$T_c = \frac{1.5W}{1.8} + \frac{60}{1.8}$

$T_c = \frac{5}{6}W + \frac{100}{3}$ As required. A1 — ①

(b) $\sum F_y = 0$ $T_A + T_c - W - 20 = 0$ M1 A1

$T_A = W + 20 - \frac{5W}{6} - \frac{100}{3}$

$T_A = \frac{1}{6}W - \frac{40}{3}$ — ② A1

(c) IF $T_c = 8 T_A$

in ① $8 T_A = \frac{5}{6}W + \frac{100}{3}$

$T_A = \frac{5}{48}W + \frac{100}{24}$

in ② $\frac{5}{48}W + \frac{100}{24} = \frac{1}{6}W - \frac{40}{3}$ M1 A1

$\frac{1}{6}W - \frac{5}{48}W = \frac{100}{24} + \frac{40}{3}$

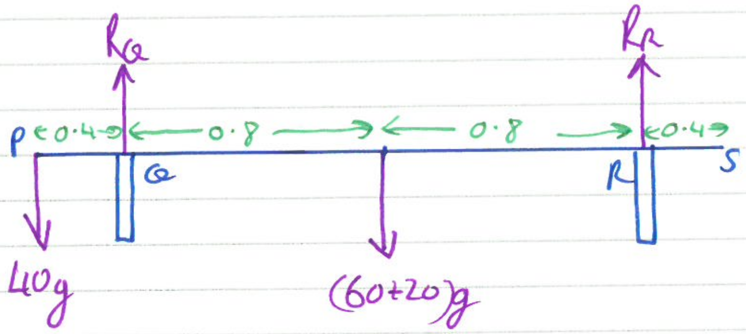
$\frac{1}{16}W = \frac{35}{2}$

$W = 280N$ A1.

M/10

M1 – JAN 2009

Q4.



(a) $\sum \overset{\frown}{C_R}$: $(-80g \times 0.8) + (R_Q \times 1.6) + (-40g \times 2) = 0$ M1 A1

$1.6R_Q = 144g$

$R_Q = 90g\ N$ M1 A1

$\sum F_y = 0 \quad R_Q + R_R - 40g - 80g = 0$ M1 A1

$R_R = 40g + 80g - 90g = 30g\ N$ A1

(b)

$\sum F_y = 0 \quad 3R = 120g \quad R = 40g$ M1 A1

$\sum \overset{\frown}{C_Q}$: $(-40g \times 0.4) + (60g \times X) + (20g \times 0.8) + (-R \times 1.6) = 0$ M1 A1

$-16g + 60gX + 16g - 64g = 0$

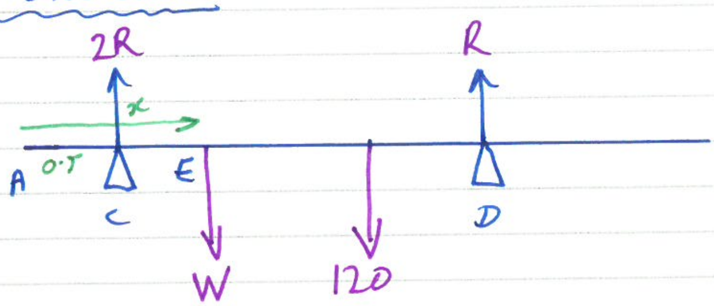
$60gX = 64g$

$X = \frac{16}{15}$ M M1 A1

M/13

M1 - JAN 2003

Q6.



(a) $\sum F_y = 0$ $\quad 3R = W + 120$ $\qquad$ M1 A1

$$R = \frac{W+120}{3}$$

$\sum \curvearrowright_A : (-2R \times 0.5) + (Wx) + (120 \times 1.5) + (-R \times 2) = 0$ $\qquad$ M1 A1 A1

$$Wx = 3R - 180$$

$$Wx = 3\left(\frac{W+120}{3}\right) - 180 \qquad \text{M1}$$

$$Wx = W + 120 - 180$$

~~Wx - Wx =~~ $W - Wx = 60$

$$W(1-x) = 60 \qquad \text{A1}$$

$$W = \frac{60}{1-x} \text{ as required.} \qquad \text{~~M1~~ A1}$$

(b) As W is weight $\quad W > 0$ $\qquad$ M1

$$\therefore \quad 1 - x > 0$$

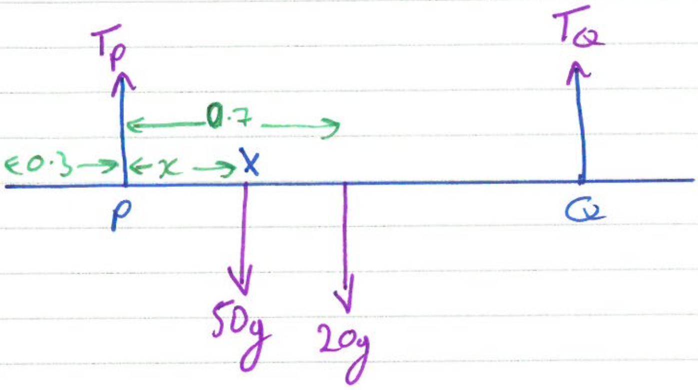
$$-x > -1$$

$$\therefore \quad x < 1. \qquad \text{A1}$$

M/10

M1 – June 09

Q7



(a) ΣF_y: $T_P + T_Q = 70g$ — ① M1 A1

ΣM_P: $(50g\,x) + (20g \times 0.7) + (-T_Q \times 1.4) = 0$ M1 A1

$50g\,x + 14g = 1.4T_Q$ — ② A1

From ① $T_Q = 70g - T_P$ — ③

$\therefore\ 50g\,x + 14g = 1.4(70g - T_P)$

$50g\,x + 14g = 98g - 1.4T_P$

$1.4T_P = 98g - 14g - 50g\,x$

$1.4T_P = 84g - 50g\,x$

$T_P = 588 - 350x$ As required. A1

(b) in ③ $T_Q = 686 - 588 + 350x$

$= 98 + 350x$ A1

(c) Given that $0 < x < 1.4$ M1

$\therefore$ For T_P: $588 - 350(0) > T_P > 588 - 350(1.4)$ A1

$588 > T_P > 98$

For T_Q: $98 + 350(0)$ T_Q $98 + 350(1.4)$ A1

$98 < T_Q < 588$

M1 - June 09

Q3(c) $T_Q = 3T_P$

$T_Q = 3(588 - 350x)$

$\therefore$ $98 + 350x = 1764 - 1050x$ M1 M1

$1400x = 1666$

$x = 1.19\,m.$ A1.

$\frac{M}{12}$