Single Mechanics – Moments 1

Taken from Sadler & Thorning's "Understanding Mechanics".

In questions 1–8 involve *light* horizontal rods in equilibrium. Find the magnitudes of P and Q and the distance x as required.

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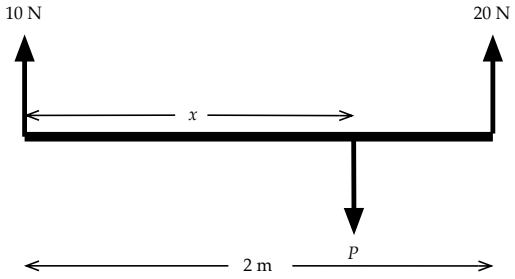

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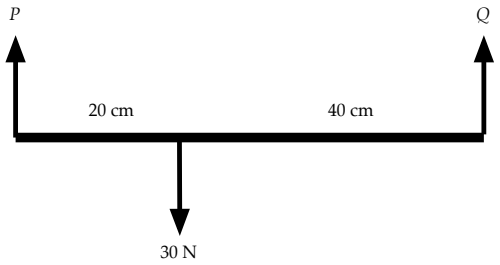

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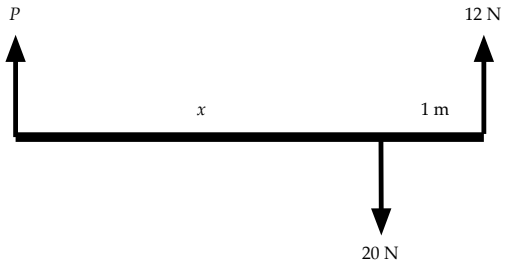

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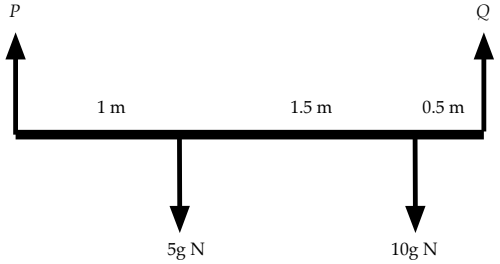

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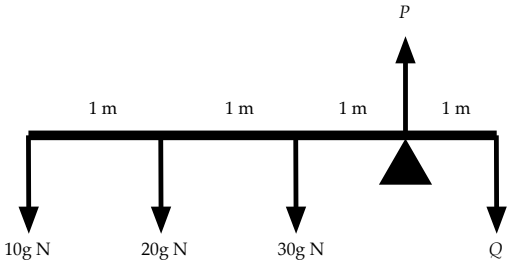

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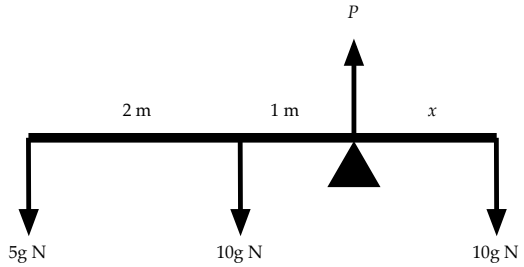

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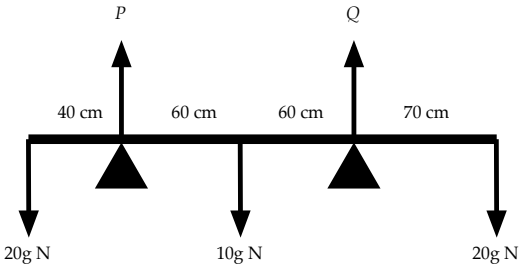

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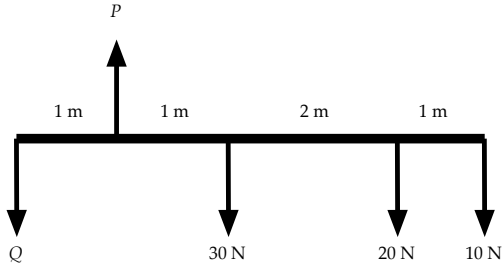
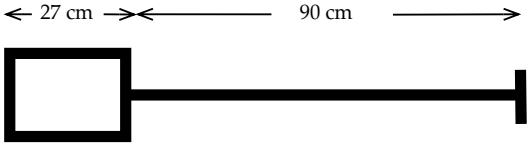


Some of the following questions involve *uniform* beams. This means the weight of the beam can be taken as acting at the centre of the beam.

9. A uniform beam of length 4 m and mass 50 kg rests horizontally, supported at each end. A mass of 20 kg is placed on the beam 1 m from one end. Find the reactions at the supports.
10. A uniform beam of length 6 m and mass 8 kg has a mass of 10 kg attached at one end and a mass of 3 kg attached at the other end. Find the position of the support if the beam rests in a horizontal position.
11. A play ground sea-saw consists of a uniform beam of length 4 m supported at its mid-point. If a girl of mass 25 kg sits at one end of the see-saw, find where her brother of mass 40 kg must sit if the see-saw is to balance horizontally.
12. A broom consists of a uniform broomstick of length 120 cm and mass 4 kg with a broom head of mass 6 kg attached at one end. Find where a support should be placed so that the broom will balance horizontally.
13. A non-uniform beam AB is of length 4 m and its weight of 5 N can be considered to act at a point 1.8 m from the end A. The rod rests horizontally on smooth supports at A and B. Find the reactions at the supports.
14. A uniform rod AB of mass 10 kg and length 4 m rests horizontally on two supports, one at A and the other 1 m from B. Where must a boy of mass 50 kg stand on the beam if he wishes to make the reactions at the supports equal?
15. A non-uniform rod AB of length 4 m is supported horizontally on two supports, one at A and the other at B. The reactions at the supports are 5g N and 3g N respectively. If instead the rod were to rest horizontally on one support find how far from end A this support would have to be placed.
16. 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 one end of the pole and the other hand at a position on the pole 80 cm away. Find the vertical forces exerted by his hands.
17. Three uniform rods of mass 2, 4 and 8 kg and each of length 20 cm, are joined together in the order mentioned to form one long rigid rod of length 60 cm. This rod is then suspended horizontally by a vertical string attached to the rod at a point x cm from its mid-point. Find the value of x and the tension in the string.
18. The diagram shows a spade which consists of a handle, a uniform shaft and a uniform rectangular blade. The handle is of mass 0.5 kg, the shaft of mass 2 kg and the blade of mass 2 kg.

    (a) If the spade is to rest horizontally on one support, where should this support be placed?

    (b) If a man carries the spade horizontally with one hand on the handle and the other at a distance of 72 cm from the handle, find the vertical forces exerted by his hands when a brick of mass 6 kg is placed at the centre of the blade.



Answers

1. $P = 30$ N, $x = \frac{4}{3}$ m
2. $P = 20$ N, $Q = 10$ N
3. $P = 8$ N, $x = \frac{3}{2}$ m
4. $P = 5g$ N, $Q = 10g$ N
5. $P = 160g$ N, $Q = 100g$ N
6. $P = 25g$ N, $x = \frac{5}{2}$ m
7. $P = 20g$ N, $Q = 30g$ N
8. $P = 190$ N, $Q = 130$ N
9. 30g N, 40g N
10. 2 m from 10 kg mass
11. 75 cm from other end
12. 24 cm from head
13. $\frac{11}{4}$ N, $\frac{9}{4}$ N
14. 1.4 m from A
15. $\frac{3}{2}$ m from A
16. $\frac{15}{2}g$ N downwards, $\frac{25}{2}g$ N upwards
17. $\frac{60}{7}$, 14g N
18. (a) 66 cm from handle
    (b) $\frac{9}{4}g$ N, $\frac{51}{4}g$ N