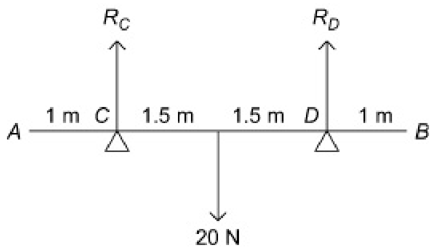
Exercise 8C

1 a



Resolving vertically:

$R_C + R_D = 20$

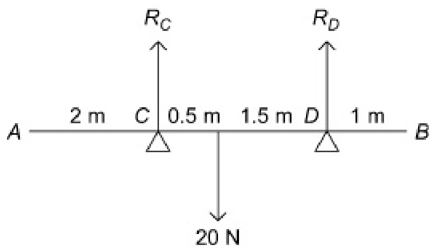
Taking moments about C:

$3 \times R_D = 1.5 \times 20$

$= 30$

$\Rightarrow R_D = 10\,\text{N}$ and $R_C = 10\,\text{N}$

b



Resolving vertically:

$R_C + R_D = 20$

Taking moments about C:

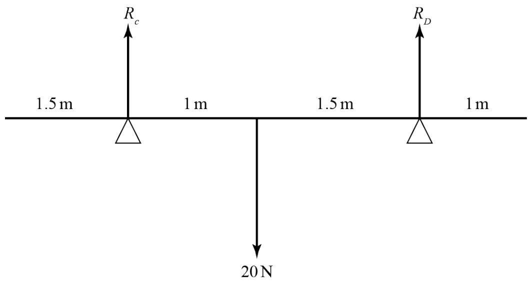
$R_D \times 2 = 20 \times 0.5$

$= 10$

$\Rightarrow R_D = 5\,\text{N}$ and $R_C = 15\,\text{N}$

© Pearson Education Ltd 2019. Copying permitted for purchasing institution only. This material is not copyright free.

1 c



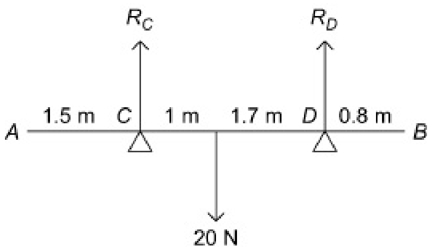
Resolving vertically:

$R_C + R_D = 20$

Taking moments about C:

$$R_D \times 2.5 = 20 \times 1$$
$$= 20$$
$$\Rightarrow R_D = \frac{20}{2.5} = 8\,\text{N} \text{ and } R_C = 12\,\text{N}$$

d



Resolving vertically:

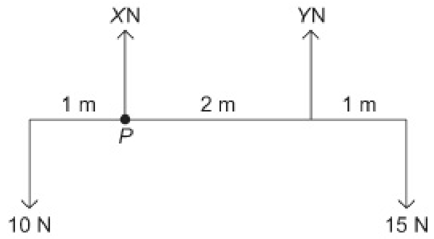
$R_C + R_D = 20$

Taking moments about C:

$$2.7 \times R_D = 20 \times 1$$
$$= 20$$
$$\Rightarrow R_D = \frac{20}{2.7} = 7.4\,\text{N} \text{ and } R_C = 12.6\,\text{N}$$

© Pearson Education Ltd 2019. Copying permitted for purchasing institution only. This material is not copyright free.

2 a



Resolving vertically:

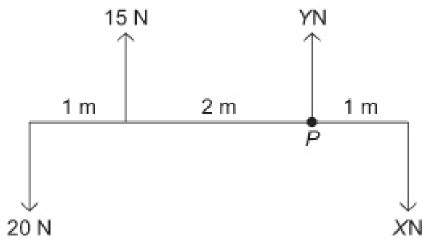
$$X + Y = 10 + 15$$
$$= 25$$

Taking moments about P:

$$15 \times (2+1) = 10 \times 1 + Y \times 2$$
$$45 = 10 + 2Y$$
$$2Y = 35$$
$$Y = 17.5$$

$\Rightarrow X = 7.5$ and $Y = 17.5$

b



Resolving vertically:

$$15 + Y = 20 + X$$
$$Y - X = 5$$

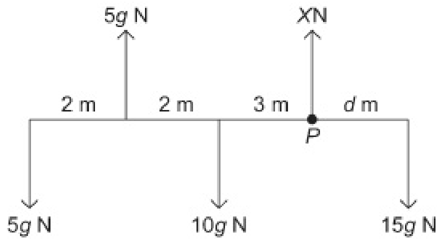
Taking moments about P:

$$20 \times (2+1) = 15 \times 2 + X \times 1$$
$$60 = 30 + X$$
$$X = 30$$

$\Rightarrow X = 30$ and $Y = 35$

© Pearson Education Ltd 2019. Copying permitted for purchasing institution only. This material is not copyright free.

2 c



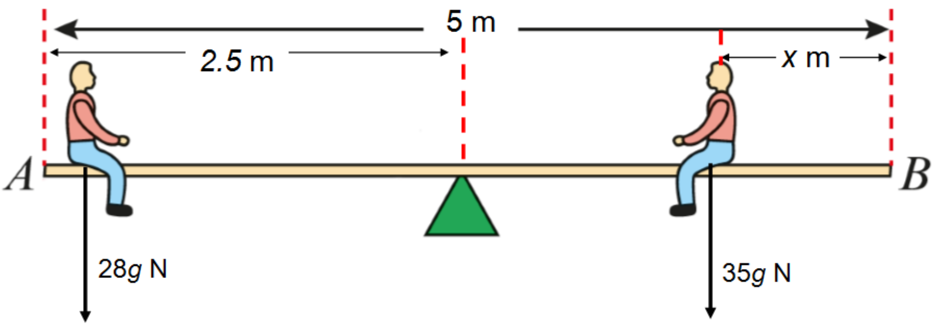
Resolving vertically:

$$5g + X = 5g + 10g + 15g$$
$$= 30g$$
$$\Rightarrow X = 25g = 245$$

Taking moments about P:

$$15g \times d + 5g \times (2+3) = 10g \times 3 + 5g \times (2+2+3)$$
$$15gd + 25g = 30g + 35g$$
$$15d = 40$$
$$d = 2\tfrac{2}{3}$$

3



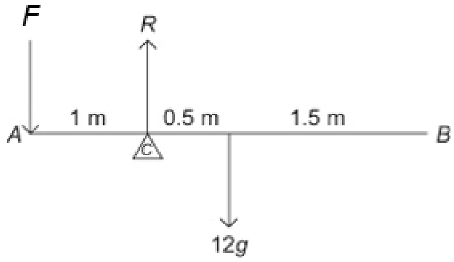
Seesaw is in equilibrium so
clockwise moment about pivot = anticlockwise moment about pivot

$$35g(2.5 - x) = 28g \times 2.5 \qquad \text{(divide both sides by } 7g\text{)}$$
$$5(2.5 - x) = 4 \times 2.5$$
$$5x = 2.5(5 - 4)$$
$$x = \frac{2.5}{5} = 0.5$$

Jack sits 0.5 m from B.

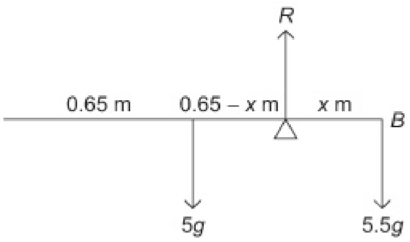
© Pearson Education Ltd 2019. Copying permitted for purchasing institution only. This material is not copyright free.

4



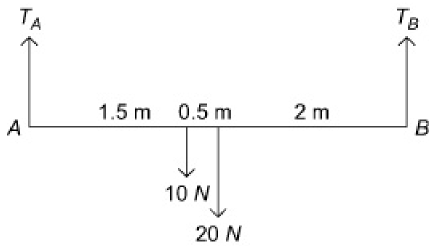
Suppose that the force required is F N acting vertically downwards at A.
Taking moments about the pivot (C):
$F \times 1 = 0.5 \times 12g$
$\Rightarrow F = 6g = 59\text{ N}$ (2 s.f.)

5



Let the support be x m from the broomhead.
Taking moments about the support:
$5.5g \times x = 5g \times (0.65 - x)$
$5.5x = 5 \times 0.65 - 5x$
$10.5x = 3.25$
$x = 0.31$
The support should be 31 cm from the broomhead.

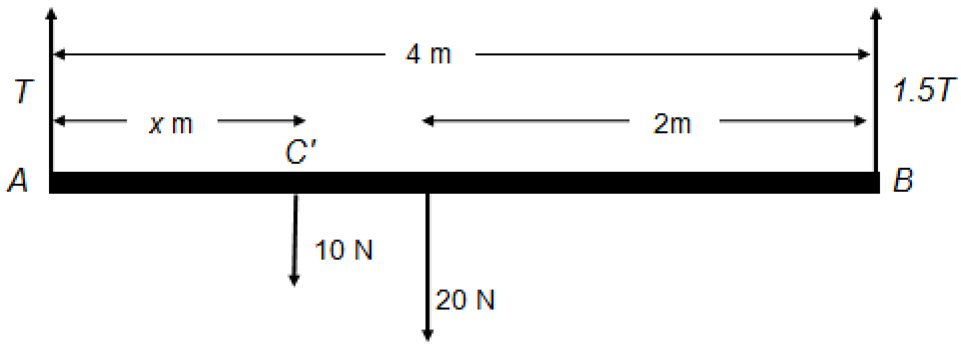
6 a



Let the tensions in the two strings be T_A and T_B respectively.
Resolving vertically:
$T_A + T_B = 10 + 20 = 30$
Taking moments about point A:
$10 \times 1.5 + 20 \times (1.5 + 0.5) = 4 \times T_B$
$\Rightarrow 4T_B = 15 + 40$
$= 55$
$T_B = 13.75\text{ N}$ and $T_A = 16.25\text{ N}$

© Pearson Education Ltd 2019. Copying permitted for purchasing institution only. This material is not copyright free.

6 b Particle is now at C' where $AC' = x$ m.



Beam is in equilibrium.
Resolving vertically:

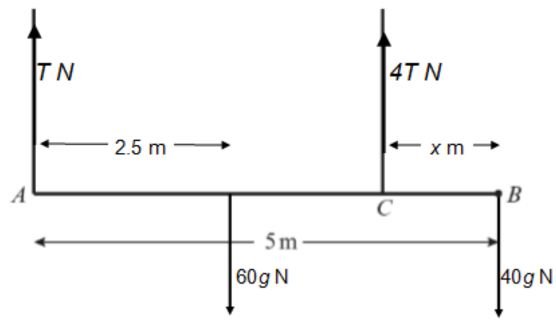
$$T + 1.5T = 10 + 20$$
$$2.5T = 30$$
$$T = 12$$

Taking moments about A:

$$10x + (20 \times 2) = (1.5 \times 12) \times 4$$
$$10x + 40 = 18 \times 4$$
$$10x = 72 - 40$$
$$x = \frac{32}{10} = 3.2$$

The particle is now 3.2 m from A.

7 $BC = x$ m.
Beam is in equilibrium.



a Resolving vertically:

$$4T + T = 40g + 60g$$
$$5T = 100g$$
$$T = 20g$$

So $4T = 80g$

$$4T = 80 \times 9.8 = 784$$

The tension in the wire at C is 784 N.

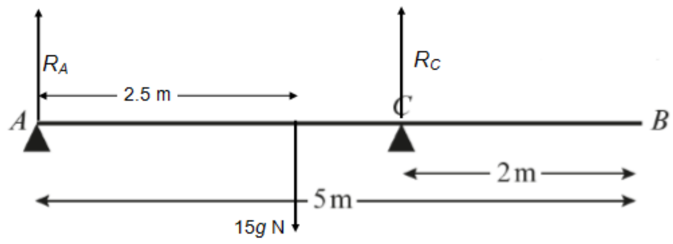
b Taking moments about B:

$$(20g \times 5) + 80gx = 60g \times 2.5 \qquad \text{(divide by } 20g\text{)}$$
$$5 + 4x = 7.5$$
$$4x = 2.5$$
$$x = \frac{2.5}{4}$$
$$= 0.625$$

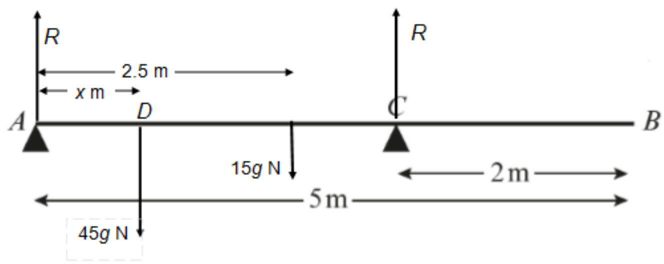
The distance CB is 0.625 m.

© Pearson Education Ltd 2019. Copying permitted for purchasing institution only. This material is not copyright free.

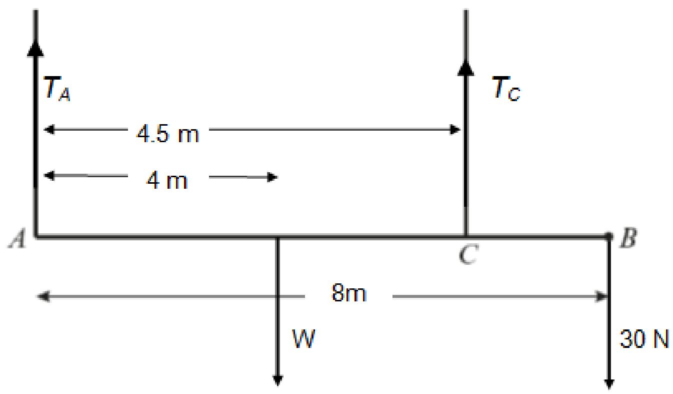
8 a Plank is in equilibrium.
Let the reactions at A and C be R_A and R_C respectively.
Taking moments about A:
$$15g\times 2.5 = R_c\times 3$$
$$R_c = 2.5\times 5g$$
$$R_c = 12.5\times 9.8$$
$$= 122.5$$
The reaction at C is 122.5 N.



b Let $AD = x$ m
Let $R_A = R_C = R$
Plank remains in equilibrium.
Resolving vertically:
$$2R = 45g + 15g = 60g$$
$$R = 30g$$
Taking moments about A:
$$45gx + (15g\times 2.5) = 30g\times 3 \qquad \text{(divide by } 15g\text{)}$$
$$3x + 2.5 = 6$$
$$3x = 3.5$$
$$x = \frac{3.5}{3}$$
$$= 1.17$$
The distance AD is 1.17 m (3 s.f.).



9 a Beam is in equilibrium.
Let tension in wire at C be T_C
Taking moments about A:
$$4.5T_C = 4W + (8\times 30)$$
$$\frac{9}{2}T_C = 4W + 240$$
$$9T_C = 8W + 480$$
$$T_C = \frac{8}{9}W + \frac{160}{3} \quad \text{as required.}$$



b Let tension in wire at A be T_A
Resolving vertically:
$$W + 30 = T_A + T_C$$
$$W + 30 = T_A + \frac{8}{9}W + \frac{160}{3}$$
$$9W + 270 = 9T_A + 8W + 480$$
$$W + 270 - 480 = 9T_A$$
$$T_A = \frac{W - 210}{9}$$
$$T_A = \frac{W}{9} - \frac{70}{3}$$

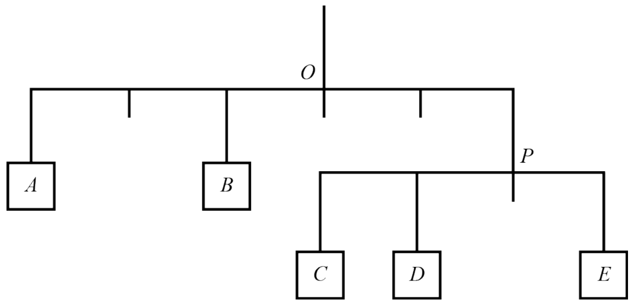
© Pearson Education Ltd 2019. Copying permitted for purchasing institution only. This material is not copyright free.

9 c

$$T_C = 12T_A$$
$$\frac{8W}{9} + \frac{160}{3} = \frac{12W}{9} - \frac{12 \times 70}{3}$$
$$8W + (160 \times 3) = 12W - (12 \times 70 \times 3)$$
$$480 + 2520 = 12W - 8W$$
$$4W = 3000$$
$$W = 750$$
The weight of the beam is 750 N.

Challenge

Let the masses of the hanging components be A, B, C, D and E kg as shown.



Treating CDE as a single component and taking moments about O:
$(3A + B)g = 2(C + D + E)g$
Since all the numbers are whole, $2(C + D + E)$ is even, so $3A + B$ must be even.
This means that **A & B are either both even or both odd**.
The minimum possible value of $C + D + E = 1 + 2 + 3 = 6$
So $3A + B \geqslant 12$
Maximum value of B is 5
So $3A \geqslant 7$
i.e. $A \geqslant \frac{7}{3} \Rightarrow$ **A cannot be 1 or 2.**

Taking moments about P:
$(2C + D)g = Eg$
Smallest possible value of $2C + D$ is $(2 \times 1) + 2 = 4$
So ***E* must be 4 or 5**

If $E = 4$ then $C = 1$ and $D = 2$
This leaves A & B as 3 and 5.
Either option allowed by rules above.
$2(C + D + E) = 2(1 + 2 + 4) = 14$
since $3 \times 5 > 14$, this means A must be 3 and B must be 5.
To check: $3A + B = (3 \times 3) + 5 = 14$
Therefore this combination works.

However, best to check other possibilities:
If $E = 5$ then either $C = 2$ & $D = 1$ or $C = 2$ & $D = 1$.
First case means A & B are 3 & 4, which **is not allowed** as one odd and one even.
In second case, since A cannot be 2, $A = 4$ and $B = 2$.
Then:
$2(C + D + E) = 2(2 + 1 + 5) = 16$
$3A + B = (3 \times 4) + 2 = 14$
Since these are **not equal**, this combination does not work either.

The masses, from left to right, are: 3 kg, 5 kg, 1 kg, 2 kg and 4 kg.

© Pearson Education Ltd 2019. Copying permitted for purchasing institution only. This material is not copyright free.