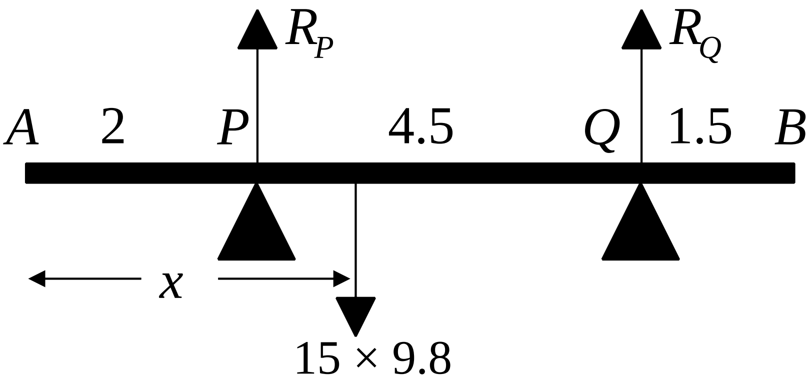
4.4 Answers

4.4.1 Solution to 4.2 Example

The question does not provide any diagram, so the first task is to remedy that shortcoming,



Balancing forces vertically,

$$\begin{aligned} R_P + R_Q &= 15 \times 9.8 \\ 2\,R_Q + R_Q &= 147 \\ R_Q &= 49\ \text{N} \\ \therefore\ R_P &= 98\ \text{N} \end{aligned}$$

It may be obvious that the centre of mass is somewhere between the two supports P and Q in which case a marginally easier calculation would take moments about P. However, with other weights around such as a man standing on the log, it may not be possible to decide in advance which side of P the centre of mass lies. The consequence of this would be to not know if the moment of the rod's weight is clockwise or anticlockwise about P.

It's thus, in general, easier to simply take moments about one of the plank's endpoints.

So, taking moments about A,

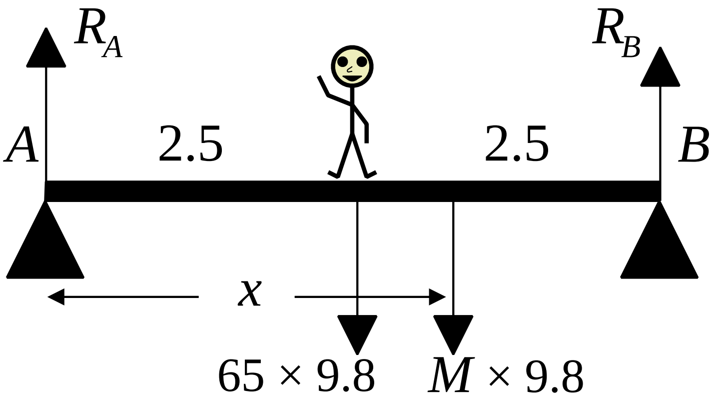
$$\begin{aligned} 15 \times 9.8 \times x &= R_P \times 2 + R_Q \times 6.5 \\ 147x &= 98 \times 2 + 49 \times 6.5 \\ 147x &= 196 + 319 \\ x &= 3.5\ \text{metres} \end{aligned}$$

As the log was 8 metres long, the centre of mass is not is the middle of the log.

4.4.2 Solution to 4.3 Exercise

Answer 1

(i) $R_A = 525$ N and $R_B = 700$ N



(ii) Balancing forces vertically,

$$R_A + R_B = 65 \times 9.8 + M \times 9.8$$

$$525 + 700 = 637 + 9.8M$$

$$9.8M = 588$$

$$M = 60 \text{ kg}$$

(iii) Taking moments about A,

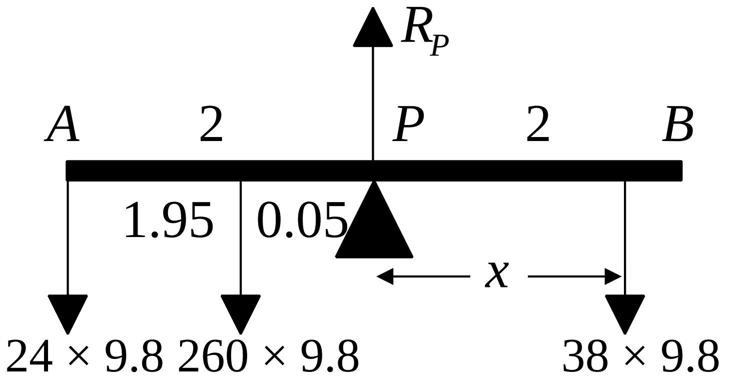
$$R_B \times 5 = 65 \times 9.8 \times 2.5 + M \times 9.8 \times x$$

$$700 \times 5 = 1593 + 588x$$

$$588x = 1907$$

$$x = 3.24 \text{ metres}$$

Answer 2



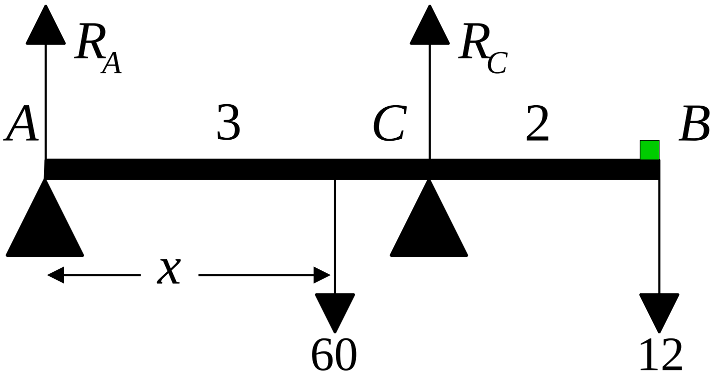
Take moments about P,

$$38 \times 9.8 \times x = 260 \times 9.8 \times 0.05 + 24 \times 9.8 \times 2$$

$$372x = 127 + 470$$

$$x = 1.60 \text{ metres}$$

Answer 3



(a) Balancing forces vertically,

$$R_A + R_C = 60 + 12$$
$$0.5\,R_C + R_C = 72$$
$$R_C = 48\text{ N}$$
$$\therefore\ R_A = 24\text{ N}$$

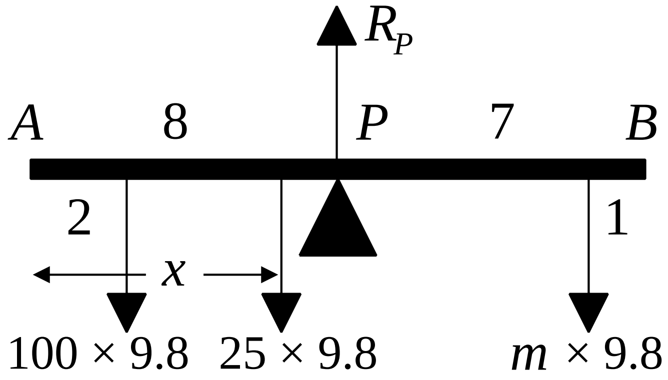
Taking moments about A,

$$60 \times x + 12 \times 5 = R_C \times 3$$
$$60x + 60 = 48 \times 3$$
$$60x = 84$$
$$x = 1.4\text{ metres}$$

(b) **(i)** Assumed that all of the parcel's weight acted at B
In reality, the parcel's centre of mass would be a few centimetres in from B as it wold otherwise fall off the end as the parcel was "placed" rather than fixed in some way at B

(ii) Assumed that the rod does not bend.
As it's long for its weight, it is likely to have some bend in reality.

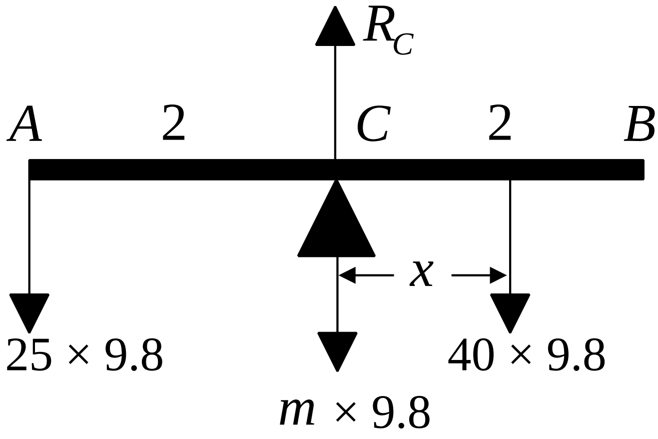
Answer 4



As the mass of the second man, near *B* is not known, and not requested, the direct method of doing this question is to take moments about where that second man is standing,

$$
\begin{aligned}
100 \times 9.8 \times 12 + 25 \times 9.8 \times (14 - x) &= R_P \times 6 \\
11760 + 245(14 - x) &= 2009 \times 6 \\
11760 + 3430 - 245x &= 12054 \\
245x &= 3136 \\
x &= 12.8 \text{ metres}
\end{aligned}
$$

Answer 5

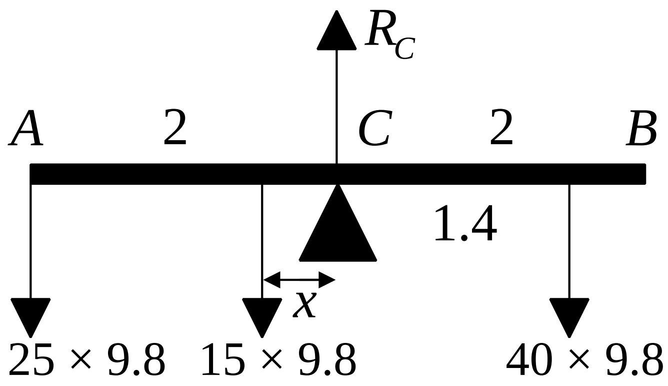


(a) As the mass of the uniform beam is not known, take moments about C,

$$40 \times 9.8 \times x = 25 \times 9.8 \times 2$$
$$392x = 490$$
$$x = 1.25 \text{ metres}$$

(b) That the mass of the beam acts at the midpoint of the beam

(c)



Taking moments about C,

$$25 \times 9.8 \times 2 + 15 \times 9.8 \times x = 40 \times 9.8 \times 1.4$$
$$490 + 147x = 549$$
$$x = 0.4 \text{ metres}$$