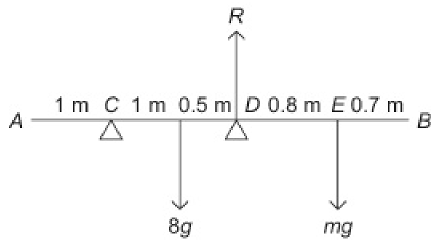
Exercise 8E

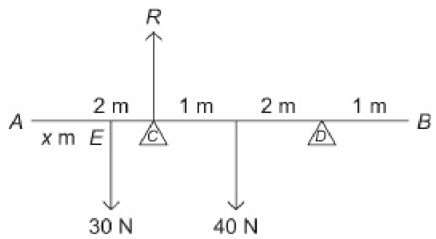
1 If the rod is about to turn about D then the reaction at C is zero.
Taking moments about point D:
$8g \times 0.5 = mg \times 0.8$
$\Rightarrow m = 5$



2 If the bar is about to tilt about C then the reaction at D is zero.
Let the distance $AE = x$**m**
Taking moments about C:

$$40 \times 1 = 30 \times (2 - x)$$
$$40 = 60 - 30x$$
$$30x = 20$$
$$x = \frac{2}{3}$$

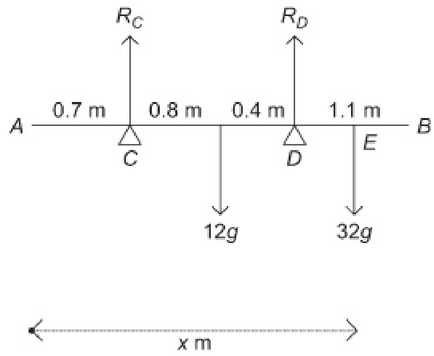
The distance $AE = \frac{2}{3}$ m



3 Let the distance AE be x m.
If the plank is about to tilt about D then $R_C = 0$
Taking moments about D:

$$12g \times 0.4 = 32g \times (x - 1.9)$$
$$12 \times 0.4 = 32x - 32 \times 1.9$$
$$32x = 4.8 + 60.8$$
$$= 65.6$$
$$\Rightarrow x = \frac{65.6}{32}$$
$$= 2.05$$

E is 2.05 m from A



4 **a** $R(\uparrow)$:

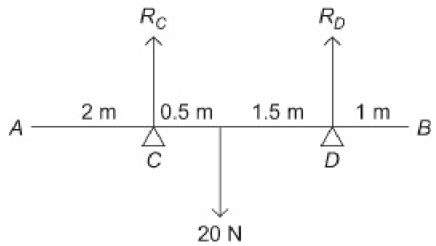
$$R_C + R_D = 20 \qquad \textbf{(1)}$$

Taking moments about C:

$$20 \times 0.5 = R_D \times 2$$
$$R_D = 5\text{ N} \qquad \textbf{(2)}$$

Substituting (**2**) into (**1**):

$$R_C = 20 - 5$$
$$= 15\text{ N}$$

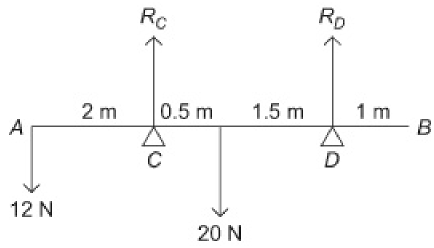


4 b Adding the weight of 12 N:
Taking moments about C:

$$20 \times 0.5 = 12 \times 2 + R_D \times 2$$

$$10 = 24 + 2R_D$$

$\Rightarrow R_D$ is negative, which is impossible, therefore there is an anticlockwise moment about C – rod will tilt.



c Distance AE is x m.
The reactions at the supports are R_C and R_D.
If rod tilts about C, $R_D = 0$.
Taking moments about C:

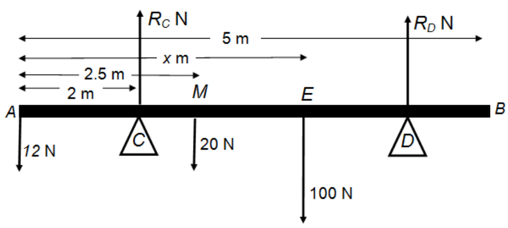
$$12 \times 2 = 20(2.5 - 2) + 100(x - 2)$$

$$24 = 10 + 100x - 200$$

$$x = \frac{200 + 24 - 10}{100}$$

$$= 2.14$$

In this case $AE = 2.14$



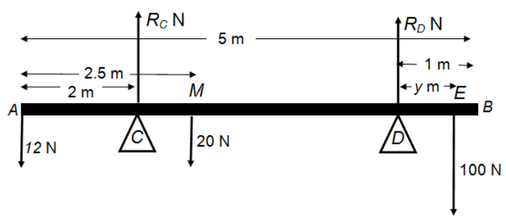
If rod tilts about D, $R_C = 0$.
E must be on the other side of D, a distance y m from B.
Taking moments about D:

$$12 \times (5 - 1) + 20(2.5 - 1) = 100y$$

$$48 + 30 = 100y$$

$$y = \frac{78}{100}$$

$$= 0.78$$



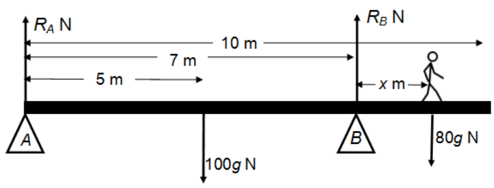
In this case $AE = 5 - 1 + 0.78 = 4.78$
The rod will remain in equilibrium if the particle is placed between 2.14 m and 4.78 m from A.

5 The reactions at the supports are R_A N and R_B N.
When the plank tilts, $R_A = 0$ and the man is x m from B.
Taking moments about B:

$$100g \times (7 - 5) = 80gx$$

$$x = \frac{200}{80}$$

$$= 2.5$$

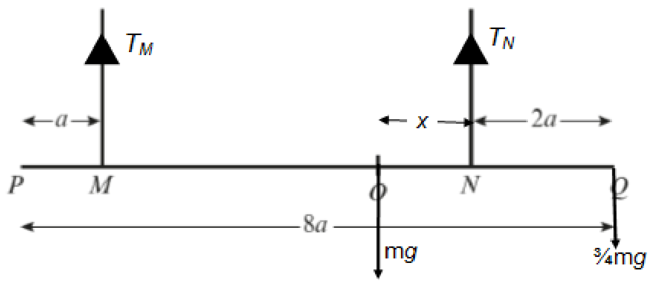


The man can walk 2.5 m past B before the plank starts to tip.

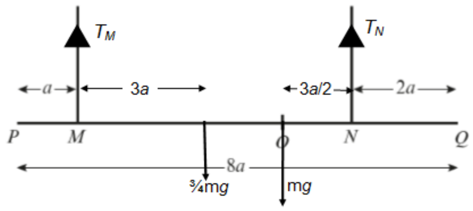
6 a Let $ON = x$ m.
Let the tensions in the two wires be T_M N and T_N N.
Since beam is on the point of tipping about N, $T_M = 0$.
Taking moments about N:

$$mgx = \frac{3}{4}mg \times 2a$$

$$x = \frac{3}{2}a \quad \text{as required.}$$



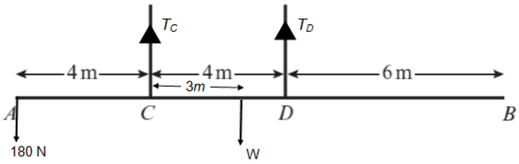
6 b Taking moments about M:



$$\left(\frac{3}{4}mg\times 3a\right)+mg\left(5-\frac{3}{2}\right)a=T_N\times 5a$$
$$\frac{9}{4}mg+5mg-\frac{3}{2}mg=5T_N$$
$$\left(\frac{9+20-6}{4}\right)mg=5T_N$$
$$\frac{23}{4}mg=5T_N$$
$$T_N=\frac{23}{20}mg$$

The tension in the wire attached at N is $\frac{23}{20}mg$

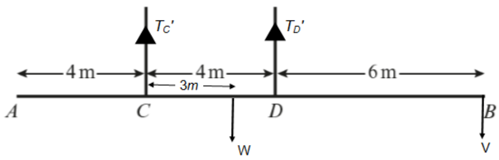
7 Let the tensions in the cables be T_C N and T_D N.



<u>In the first case</u>:
The beam must be on the point of tipping about C, so
$T_D = 0$
(This is because, if $T_C = 0$, there would be a resultant moment around D no matter what the value of W, and the beam would not be in equilibrium.)

Taking moments about C:
$$180\times 4=3W$$
$$W=240$$

<u>In the second case</u>:
When V is at maximum value, the beam will be on the point of tipping around D and $T_C = 0$.



Taking moments about D:
$$W\times 1=V\times 6$$
$$V=\frac{240\times 1}{6}$$
$$=40$$
The maximum value of V that keeps the beam level is 40 N.