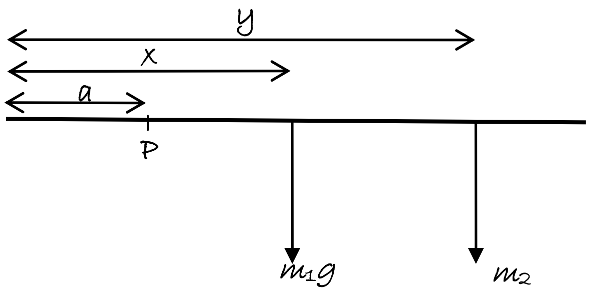
Edexcel A level Maths Moments

Section 1: The moment of a force

Solutions to Exercise level 3

1.



(i) Total moment $= m_1 g(x-a) + m_2 g(y-a)$

(ii) The minimum possible value of the magnitude of the moment is zero.
This occurs when $m_1 g(x-a) + m_2 g(y-a) = 0$

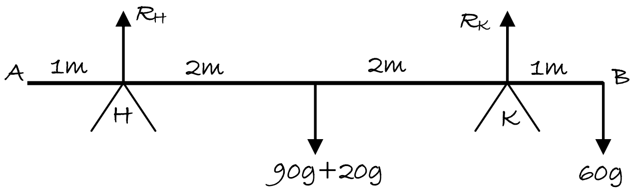
$$m_1 x - m_1 a + m_2 y - m_2 a = 0$$
$$m_1 x + m_2 y = m_1 a + m_2 a$$
$$a = \frac{m_1 x + m_2 y}{m_1 + m_2}$$

This expression can be written as $a = x + \frac{m_2(y-x)}{m_1 + m_2}$

or as $a = y + \frac{m_2(x-y)}{m_1 + m_2}$

If $y > x$, the first expression shows that $a > x$
and the second expression shows that since $x - y < 0$, $a < y$
so $x < a < y$
Similarly if $y < x$, the first expression shows that $a < x$ and the second shows that $a > y$, so $y < a < x$.
So the point P lies between the two masses.

2.



Edexcel A level Maths Moments 1 Exercise solutions

Taking moments about H: $110g \times 2 + 60g \times 5 - R_K \times 4 = 0$

$520g = 4R_K$

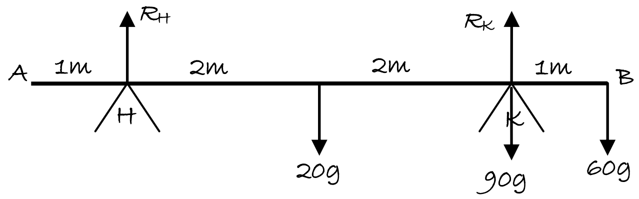
$R_K = 130g$

Resolving vertically: $R_H + R_K = 90g + 20g + 60g$

$R_H + 130g = 170g$

$R_H = 40g$

(ii)



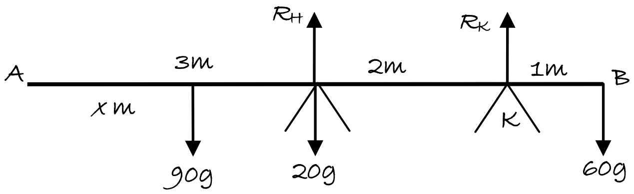
Taking moments about K: $20g \times 2 - R_H \times 4 - 60g \times 1 = 0$

$-20g = 4R_H$

$R_K = -5g$

It is not possible, as the reaction force cannot be negative.

(iii)



Taking moments about H: $60g \times 3 - R_K \times 2 - 90g(3 - x) = 0$

$-90g + 90gx = 2R_K$

For $R_K > 0$ (so the plank does not tip)

$-90g + 90gx > 0$

$x > 1$

Taking moments about K: $60g \times 1 - 20g \times 2 - 90g(5 - x) + R_H \times 2 = 0$

$-430g + 90gx = 2R_H$

For $R_H > 0$ (so the plank does not tip)

$-430g + 90gx > 0$

$x > \frac{43}{9} = 4\frac{7}{9}$

So he must stand at least $4\frac{7}{9}$ from end A.

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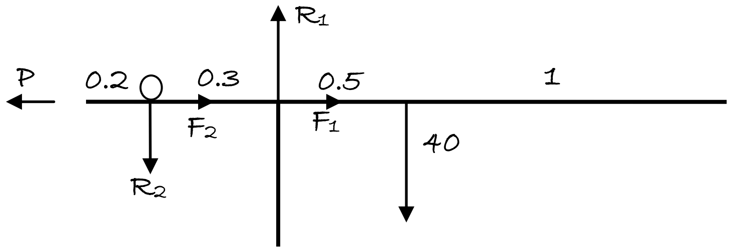
3.



(i) Taking moments about the fence: $40 \times 0.5 - R_2 \times 0.3 = 0$

$$R_2 = \frac{200}{3}$$

Resolving vertically: $R_1 - \frac{200}{3} - 40 = 0$

$$R_1 = \frac{320}{3}$$

If the plank is just about to move, friction is limiting in both places:

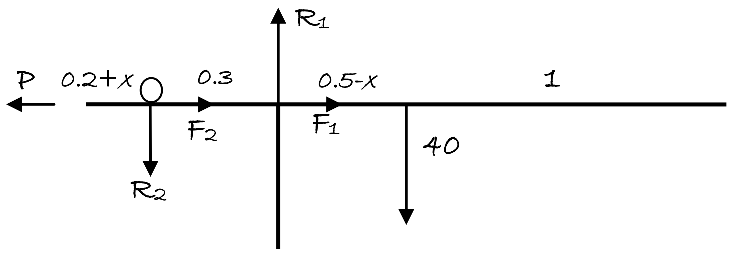
$$F_1 = \mu_1 R_1 = \frac{320}{3}\mu_1$$

$$F_2 = \mu_2 R_2 = \frac{200}{3}\mu_2$$

Resolving horizontally: $P - F_1 - F_2 = 0$

$$P = \tfrac{1}{3}(320\mu_1 + 200\mu_2)$$

(ii) If the plank has moved a distance x to the left:



Taking moments about the fence: $40(0.5 - x) - R_2 \times 0.3 = 0$

$$0.3R_2 = 20 - 40x$$

so R_2 decreases and hence F_2 decreases

Resolving vertically: $R_1 = 40 + R_2$

Since R_2 decreases, R_1 decreases and hence F_1 decreases

So the force required decreases.