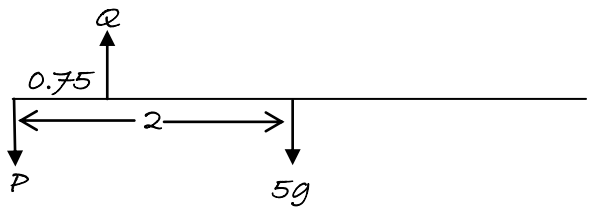
Section 1: The moment of a force

Solutions to Exercise level 2

1.



Taking moments about left-hand end: $0.75Q - 5g \times 2 = 0$

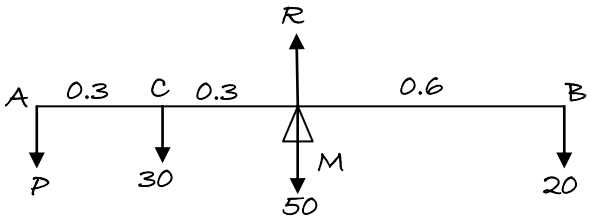
$0.75Q = 10g$

$Q = \frac{40}{3}g$ N upwards

Resolving vertically: $Q - P - 5g = 0$

$P = \frac{40}{3}g - 5g = \frac{25}{3}g$ N downwards

2.



Taking moments about M: $0.6P + 30 \times 0.3 - 20 \times 0.6 = 0$

$0.6P + 9 - 12 = 0$

$0.6P = 3$

$P = 5$

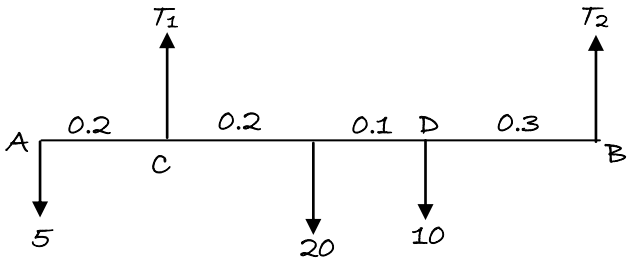
The magnitude of P is 5 N.

Resolving vertically: $R - P - 30 - 50 - 20 = 0$

$R = 100 + P = 105$

The reaction at the fulcrum is 105 N.

3.



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Taking moments about B: $(5\times0.8)+(20\times0.4)+(10\times0.3)-0.6T_1=0$

$$0.6T_1=15$$

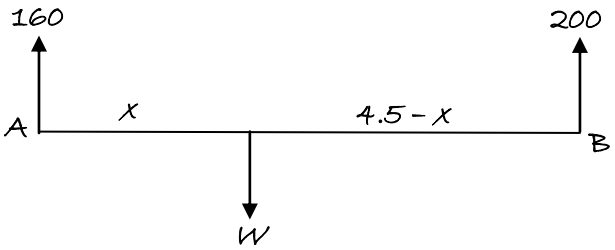
$$T_1=25$$

$T_1+T_2-5-20-10=0$

$T_2=35-25=10$

The tensions in the strings are 25 N and 10 N.

4.



Resolving vertically: $160+200-W=0$

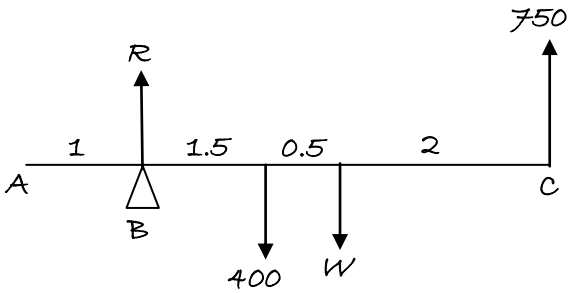
$$W=360$$

Taking moments about A: $(200\times4.5)-Wx=0$

$$360x=900$$

$$x=2.5$$

5. (i)



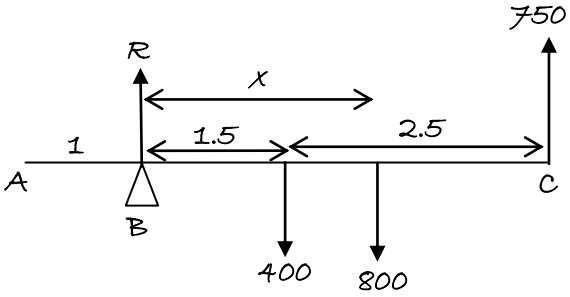
Taking moments about B: $(4\times750)-(1.5\times400)-2W=0$

$$2W=3000-600$$

$$W=1200$$

The maximum weight is 1200 N.

(ii)



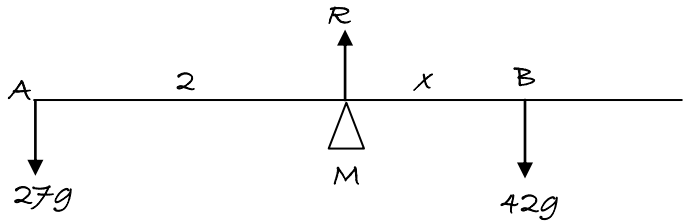
Taking moments about B: $(4\times 750)-(1.5\times 400)-800x=0$

$$800x=2400$$

$$x=3$$

He can walk 3 m from B towards C.

6.

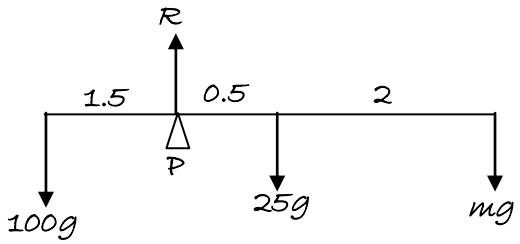


Taking moments about M: $(27g\times 2)-42gx=0$

$$x=\frac{27\times 2}{42}=\frac{9}{7}$$

He must sit $\frac{5}{7}$ m from the other end.

7. (i)



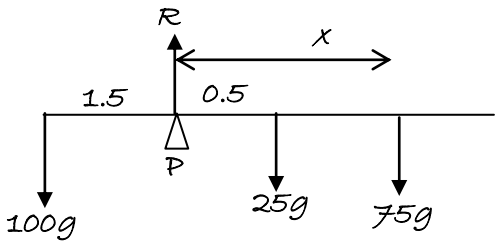
Taking moments about P: $100g\times 1.5-25g\times 0.5-2.5mg=0$

$$2.5m=150-12.5$$

$$m=55$$

The maximum mass is 55 kg.

(ii)



Taking moments about P: $100g\times 1.5-25g\times 0.5-75gx=0$

$$75x=150-12.5$$

$$x=1.83$$

He can walk 1.83 m from the side of the ship.

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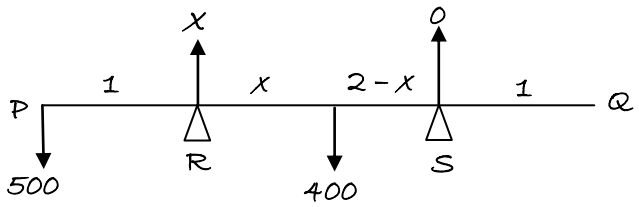
8. (i) If the beam is just about to tip about R, the reaction force at S is zero.

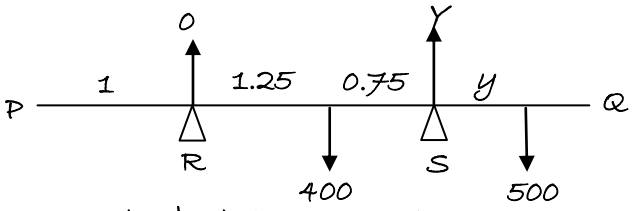


Taking moments about R: $500 \times 1 = 400x = 0$

$x = 1.25$

The centre of mass of the beam is 2.25 m from P.

(ii) The beam will tip about S when the reaction force at R = 0.



Taking moments about S: $400 \times 0.75 - 500y = 0$

$y = 0.6$

He is 0.4 m from Q when the beam is about to tip.